
Annex 1: Policy on Load-Frequency Control and Reserves

Version History Table

Date	Description
14/04/2019	SAFA entry into force
03/12/2019	SAFA Amendment 3 is applied to Article B-1, after SAFA parties' approval
16/07/2020	SAFA Amendment 5 is applied to Article B-1, after SAFA parties' approval SAFA Amendment 6 is applied to Article C-9, after SAFA parties' approval SAFA Amendment 7 is applied to Article C-2-2-6, after SAFA parties' approval
29/09/2020	SAFA Amendment 8 is applied to Article B-6-2, after SAFA parties' approval
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15/06/2021	SAFA amendment 13 is applied to Article C-9, after SAFA parties' approval SAFA amendment 14 is applied to Article C-8, after SAFA parties' approval SAFA amendment 15 is applied to Article B-1-2, after SAFA parties' approval
28/09/2021	SAFA amendment 16 is applied to Article A-2, after SAFA parties' approval
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15/02/2022	Version history table added
11/03/2022	SAFA amendment 20 is applied to Article C-8, after SAFA parties' approval
14/04/2022	Derogations renewed : for MEPSO and EMS from 14.04.2022 to 14.04.2023 and 14.04.2024 Derogations removed : MEPSO, OST, CGES, EMS and NOSBiH derogations expired on 14.04.2022
07/06/2022	SAFA amendment 22 is applied to Article B-1-2, after SAFA parties' approval SAFA amendment 23 is applied to Article C-9, after SAFA parties' approval
20/07/2022	SAFA amendment 12 is applied to Article A-7, after NRAs approval
29/11/2022	SAFA amendment 26 is applied to Article C-9, after SAFA parties' approval
12/01/2023	SAFA amendment 27 is applied to Article B-1-2, after SAFA parties' approval
14/02/2023	SAFA amendment 28 is applied to Article C-5, after SAFA parties' approval
08/11/2023	SAFA amendment 30 is applied to Article B-1-2, after SAFA parties' approval SAFA amendment 31 is applied to Article C-9, after SAFA parties' approval

TABLE OF CONTENTS

Introduction.....	6
A Methodologies, conditions and values subject to all regulatory authorities approval.....	7
A-1 FCR dimensioning according to Article 118(1)(a) SO GL (mandatory & NRA approval)	7
A-2 Additional properties of frequency containment reserves according to Article 118(1)(b) SO GL (optional & NRA approval)	7
A-3 Frequency quality parameters according to Article 118(1)(c) SO GL (optional & NRA approval).....	7
A-4 If Applicable, for Synchronous Areas other than CE, Limits for the Exchange of FCR between the TSOs according to Article 118(1)(t) SO GL (optional & NRA approval).....	7
A-5 Limits on the amount of Exchange and Sharing of FRR between Synchronous Areas according to Article 118(1)(z) SO GL (mandatory & NRA approval).....	7
A-6 Limits on the amount of Exchange and Sharing of RR between Synchronous Areas according to Article 118(1)(aa) SO GL (mandatory & NRA approval).....	8
A-7 Common Proposal per Synchronous Area for the Determination of LFC Blocks in accordance with Article 141(2) (mandatory & NRA approval).....	8
B Methodologies, Conditions and Values Subject to Approval by all TSOs	9
B-1 Frequency Restoration Control Error Target Parameters according to Article 118(1)(d) (mandatory)	9
B-1-1 Calculation of level 1 and level 2 target values	9
B-1-2 List of Frequency Control Error Target Parameters	12
B-2 Methodology to Assess Risk and Evolution of the Risk Exhaustion of FCR according to Article 118(1)(e) SO GL (mandatory).....	18
B-3 Nomination of the Synchronous Area Monitor according to Article 118(1)(f) SO GL (mandatory).....	21
B-4 Calculation of the control program according to Article 118(1)(g) SO GL (mandatory)	21
B-5 Restrictions for the Active Power Output of HVDC Interconnectors according to Article 118(1)(h) SO GL (optional).....	22
B-6 Load-Frequency-Control Structure according to Article 118(1)(i) SO GL (mandatory)	22
B-6-1 Process Responsibility Structure	23
B-6-2 Process Activation Structure.....	24
B-7 Methodology to reduce the electrical time deviation according to Article 118(1)(j) SO GL (mandatory).....	30
B-7-1 Implementation of Time Control.....	31
B-8 Allocation of Responsibilities between the TSOs according to Article 118(1)(k) SO GL (mandatory).....	32

B-9	Operational Procedures to Reduce Frequency Deviation according to Article 118(1)(n) SO GL (mandatory)	33
B-9-1	Extraordinary Procedure in case of Alert State due to a Violation of System Frequency Limits	33
B-10	Roles and responsibilities of the TSOs implementing an imbalance netting process, a cross-border FRR activation process or a cross-border RR activation process according to Article 118(1)(o) SO GL (mandatory)	37
B-10-1	Roles Related to Imbalance netting, Cross-Border Activation of Reserves, Exchange of Reserves and Sharing of Reserves	37
B-10-2	Responsibilities Related to Imbalance netting, Cross-Border Activation of Reserves, Exchange of Reserves and Sharing of Reserves	37
B-10-3	Trial Phase	38
B-11	requirements concerning the availability, reliability and redundancy of the technical infrastructure according to Article 118(1)(p) SO GL (mandatory)	39
B-11-1	Reliability	39
B-11-2	Redundancy	39
B-11-3	Availability	40
B-12	Common Rules for the Operation in Normal State and Alert State according to Article 118(1)(q) SO GL (mandatory)	40
B-13	Roles and responsibilities of the reserve connecting TSO, the reserve receiving TSO and the affected TSO as regards the exchange of FRR and RR according to Article 118(1)(u) SO GL (mandatory)	41
B-14	Roles and responsibilities of the control capability providing TSO, the control capability receiving TSO and the affected TSO for the sharing of FRR and RR according to Article 118(1)(v) SO GL (mandatory)	41
B-15	Roles and responsibilities of the Reserve Connecting TSO, the Reserve Receiving TSO and the Affected TSO for the exchange of Reserves between Synchronous Areas, and of the Control Capability Providing TSO, the Control Capability Receiving TSO and the Affected TSO for the sharing of Reserves according to Article 118(1)(w) SO GL (mandatory)	41
B-16	Technical design of the Frequency coupling Process according to article 172(2) SO GL (MANDATORY)	42
B-17	Methodology to determine limits on the amount of Exchange and sharing of FCR between Synchronous Areas according to Article 173(4) and Article 118(1)(x) SO GL (mandatory)	43
B-17-1-1	Exchange of FCR between Synchronous Areas	43
B-17-1-2	Sharing of FCR between Synchronous Areas	43
C	Methodologies, conditions and values agreed among the Parties	45
C-1	Nomination of special roles	45

C-1-1	Nomination of decision body/bodies	45
C-1-2	Nomination of sub-groups, Working-Groups and Supporting Bodies	45
C-2	Information exchange, reporting and Transparency	45
C-2-1	Information Exchange	45
C-2-2	Reporting	46
C-2-3	Transparency.....	48
C-3	Determination of the K-Factor	49
C-3-1	K-Factor of the Synchronous Area CE	49
C-3-2	K-Factor of the LFC Blocks	50
C-3-3	Adaptation of the K-Factor of the LFC Blocks in case of Exchange of FCR within the Synchronous area.....	50
C-4	Process of FCR Dimensioning	50
C-4-1	Application of the Dimensioning Approach	50
C-5	Online Observation	51
C-5-1	Clarification of Responsibilities	51
C-5-2	List of Variables Subject to Online Observation	52
C-5-3	Observation of the LFC Inputs	54
C-5-4	Observation of Control Programs	54
C-5-5	Observation of Physical Cross-Border Power Flows.....	54
C-5-6	Observation of Flows Through Virtual Tie-Lines	54
C-5-7	Observation of Frequency Deviation	54
C-5-8	Operational Procedure in Case of INSUFFICIENT DATA, POOR DATA QUALITY AND INCONSISTENCY	54
C-5-9	Technical Conditions for the Exchange of Relevant Observation Data	55
C-6	Exchange and Sharing of FCR between Synchronous Areas	55
C-6-1	Definition of Exchange and Sharing	55
C-6-2	General Requirements for Exchange and Sharing of FCR	55
C-6-3	Requirements for Exchange.....	56
C-6-4	Requirements for Sharing	56
C-7	Common Rules for HVDC Ramping between Synchronous Areas	56
C-8	LFC Block Determination for Non-EU TSOs	57
C-9	Limits of LFC block contribution to deterministic frequency deviations	58

INTRODUCTION

This document is part of the Synchronous Area Operational Agreement for the Synchronous Area CE as defined in Article 118 of the guideline on electricity system operation (SO GL) (Part IV LFC&R).

Electricity generation and consumption need to be controlled and monitored for the secure and high-quality operation. Frequency control, Active Power Reserves and the corresponding control performance are essential for TSOs to perform their professional business.

Within the Synchronous Area, the control actions and the reserves are organised in a hierarchical structure with Scheduling Areas, Monitoring Areas, LFC Areas, LFC Blocks and the Synchronous Area with two Coordination Centres.

Control actions are performed by different complementary processes, each relying on reserves with different characteristics and qualities:

- a. Frequency Containment Reserves (FCR) as defined in the Article 3 SO GL correspond to Primary Control Reserves used in the Policy 1 of the MLA OH prior to 2009;
- b. Automatic Frequency Restoration Reserves (aFRR) as defined in the Article 3 SO GL correspond to Secondary Control Reserves used in the Policy 1 of the MLA OH prior to 2009;
- c. Manual Frequency Restoration Reserves (mFRR) as defined in the SO GL Article 3 correspond to Tertiary Control Reserves with an activation time (independent of the time of activation) of at most 15 minutes used in the Policy 1 of the MLA OH prior to 2009;
- d. Replacement Reserves (RR) as defined in the Article 3 SO GL refer to Tertiary Control Reserves which correspond to various types of reserves, e.g. schedule-based tertiary reserves used in the Policy 1 of the MLA OH prior to 2009.

The ENTSO-E Sub Group Coordinated System Operation (SG CSO) and the Sub Group System Frequency (the sub-group or Working-group for Reporting) serve as the common body in the RG CE for agreeing on all operational and organisational matters in the framework of this Load-Frequency Control and Reserves Policy.

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

The following section includes all methodologies, conditions and values jointly developed by all TSOs from the Synchronous Area CE according to Article 118 and which are subject to approval by all regulatory authorities according to Article 6(3) SO GL.

A-1 FCR DIMENSIONING ACCORDING TO ARTICLE 118(1)(A) SO GL (MANDATORY & NRA APPROVAL)

The SAFA-Parties acknowledge that the document “All CE TSOs proposal for the dimensioning rules for FCR 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” that has been approved by all regulatory authorities of the concerned region in accordance with Article 6(2) SO GL on May 28th 2019 is accepted by all Parties and is an integral part of this Agreement.

A-2 ADDITIONAL PROPERTIES OF FREQUENCY CONTAINMENT RESERVES ACCORDING TO ARTICLE 118(1)(B) SO GL (OPTIONAL & NRA APPROVAL)

The Parties acknowledge that the document “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” that has been approved by all regulatory authorities of the concerned region in accordance with Article 6(2) SO GL on June 30th 2021 is accepted by all Parties and is an integral part of this Agreement.

A-3 FREQUENCY QUALITY PARAMETERS ACCORDING TO ARTICLE 118(1)(C) SO GL (OPTIONAL & NRA APPROVAL)

[NO CONTENT]

A-4 IF APPLICABLE, FOR SYNCHRONOUS AREAS OTHER THAN CE, LIMITS FOR THE EXCHANGE OF FCR BETWEEN THE TSOs ACCORDING TO ARTICLE 118(1)(T) SO GL (OPTIONAL & NRA APPROVAL)

[NO CONTENT]

A-5 LIMITS ON THE AMOUNT OF EXCHANGE AND SHARING OF FRR BETWEEN SYNCHRONOUS AREAS ACCORDING TO ARTICLE 118(1)(z) SO GL (MANDATORY & NRA APPROVAL)

The SAFA-Parties acknowledge that the document “All CE TSOs proposal for the limits on the amount of exchange and sharing of FRR between synchronous areas in accordance with Article 176(1) and Article 177(1) of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation” that has been approved by all regulatory authorities of the concerned region in accordance with Article 6(2) SO GL on May 28th 2019 is accepted by all Parties and is an integral part of this Agreement.

A-6 LIMITS ON THE AMOUNT OF EXCHANGE AND SHARING OF RR BETWEEN SYNCHRONOUS AREAS ACCORDING TO ARTICLE 118(1)(AA) SO GL (MANDATORY & NRA APPROVAL)

The SAFA-Parties acknowledge that the document “All CE TSOs proposal for the limits on the amount of exchange and sharing of RR between synchronous areas in accordance with Article 178(1) and Article 179(1) of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation” that has been approved by all regulatory authorities of the concerned region in accordance with Article 6(2) SO GL on May 28th 2019 is accepted by all Parties and is an integral part of this Agreement.

A-7 COMMON PROPOSAL PER SYNCHRONOUS AREA FOR THE DETERMINATION OF LFC BLOCKS IN ACCORDANCE WITH ARTICLE 141(2) (MANDATORY & NRA APPROVAL)

The SAFA-Parties agree that the document “Determination of LFC blocks for the Synchronous Area Continental Europe, in amended version of 11 February 2022” that has been approved by SAFA Parties on 2 February 2022, and subsequently by competent regulatory authorities in accordance with Article 6 (2) SO GL, shall be applied by all SAFA-Parties.

B METHODOLOGIES, CONDITIONS AND VALUES SUBJECT TO APPROVAL BY ALL TSOs

The following section includes all methodologies, conditions and values which were jointly developed by all CE TSOs according to Article 118 of the SO GL and have been approved according to Article 5 of the SO GL on 7 September 2018, but are not subject to approval by the regulatory authorities.

B-1 FREQUENCY RESTORATION CONTROL ERROR TARGET PARAMETERS ACCORDING TO ARTICLE 118(1)(D) (MANDATORY)

The mandatory assessment of the load-frequency control performance of the LFC blocks shall be based on the ACE target parameters and frequency quality evaluation criteria according to the Article 128 and 131 of the SO GL.

The objective behind the level 1 and level 2 parameters is to provide quality targets for the individual ACE quality of each LFC block. Since it is the responsibility of each TSO in its LFC block to keep ACE as low as possible, the level 1 and level 2 parameters must not be exploited in order to reduce reserves or reserves activation. These parameters should rather be interpreted as an absolute warning limit that shows that quality of ACE is below the required standard and that respective countermeasures have been reported and will be implemented urgently.

B-1-1 CALCULATION OF LEVEL 1 AND LEVEL 2 TARGET VALUES

The Subgroup or Working group for reporting shall calculate level 1 and level 2 target parameters for each LFC BLOCK on a yearly basis by using the initial k-Factors as calculated according to C-3.

The methodology is based on the following simplifying assumptions:

- (1) The frequency behaviour can be considered as a sum of two uncorrelated components, the quarter-hourly frequency average (f_{qh}) and the deviation from this average, the frequency noise (Δf_{noise}).
- (2) Both signals, f_{qh} and Δf_{noise} , can be approximately modelled as normal distributions with mean value equal to zero.
- (3) The sum of ACE values of the SYNCHRONOUS AREA is equal to the frequency deviation multiplied with the total K-Factor of the SYNCHRONOUS AREA.
- (4) The ACE behaviour of the LFC BLOCKS is not correlated.
- (5) The ACE of a LFC BLOCK can be approximately modelled as a normal distribution with mean value equal to zero.

The main steps for the calculation of level 1 and level 2 FRCE targets for the individual LFC BLOCKS are the following:

- Calculate the distribution of frequency noise;
- Calculate the distribution of quarter-hourly frequency average values which after convolution with the frequency noise distribution will fulfil the frequency quality target parameter (15000 minutes outside ± 50 mHz).
- Calculate the frequency deviations for the probabilities defined by level 1 and level 2.

- Calculate the shares of each LFC BLOCK proportional to the square root of the respective K-Factor.

The determination of FRCE target parameters is based on frequency data for at least one year with a measurement period equal to or shorter than one second (INSTANTANEOUS FREQUENCY DATA according to SO GL).

In the first step, the average frequency f_{qh} for each quarter of an hour is calculated from the INSTANTANEOUS FREQUENCY DATA.

In order to obtain the frequency deviation noise Δf_{noise} , f_{qh} is subtracted from the frequency f , which is based on the INSTANTANEOUS FREQUENCY DATA, i.e.

$$\Delta f_{noise} = f - f_{qh}$$

SO GL Article 127(3) and Article 127(4) require that the range of ± 50 mHz must not be exceeded for more than 15000 minutes per year. Therefore, in the second step, the range of $\pm r_{noise}$, which must not be exceeded for more than 15000 minutes a year, is estimated based on the assumption of a normal distribution.

The probability p_m of exceeding the 15000 minutes per year is calculated based on the following equation:

$$p = 1 - \left(\frac{\text{time intervals per year outside the range}}{\text{total time intervals per year}} \right)$$

$$p_m = 1 - \left(\frac{7500}{525600} \right) = 0,9857$$

In order to calculate r_{noise} , the standard deviation of Δf_{noise} (σ_{noise}) is estimated from the data and multiplied with the inverse cumulative probability value of p_m . (see Table 2).

$$r_{noise} = \sigma_{noise} \cdot 2.1898$$

SO GL parameters	minutes per year	Probability p_m	inverse cumulative probability value as $c \sigma$
minutes outside standard frequency range (for deviations in one of the directions)	7500 ¹	0.9857	2.1898 σ

Table 2: Minutes per year with the corresponding probability and the inverse cumulative probability as a function of standard deviation.

In the third step, the value r_{qh} , which represents the same range for an allowed normal distribution of the quarter-hourly average frequency deviation, is calculated based on the assumption that the two signals are not correlated:

¹ It is half of the 15000 minutes defined in SO GL as it only refers to the Standard Frequency Range of 50 mHz.

$$r_{qh}[Hz] = \sqrt{(0.05)^2 - r_{noise}^2}$$

In the fourth step, the ranges which correspond to the probabilities required by SO GL Article 128(3) are calculated taking r_{qh} as basis. The probabilities are calculated as follows:

$$p_{qh,Level 1} = 1 - \left(\frac{5256}{35040}\right) = 0,85$$

$$p_{qh,Level 2} = 1 - \left(\frac{876}{35040}\right) = 0,975$$

For the calculation of the ranges, the inverse cumulative probabilities of $p_{qh,Level 1}$ and $p_{qh,Level 2}$ will be used.

SO GL Parameters	qh per year	Probability p_{qh}	inverse cumulative probability value as $c \sigma$
qh outside level 1 ACE range	5256	0.85	1.0364 σ
qh outside level 2 ACE range	876	0.975	1.96 σ

Table 3: Values outside the ranges.

$$r_1[Hz] = r_{qh} \frac{1,0364}{2,1898} \text{ and } r_2[Hz] = r_{qh} \frac{1,96}{2,1898}$$

In the last step, the level 1 and level 2 ranges (L_1 and L_2) are calculated for each LFC BLOCK. With K_{SA} as K-Factor of the Synchronous Area expressed in MW/Hz, K_{FCR} as the total FCR of the Synchronous Area and $K_{FCR,i}$ as initial FCR obligation of LFC BLOCK i, the targets are given by:

$$L_1[MW] = K_{SA} \cdot r_1 \cdot \sqrt{\frac{K_{FCR,i}}{K_{FCR}}}$$

$$L_2[MW] = K_{SA} \cdot r_2 \cdot \sqrt{\frac{K_{FCR,i}}{K_{FCR}}}$$

B-1.1.1 Consideration of imbalance netting and Cross-Border Activation of Reserves

In case of a cross-border activation of reserves, the TSOs of the participating LFC Blocks can agree to take the effect of the cross-border activation into account for their level 1 and level 2 target values according to the B-1.

The definition of level 1 and level 2 target values derived above relies on the assumption that the disturbances of a LFC Block increase with the size of its generation and consumption. This assumption may not be valid for LFC Blocks with altered FRR or RR activation requests due to the implementation of Exchange of Reserves, Sharing of Reserves or Cross-Border

Activation of Reserves. In this case, the participating LFC Blocks may agree to take the effect of the Cross-Border Activation of Reserves or Imbalance Netting into account for the calculation of FRCE target parameters for the evaluation of the FRCE quality.

B-1-2 LIST OF FREQUENCY CONTROL ERROR TARGET PARAMETERS

Values valid from 01.01.2024.

B-1-2 LIST OF FREQUENCY CONTROL ERROR TARGET PARAMETERS

LFC-Block	Belonging LFC-Areas	Level 1	Level 2
AK	OST+KOSTT	27	52
APG	APG	71	135
SHB	NOS BiH, HOPS, ELES	55	105
Elia	Elia	81	153
ESO	ESO	53	100
SG	SG	66	125
CEPS	CEPS	73	139
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	203	384
REE	REE	148	281
RTE	RTE	185	349
IPTO	IPTO	61	115
MAVIR	MAVIR	53	100
TERNA	TERNA	147	279
SMM	CGES, MEPSO, EMS	56	106
TTB	TTB	88	166
PSE	PSE	111	211
REN	REN	60	113
TEL	TEL	63	120
SEPS	SEPS	44	83
TEIAS	TEIAS	155	293
UAMD	Ukrenergo	86	163

Past FCRE target parameters values (for analysis and reporting purposes)

FRCE target parameters 2017:

LFC-Block	Belonging LFC-Areas	Level 1	Level 2
OST	OST	23	44
APG	APG	77	146
SHB	NOS BiH, HOPS, ELES	61	115

Synchronous Area Framework Agreement for Regional Group Continental Europe

Elia	Elia	80	152
ESO	ESO	66	125
SG	SG	80	152
CEPS	CEPS	87	165
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	243	459
REE	REE	190	359
RTE	RTE	231	437
IPTO	IPTO	64	121
MAVIR	MAVIR	51	97
TERNA	TERNA	159	300
SMM	CGES, MEPSO, EMS	69	131
TTB	TTB	101	190
PSE	PSE, Western WPS	126	238
REN	REN	69	130
TEL	TEL	78	147
SEPS	SEPS	50	94
TEIAS	TEIAS	159	301

FRCE target parameters 2018:

LFC-Block	Belonging LFC-Areas	Level 1	Level 2
OST	OST	25	48
APG	APG	78	148
SHB	NOS BiH, HOPS, ELES	64	121
Elia	Elia	88	166
ESO	ESO	63	119
SG	SG	77	145
CEPS	CEPS	86	163
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	248	468
REE	REE	187	354
RTE	RTE	226	427
IPTO	IPTO	64	121
MAVIR	MAVIR	52	98
TERNA	TERNA	159	301
SMM	CGES, MEPSO, EMS	69	131
TTB	TTB	103	194
PSE	PSE, Western WPS	125	236
REN	REN	73	139
TEL	TEL	76	144
SEPS	SEPS	49	93
TEIAS	TEIAS	162	306

FRCE target parameters 2019:

Synchronous Area Framework Agreement for Regional Group Continental Europe

LFC-Block	Belonging LFC-Areas	Level 1	Level 2
OST	OST	25,285	47,817
APG	APG	78,234	147,954
SHB	NOS BiH, HOPS, ELES	64,015	121,062
Elia	Elia	87,887	166,208
ESO	ESO	62,775	118,717
SG	SG	76,883	145,398
CEPS	CEPS	86,080	162,790
TNG, TTG, AMP, 50HZT, EN, CREOS	TNG, TTG, AMP, 50HZT, EN, CREOS	247,631	468,311
REE	REE	187,236	354,093
RTE	RTE	225,851	427,120
IPTO	IPTO	63,851	120,752
MAVIR	MAVIR	52,000	98,340
TERNA	TERNA	158,993	300,682
SMM	CGES, MEPSO, EMS	69,358	131,167
TTB	TTB	102,579	193,993
PSE	PSE, Western WPS	124,964	236,326
REN	REN	73,253	138,533
TEL	TEL	76,336	144,363
SEPS	SEPS	49,310	93,253
TEIAS	TEIAS	161,771	305,934

FRCE target parameters 2020:

LFC-Block	Belonging LFC-Areas	Level 1	Level 2
OST	OST	29	55
APG	APG	87	164
SHB	NOS BiH, HOPS, ELES	71	133
Elia	Elia	93	175
ESO	ESO	65	123
SG	SG	85	161
CEPS	CEPS	91	172
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	256	485
REE	REE	205	388
RTE	RTE	239	452
IPTO	IPTO	60	113
MAVIR	MAVIR	63	119
TERNA	TERNA	181	341
SMM	CGES, MEPSO, EMS	74	140
TTB	TTB	112	212
PSE	PSE, Western WPS	137	258

Synchronous Area Framework Agreement for Regional Group Continental Europe

REN	REN	77	145
TEL	TEL	81	154
SEPS	SEPS	54	103
TEIAS	TEIAS	183	346

FRCE target parameters 2021, from 1 January to 15 June:

LFC-Block	belonging LFC-Areas	Level 1	Level 2
OST	OST	26	49
APG	APG	89	168
SHB	NOS BiH, HOPS, ELES	69	131
Elia	Elia	98	186
ESO	ESO	64	121
SG	SG	86	163
CEPS	CEPS	91	172
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	254	481
REE	REE	206	389
RTE	RTE	238	450
IPTO	IPTO	73	137
MAVIR	MAVIR	64	121
TERNA	TERNA	181	343
SMM	CGES, MEPSO, EMS	74	140
TTB	TTB	113	213
PSE	PSE, Western WPS	135	256
REN	REN	74	141
TEL	TEL	80	151
SEPS	SEPS	55	104
TEIAS	TEIAS	184	348

FRCE target parameters 2021, from 15 June to 31 December:

LFC-Block	belonging LFC-Areas	Level 1	Level 2
OST	OST, KOSTT	36	69
APG	APG	89	168
SHB	NOS BiH, HOPS, ELES	69	131
Elia	Elia	98	186
ESO	ESO	64	121
SG	SG	86	163
CEPS	CEPS	91	172
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	254	481

Synchronous Area Framework Agreement for Regional Group Continental Europe

REE	REE	206	389
RTE	RTE	238	450
IPTO	IPTO	73	137
MAVIR	MAVIR	64	121
TERNA	TERNA	181	343
SMM	CGES, MEPSO, EMS	69	131
TTB	TTB	113	213
PSE	PSE, Western WPS	135	256
REN	REN	74	141
TEL	TEL	80	151
SEPS	SEPS	55	104
TEIAS	TEIAS	184	348

FRCE target parameters 2022, from 1 January to 6 June:

LFC-Block	belonging LFC-Areas	Level 1	Level 2
AK	OST, KOSTT	32	60
APG	APG	89	169
SHB	NOS BiH, HOPS, ELES	69	130
Elia	Elia	96	182
ESO	ESO	63	118
SG	SG	83	158
CEPS	CEPS	89	169
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	250	474
REE	REE	206	389
RTE	RTE	231	436
IPTO	IPTO	72	136
MAVIR	MAVIR	64	122
TERNA	TERNA	178	337
SMM	CGES, MEPSO, EMS	70	133
TTB	TTB	112	213
PSE	PSE, Western WPS	134	254
REN	REN	75	141
TEL	TEL	79	149
SEPS	SEPS	55	104
TEIAS	TEIAS	187	353

FRCE target parameters 2022, from 7 June 2022 to 31 December 2022.

LFC-Block	Belonging LFC-Areas	Level 1	Level 2

Synchronous Area Framework Agreement for Regional Group Continental Europe

AK	OST, KOSTT	32	60
APG	APG	89	169
SHB	NOS BiH, HOPS, ELES	69	130
Elia	Elia	96	182
ESO	ESO	63	118
SG	SG	83	158
CEPS	CEPS	89	169
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	250	474
REE	REE	206	389
RTE	RTE	231	436
IPTO	IPTO	72	136
MAVIR	MAVIR	64	122
TERNA	TERNA	178	337
SMM	CGES, MEPSO, EMS	70	133
TTB	TTB	112	213
PSE	PSE	132	249
REN	REN	75	141
TEL	TEL	79	149
SEPS	SEPS	55	104
TEIAS	TEIAS	187	353
UAMD	Ukrenergo	123	233

FRCE target parameters 2023, from 1 January 2023 to 30 April 2023.

LFC-Block	Belonging LFC-Areas	Level 1	Level 2
AK	OST, KOSTT	32	60
APG	APG	89	169
SHB	NOS BiH, HOPS, ELES	69	130
Elia	Elia	96	182
ESO	ESO	63	118
SG	SG	83	158
CEPS	CEPS	89	169
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	250	474
REE	REE	206	389
RTE	RTE	231	436
IPTO	IPTO	72	136
MAVIR	MAVIR	64	122
TERNA	TERNA	178	337
SMM	CGES, MEPSO, EMS	70	133
TTB	TTB	112	213
PSE	PSE	132	249
REN	REN	75	141
TEL	TEL	79	149
SEPS	SEPS	55	104

Synchronous Area Framework Agreement for Regional Group Continental Europe

TEIAS	TEIAS	187	353
UAMD	Ukrenergo	123	233

FRCE target parameters 2023, from 3 May 2023 to 31 December 2023.

LFC-Block	Belonging LFC-Areas	Level 1	Level 2
AK	OST, KOSTT	31	58
APG	APG	76	145
SHB	NOS BiH, HOPS, ELES	61	115
Elia	Elia	85	160
ESO	ESO	56	106
SG	SG	71	134
CEPS	CEPS	79	149
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	220	416
REE	REE	156	295
RTE	RTE	205	387
IPTO	IPTO	66	124
MAVIR	MAVIR	57	107
TERNA	TERNA	157	297
SMM	CGES, MEPSO, EMS	61	116
TTB	TTB	95	179
PSE	PSE	119	225
REN	REN	64	121
TEL	TEL	70	132
SEPS	SEPS	49	93
TEIAS	TEIAS	165	312
UAMD	Ukrenergo	82	156

B-2 METHODOLOGY TO ASSESS RISK AND EVOLUTION OF THE RISK EXHAUSTION OF FCR ACCORDING TO ARTICLE 118(1)(E) SO GL (MANDATORY)

The methodology to assess the risk of exhaustion of FCR is based on a probabilistic approach and takes into account the probability of FCR deployment due to the following operational situations:

- forced instantaneous outages of generation modules, HVDC interconnectors between two synchronous areas and substations/bus bars which connect two generation units/blocks: modelled by a probability density function, calculated by using a one-minute sequential Monte Carlo simulation.
- Imbalances due to changes in demand, renewable generation, long lasting Frequency Deviation events or the market-induced Imbalances: modelled by a probability density

function calculated using the worst 15-seconds average Frequency Deviation data (15-seconds is equal half time of Full Activation Time [FAT] for FCR) for every minute of the last year.

The probability density function of the total amount of FCR needed is the convolution of the previous probability density functions. Therefore, the risk of exhaustion of FCR will be the number of events in 20 years (10.512.000 minutes) in which the FCR need is larger than the FCR dimensioned.

This methodology is described in the following paragraphs.

STEP 1. Calculation of the probability density function of FCR required due to generation tripping

This calculation shall be carried out using a probabilistic assessment with the aim of determining which is the largest expected FCR spent due to generation/in-feed loss for a certain number of years.

Starting from a generation scenario and the trip probability of each unit, a Monte Carlo simulation shall be performed for every minute in the period considered in order to calculate the amount of FCR required due to generation trips. This simulation is time sequential, since it is essential to model that the FCR used in one minute to counteract an Imbalance in the previous minute will not be instantly recovered, and there is a probability for another unit to trip before the FCR has been replaced by the Frequency Restoration Reserves (FRR).

The following assumptions shall be taken into account:

- a peak hour generation scenario modelled, considering exclusively units larger than 600 MW, operating at full capacity. Consequently, a generation trip is equivalent to the full loss of the generation capacity of one single unit;
- the generation trips occur independently from each other, except for generating units located in the same plant or that are connected to the network on the same node;
- the reconnection time of the units that have tripped is assumed to be at least larger than 30 minutes. This is based on the consideration that the unit that tripped will not be reconnected and partially compensate the Imbalance it has caused within the time of deployment of FRR;
- the trip probability of each generation unit is constant in time and is assumed to follow this Poisson distribution:

$$p(\lambda) = 1 - e^{\frac{-\lambda}{525600}}$$

Where p is the probability of tripping of the unit in a certain minute and λ is the number of trips per year of the unit. The number of trips per year must be divided by the number of minutes in a year (525.600 for a non-leap year) as the probability to be calculated is the probability in each minute;

- the used probability of failure of generating units will be based on historical data provided by each LFC block, and yearly updated. Also, the expected rate of relevant simultaneous outages (i.e. simultaneous tripping of large units due to cooling issues, bus-bar or substation trips affecting several units, etc.) is provided according to historical values;
- the FRR deployment is approximated to a first order linear system with a FAT based on historical values. The deployment of FRR replaces, for each minute, the correspondent part of the deployed FCR in the previous minute;
- the time-sequential Monte Carlo simulation shall be performed considering at least 10^8 minutes (≈ 190 years) with a granularity of 1 minute.

STEP 2. Calculation of the probability density function of FCR required due to other causes than generation tripping

The expected FCR in use when the generation trip occurs due to fast demand changes, RES or – mainly – deterministic Frequency Deviations shall be modelled, and taken into account in order to calculate the total risk of exhaustion of FCR.

The following assumptions will be taken into account:

- The deployment of FCR shall be proportional to the Frequency Deviation in quasi-steady state after the dynamic effects of the Imbalance have disappeared. Since the minimum available FCR at all times is 3000 MW and the quasi-steady state Frequency Deviation is 0.2 Hz, then the proportional constant between the FCR used and Frequency Deviations is 15000 MW/Hz;

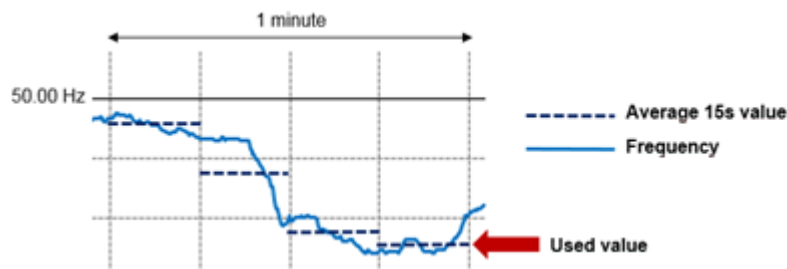


Figure 1: Worst 15-seconds average Frequency Deviation

- The data used to calculate this expected use of FCR shall consider the worst 15-seconds average Frequency Deviations for each minute of the last year. In order to avoid taking into account deviations due to large generation trips twice, the 15 minutes after a generation loss recorded according to observation of outages shall be discarded

STEP 3. Calculation of the total required FCR

The probability density function of the total FCR required shall be calculated as the convolution of the probability distribution of FCR demand due to generation tripping, and the probability distribution of FCR in use due to previous Imbalances.

Therefore, the number of events in which the FCR demand is larger than the FCR dimensioned (i.e. the risk of FCR exhaustion) is given by the following expression:

$$risk\ of\ FCR\ exhaustion = F_{FCR}(x) \cdot 10.512.000$$

Where $F_{FCR}(x)$ is the cumulative distribution function of the previous convoluted function where the FCR demand is larger than the FCR dimensioned, i.e.

$$F_{FCR}(x) = \int_x^{\infty} f$$

f being the probability distribution of the total FCR needed.

Values larger than 1 means a risk of FCR exhaustion higher than once in twenty years.

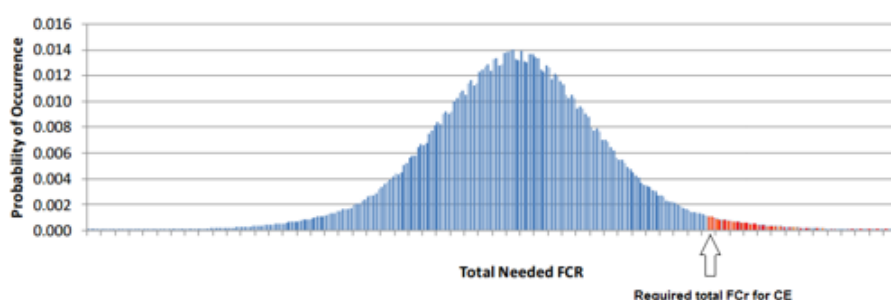


Figure 2: Probability distribution of the total FCR

B-3 NOMINATION OF THE SYNCHRONOUS AREA MONITOR ACCORDING TO ARTICLE 118(1)(F) SO GL (MANDATORY)

The Coordination Centres shall fulfil the obligations of the synchronous area monitor according to Article 133 of the SO GL by assigning specific tasks to the SG SF. Such tasks shall be jointly specified between the Synchronous Area Monitor and SG SF.

B-4 CALCULATION OF THE CONTROL PROGRAM ACCORDING TO ARTICLE 118(1)(G) SO GL (MANDATORY)

In accordance with Article 136 of SO GL, the ramping period for ACE calculation in synchronous area CE is defined as follows:

- the starting point of the ramping period of the control program is 5 minutes before the control program changes;
- the ending point of the ramping period of the control program is 5 minutes after the control program changes;
- the length of the ramping period is 10 minutes, the ramping is linear.

The control program (e.g. for power exchanges and frequency set-points) must be entered into the LFC input and ACE calculation as time-dependant set-point values of the netted area AC position of the LFC area. An example for an hourly exchange schedule is given in Figure 3.

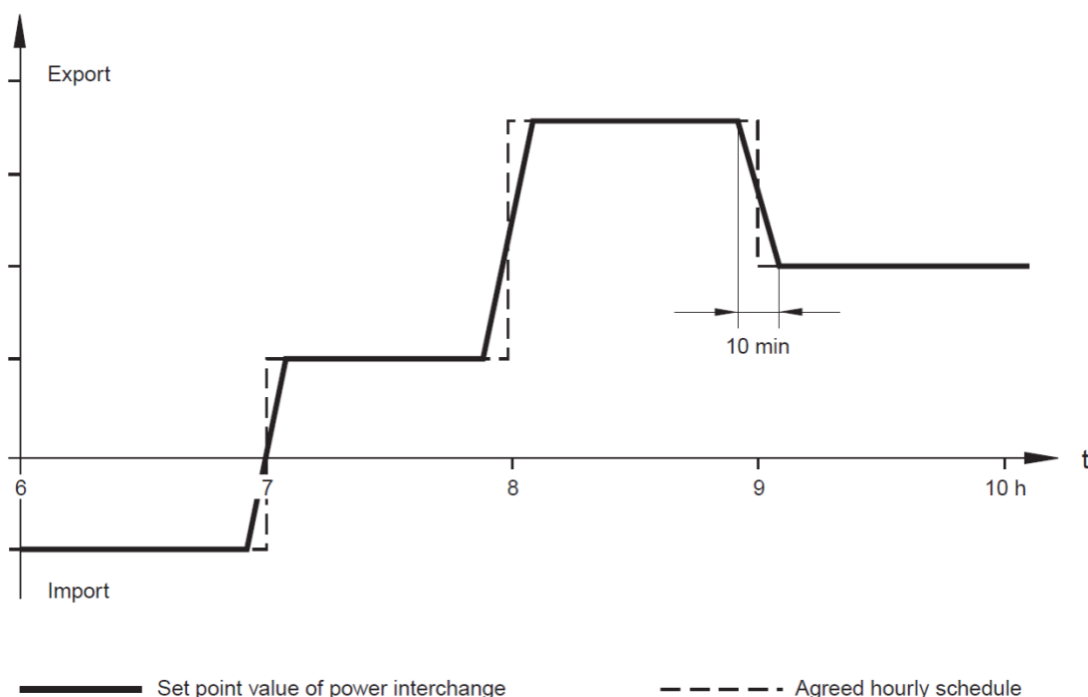


Figure 3: Example for an hourly control program

For avoidance of doubt, the ramping period shall apply to any change of control program: market, countertrading, cross-border redispatch, balancing program interchange, offset in case of application of the Extraordinary Procedure.

In order to prevent unintentional Frequency Deviations and major control actions under undisturbed conditions, TSOs are required to maintain careful compliance with times for program changes, particularly where changes in the exchange programs of several hundred MW are involved. In particular, care must be taken to ensure that generating capacity is brought on line or disconnected on a staggered basis.

Ramping should be considered by each TSO of a LFC area in order to minimize the activation of active power reserves, the magnitude of the ACE and the corresponding Frequency Deviation. This could be reflected, for example, with financial incentives or operational requirements provided by TSO to generating units to follow the defined ramping requirements.

B-5 RESTRICTIONS FOR THE ACTIVE POWER OUTPUT OF HVDC INTERCONNECTORS ACCORDING TO ARTICLE 118(1)(H) SO GL (OPTIONAL)

[NO CONTENT]

B-6 LOAD-FREQUENCY-CONTROL STRUCTURE ACCORDING TO ARTICLE 118(1)(I) SO GL (MANDATORY)

In accordance with Article 139 of the SO GL, the SAFA Parties hereby define for the Synchronous Area CE:

- the Process Responsibility Structure; and
- the Process Activation Structure.

B-6-1 PROCESS RESPONSIBILITY STRUCTURE

B-6-1-1 LIST OF MONITORING AREAS, LFC AREAS AND LFC BLOCKS

The current Process Responsibility Structure according to Article 141 of the SO GL is defined in Article A-7 *LFC Block Determination*.

The operation of Load-Frequency Control processes is based on operational areas, where every area has its own responsibilities in the LFC structure. The overall body is the Synchronous Area in which frequency and phase are the same for the whole area. The Synchronous Area CE consists of several LFC Blocks, each LFC Block consists of one or more LFC Areas. An LFC Area itself consists of one or more Monitoring Areas, which also consist of one or more Scheduling Areas.

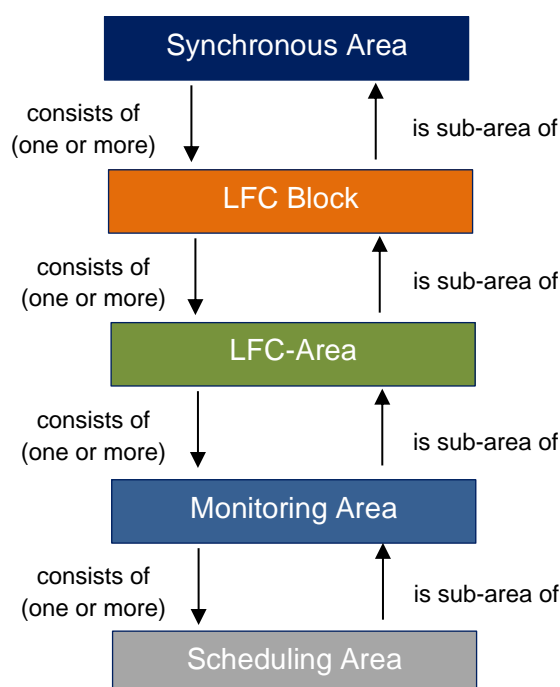


Figure 4: Hierarchy of operational areas

The above described hierarchy is illustrated in Figure 4: Hierarchy of operational areas. Each of these operational areas have its own obligations. A Scheduling Area is responsible for the scheduling process in that area. A Monitoring Area has in addition to the scheduling the obligation to calculate and measure the active power interchange in real-time in that area. An LFC Area has the additional obligation to fulfil the Frequency Restoration Control Error Target Parameters by using the Frequency Restoration Process (FRP).

A LFC Block is additionally responsible for the dimensioning of FRR and RR. The Synchronous Area has the obligation to fulfil the Frequency Restoration Control Error Target Parameters by using the Frequency Containment Process (FCP).

B-6-1-2 DEMARCATION OF SCHEDULING AREAS, MONITORING AREAS, LFC AREAS AND LFC BLOCKS

Each TSO operating a Monitoring Area, a LFC Area or a LFC Block shall cooperate with TSOs of neighbouring Monitoring Areas, LFC Areas and LFC Blocks

- to demarcate its areas by the position of physical points of measurement of the interchanged power over Tie-Lines and Virtual Tie-Lines;
- the TSOs operating a Tie-Line shall agree on one physical measurement point which serves as the common point of control for both TSOs;
- the TSOs operating a Tie-Line shall agree on a fall-back physical measurement point;
- to declare the list of Tie-Lines and Virtual Tie-Lines of each Monitoring Area, LFC Area and LFC Block in operation (including transmission lines and transformers of the different voltage levels between the areas) to the SG CSO and
- to maintain and update the list of Tie-Lines and Virtual Tie-Lines.

B-6-1-3 CONNECTION OF POWER GENERATING MODULES AND DEMAND FACILITIES VIA VIRTUAL TIE-LINES

Two or more TSOs of more than one LFC Areas are allowed to agree on cross-border operation of Power Generating Modules or Demand Facilities through Virtual Tie-Lines. In this case, a share of the respective Active Power output shall be transferred through the Virtual Tie-Line.

B-6-2 PROCESS ACTIVATION STRUCTURE

The Process Activation Structure of the synchronous area CE according to Article 140 of the SO GL includes mandatory processes:

- the Frequency Containment Process (FCP);
- the Frequency Restoration Process (FRP) and
- the Time Control Process.

Furthermore, there are optional processes:

- the Reserve Replacement Process (RRP);
- the Imbalance Netting Process operated by the IN-Platform²;
 - the cross-border imbalance netting power interchange is defined as an active power flow over a virtual tie-line.
- the cross-border mFRR Activation Process operated by the mFRR-Platform³;
 - the mFRR Platform supports both direct and scheduled mFRR activation for the participating TSOs cooperating within an LFC area.
 - the cross-border mFRR power interchange is defined by the mFRR-Platform and is used optionally per LFC Area by adjusting a control program or defining an active power flow over a virtual tie-line.
- the cross-border aFRR Activation Process operated by the aFRR-Platform⁴.

² The Imbalance Netting Process is operated technically by the aFRR-Platform after the aFRR-Platform Go-live, as described in the Figure 5.

³ Before mFRR-Platform Go-live, optional processes of cross-border mFRR activation may exist between LFC areas and shall follow the same principles as described in the Figure 5, for direct and schedule mFRR activation.

⁴ Before aFRR-Platform Go-live, optional processes of imbalance netting and cross-border aFRR activation may exist between LFC areas and shall follow the same principles as described in the Figure 5, for cross-border aFRR activation (except the performance of a coordinated FRCE calculation).

- the cross-border aFRR power interchange is defined as an active power flow over a virtual tie-line.
 - the cross-border RR Activation Process operated by the RR-Platform.
 - the cross-border RR power interchange is defined by adjusting a control program.
- In case of applying a cross-border aFRR activation process, the FRCE is recalculated in a coordinated manner by the aFRR-Platform in order to reflect the remaining imbalance of the LFC area resulting only from imbalances of this area. The recalculation of FRCE uses the following inputs: the Virtual Tie-Line(s) involved in the cross-border exchange process, the set-points of FRR activation and the estimated FRR activation.

At any time, the calculation of FRCE is mandatory for an LFC Area. When there is no coordinated calculation of FRCE, the ACE (equal to the FRCE) for an LFC Area is directly determined as equal to the opposite of the LFC input according to Figure 5.

The Process Activation Structure of the Synchronous Area CE is implemented in each LFC Area according to the control process in

- the control error, i.e. input, of the FCP is the Frequency Deviation;
- the control error, i.e. input, of aFRP is the LFC input of an LFC Area;
- the mFRP and RRP are manually triggered by the TSO in order to release or to supplement aFRP based on observed or expected imbalances;
- optionally, optimization of local aFRP may be introduced leading to additional aFRR activation (e.g. predictive aFRR activation).

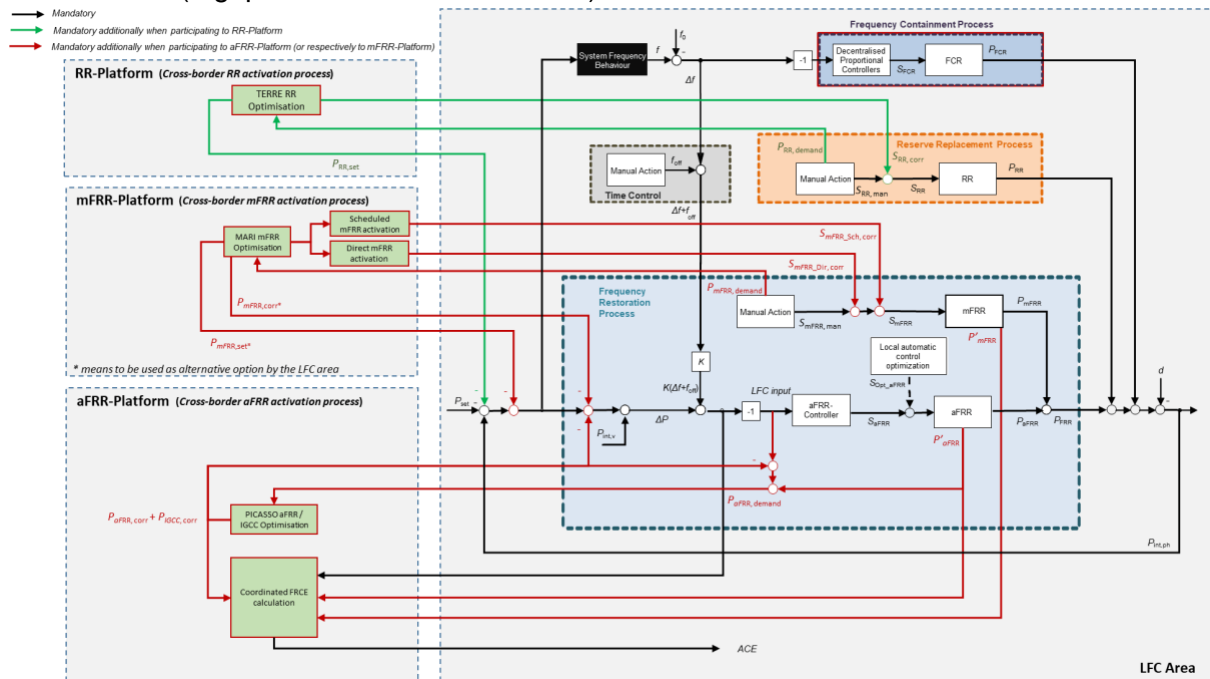


Figure 5: Control Process⁵

Variable	Short Description and Sign Conventions
ACE	The ACE represents the individual remaining imbalance the LFC area is responsible for. In case of coordinated FRR activation the ACE may differ to the LFC Input and be

⁵ The mandatory ACE arrow leading to the box of this coordinated calculation is only mandatory when there is no coordinated FRCE calculation.

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	recalculated in coordinated manner. Without coordinated FRCE calculation, the ACE corresponds to the opposite of the LFC Input.
<i>FRCE</i>	equals the ACE (only for RG CE).
<i>d</i>	Disturbance observed in the system due to change of production versus consumption (in MW); <i>d</i> reflects the effect of a disturbance on the cross-border physical flow deviation compared to a balanced situation.
f_0	Nominal System Frequency of the Synchronous Area. The Nominal System Frequency is equal to 50 Hz.
f	System Frequency of the Synchronous Area measured in Hertz (Hz).
$\Delta f = f - f_0$	Frequency Deviation.
f_{off}	Frequency Offset used for Time Control. Positive if the Synchronous Time is behind UTC.
$f_{set} = f_0 + f_{off}$	Reference frequency set-point of the Synchronous Area in Hz equal to the sum of Nominal Frequency of the Synchronous Area and the Frequency Offset used for Time Control.
<i>K</i>	the K-Factor defined in MW/Hz is an estimation for the change of Active Power output of a LFC Area resulting from a Frequency Deviation, i.e. including FCR, self-regulation, etc.
$K(\Delta f + f_{off})$	the Frequency Control Error is the estimation for the actual amount of Active Power which is adjusted in the LFC Area in response to the System Frequency to $f_{set} = f_0 + f_{off}$.
$LFC\ Input = -(\Delta P + K(\Delta f + f_{off}))$	the LFC Input is the opposite of the sum of the Power Control Error and the Frequency Control Error. The LFC Input is the input of the aFRR controller.
P_{set}	set-point power interchange of a LFC Area calculated from the ramped Control Program, positive in case of export.
$P_{int,ph}$	sum of the active power flows over physical Tie-Lines ($P_{T,ph}$) of the LFC Area (positive in case of export).
$P_{int,v}$	sum of the active power flows over Virtual Tie-Lines of the LFC Area (positive in case of export) excluding the correction signals from common optimization platforms for Imbalance Netting, aFRR energy exchange and mFRR energy exchange.
$\Delta P = (P_{int,ph} - P_{IGCC,corr} - P_{aFRR,corr} - P_{mFRR,corr} + P_{int,v}) - P_{set} - P_{set,RR} - P_{set,mFRR}$	the Power Control Error is the deviation between the set-point power interchange of the LFC Area (including the interchange of cross-border RR and mFRR activation) and the sum of the Active Power flows over Tie-Lines (physical and virtual, and including the correction signals for Imbalance Netting, cross-border aFRR and mFRR activation).
S_{FCR}	set-point for activation of FCR
S_{RR}	set-point for activation of RR sent to the RR provider defined as the sum of $S_{RR,man}$ and $S_{RR,corr}$ when applicable.
S_{mFRR}	set-point for activation of mFRR sent to the mFRR provider defined as the sum of $S_{mFRR,man}$, $S_{mFRR,Dir,corr}$ and $S_{mFRR,Sch,corr}$ when applicable.
S_{aFRR}	set-point for activation of aFRR sent to the aFRR provider.
$S_{Opt,aFRR}$	set-point for local optimization of aFRR activation.

P_{FCR}	activated FCR delivered by the FCR providers.
P_{RR}	activated RR delivered by the RR providers.
P_{FRR}	activated FRR delivered by the FRR providers.
P_{aFRR}	activated aFRR delivered by the aFRR providers.
P_{mFRR}	activated mFRR delivered by the mFRR providers.
$S_{RR, man}$	set-point for activation of RR deriving from manual action sent to the RR provider.
$P_{RR, demand}$	demand of RR.
$S_{RR, corr}$	corrected set-point for activation of RR sent to the RR provider.
$P_{set, RR}$	set-point power interchange of RR cross-border activation.
$S_{mFRR, man}$	set-point for activation of mFRR deriving from manual action sent to the mFRR provider.
$P_{mFRR, demand}$	demand of mFRR.
$S_{mFRR_Dir, corr}$	corrected set-point for direct activation of mFRR sent to the mFRR provider.
$S_{mFRR_Dir, corr}$	corrected set-point for scheduled activation of mFRR sent to the mFRR provider.
$P_{mFRR, corr}$	mFRR Correction value representing the active power flows of cross-border mFRR activation over a Virtual Tie-Line of the LFC Area (positive in case of export)
$P_{set, mFRR}$	set-point power interchange of mFRR cross-border activation.
P'_{mFRR}	estimation of activated mFRR delivered by the mFRR providers.
$P_{aFRR, demand}$	demand of aFRR (positive in case of upward demand).
$P_{aFRR, corr}$	aFRR Correction value representing the active power flows of cross-border aFRR activation over a Virtual Tie-Line of the LFC Area (positive in case of export)
$P_{IGCC, corr}$	IN Correction value, for IGCC ("International Grid Control Cooperation"), representing the active power flows of imbalance netting over a Virtual Tie-Line of the LFC Area (positive in case of export)
P'_{aFRR}	Estimation of activated aFRR delivered by the aFRR providers.

Table 1: Short Descriptions and Sign Conventions

B-6-2-1 FREQUENCY CONTAINMENT PROCESS

B-6-2-1-1 IMPLEMENTATION OF THE CONTROL FUNCTION

Each TSO of each LFC Area shall implement the FCP and organise the availability of the corresponding reserves, according to Article 142 of the SO GL.

B-6-2-2 IMPLEMENTATION OF THE FREQUENCY RESTORATION PROCESS (FRP)

B-6-2-2-1 IMPLEMENTATION OF THE CONTROL FUNCTION

Each TSO of each LFC Area shall implement the FRP with a respective load-frequency controller and organise the availability of the respective reserves.

The FRR shall be used for the FRP, according to Article 143 of the SO GL, in order to regulate the ACE to zero, other purposes, for example, the minimisation of unintentional energy exchange, are not allowed.

B-6-2-2-1-1 LOAD-FREQUENCY CONTROLLER

The load-frequency controller shall have proportional-integral behaviour. The controller parameter shall reflect the dynamic properties of the aFRR. The typical values for the load-frequency controller parameters are:

- 0 % to 50 % for the proportional term;
- 50 s to 200 s for the integral term; and
- 1 s to 5 s for the controller cycle time.

All TSOs shall provide the load-frequency controller parameters to the Synchronous Area Monitor on a yearly basis or if the parameters significantly change.

B-6-2-2-1-2 ACCURACY OF MEASUREMENTS

To ensure consistent calculations of the ACE:

- the accuracy and sensitivity of frequency measurement shall be at least 1 mHz;
- the accuracy of the active power measurements on each Tie-Line must be better than 1.5 % of its highest rated value (the complete measurement range, including discretisation);
- the controller cycle, i.e. refresh rate, shall not exceed 5 s;
- it is recommended that the transmission latency from measurement equipment of the tie-lines to the SCADA system does not exceed 1 s.

B-6-2-2-1-3 LOAD-FREQUENCY CONTROLLER CLOCK:

Each TSO shall implement a synchronisation of the load-frequency controller clock to a reference time.

B-6-2-2-1-4 OPERATION MODES OF THE LOAD-FREQUENCY CONTROLLER:

The load-frequency controller shall include the following operation modes:

1. Normal Operation Mode: In Normal Operation Mode the LFC input of the LFC Area "i" is calculated as the sum of the Power Control Error and the Frequency Control Error.

$$LFC\ input_i = - \left(\sum_{j \in \Omega_i} (P_{Tph,i}^j) - P_{set} + K_i(f - f_{set}) \right) \quad (1)$$

where Ω_i corresponds to the set of the tie lines of the LFC area i

2. Frequency Control Mode: In Frequency Control Mode the LFC input of the LFC Area "i" is equal to the Frequency Control Error (the Power Control Error is omitted).

$$LFC\ input_i = - K_i(f - f_{set}) \quad (2)$$

4. Frozen Control Mode: In Frozen Control Mode the output of the load-frequency controller of the LFC Area "i", and thus the set-point for the activation of aFRR, remains constant (ACE is not controlled).

$$S_{aFRR,i} = const. \quad (4)$$

5. Manual Control Mode: In Manual Control Mode one or more Tie-Line measurements, Power Control Error, Frequency Control Error and/or the output of the load-frequency controller of the LFC Area "i" is overwritten by a manually defined value.

The controller is deactivated meaning that there is a fixed set-point for activation of aFRR. This fixed set point and the actual value of this set point should be able to ramp up or down to another value. A possible value can be zero.

$$LFC\ input_i(t) = - \left(\Delta P_i^{manual}(t) + \Delta f^{manual}(t) \right) \quad (6)$$

Additional recommendations:

It is recommended that the load-frequency controller includes the following operation mode

3. Tie-Line Control Mode: In Tie-Line Control Mode the LFC input of the LFC Area i is equal to the Power Control Error (the Frequency Control Error is omitted).

$$LFC\ input_i = - \left(\sum_{j \in \Omega_i} \left(P_{T_{phi}^j}^j \right) - P_{set} \right) \quad (3)$$

B-6-2-2-1-5 AFRR MINIMUM AMOUNT RECOMMENDATION:

Additional recommendations:

The amount of aFRR is the range of adjustment within which the load-frequency controller can operate automatically, in both directions (positive and negative) at the time concerned, from the working point of the FRR.

The amount of the aFRR that is needed typically depends on the size of load variations, schedule changes and generating units. In this respect, the recommended minimum amount of aFRR has to ensure:

- that the positive aFRR is larger than the 1st percentile of the difference⁶ of the 1-minute average ACEol⁷ and the 15 minute average ACEol of the LFC Block of the corresponding quarter of hour⁸, and
- that the negative aFRR is larger than the 99th percentile of the difference of the 1-minute average ACEol and the 15 minute average ACEol of the LFC Block of the corresponding quarter of hour.

This recommended statistical approach is based on historical data.

An alternative approach based on empiric noise management (recommended in the former UCTE) may also be taken into account leading to recommended minimum amount of aFRR given in the following

⁶ Difference to be calculated on 1-minute resolution

⁷ **ACEol** means remaining ACE open loop without contribution of mFRR and RR activations.

⁸ To be calculated between minutes 0:00-14:59, 15:00-29:59, 30:00-44:59, 45:00-59:59 of each hour of the day.

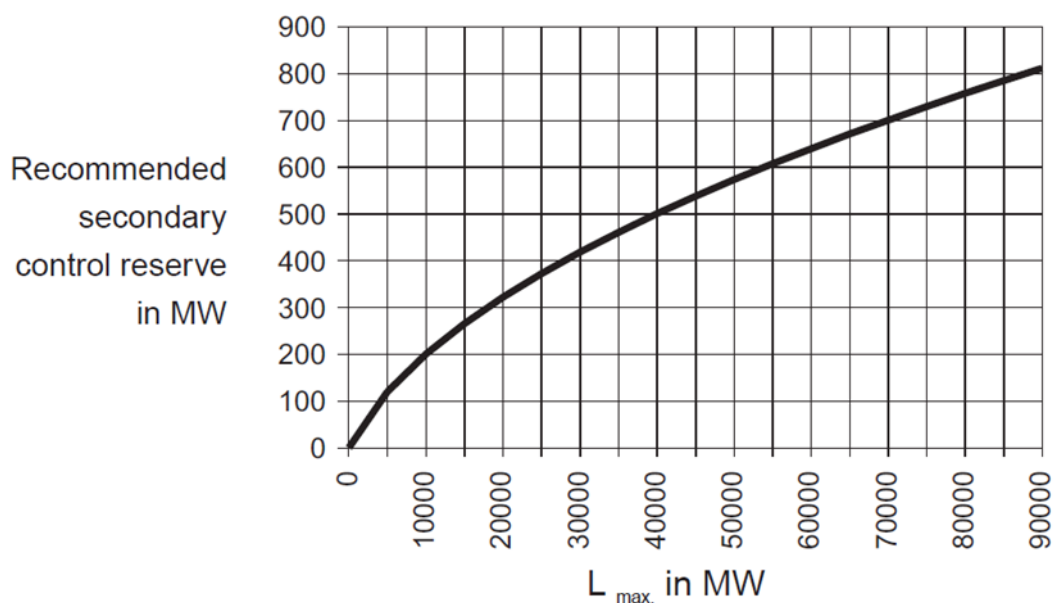


Figure 6: Recommended minimum aFRR reserve in the former UCTE

with L_{max} being the maximum anticipated consumer load for an LFC Area over the period considered.

A comparison between the new and the legacy recommendation for data between 2010 and 2014 resulted in comparable amounts per LFC Block; however, the new recommendation is considered more future-proof as it implicitly considers not only peak load, but all Imbalances. Both approaches may also be combined.

B-7 METHODOLOGY TO REDUCE THE ELECTRICAL TIME DEVIATION ACCORDING TO ARTICLE 118(1)(J) SO GL (MANDATORY)

At the synchronous area level, the electrical system operation is based on Active Power control with the aim of maintaining continuously the equilibrium between consumption and generation. In this process, the global parameter controlled is the system frequency meaning the number of times that the repeated event (voltage wave cycle) occurs per unit time (1 second). Whichever is the adopted control process structure for the repeated phenomena (frequency or time of voltage wave cycle) the performance for a long term period is the deviation of the electrical time from a time reference. In this sense, the final evaluation and control refers at the same values: time as integration of period of voltage wave and time etalon as Universal Time Control (UTC). The integration of frequency / voltage time period is considered the electrical time or the Synchronous Time (the electrical time of the Synchronous Area). If the Nominal Frequency is 50 Hz, the voltage time period represents 1/50 Hz-1 or 20 ms.

The responsibilities of the Synchronous Area Monitor according to Article 181(3) of the SO GL are fulfilled by the Time Monitor that shall act as a service provider for the Synchronous Area Monitor.

A long term integration of Nominal Frequency is absolute interval of astronomical time, while that same time integration of real voltage time period (frequency) has a different value. This difference serves in the majorities of the Synchronous Area as a performance indicator for the real time operating of the structure of control and maintaining the system power equilibrium.

During the normal operation, the average System Frequency usually deviates from its nominal value. These deviations can be the consequences of different events which occur in system operation and typically controlled by the Frequency Restoration Process (FRP). Even in normal operation due to the fact that the Frequency Deviation cannot be controlled exactly to zero, especially in presence of Imbalances pointing in one direction. Thus, electrical time deviations cannot be avoided and have to be controlled. This task shall be carried out by the Time Monitor, which has the obligation to monitor the electrical time deviation and based on that to calculate the new frequency set point for the Synchronous Area.

Moreover, significant electrical time deviations are proportional to the energy amount delivered due to FCR activation.

B-7-1 IMPLEMENTATION OF TIME CONTROL

B-7-1-1 FREQUENCY SET-POINT

The actual frequency set-point value for time control shall be used in the frequency restoration controller for the calculation of the Frequency Deviation in order to limit the deviation between Synchronous Time and UTC. The frequency set-point value shall be calculated by the Time Monitor, which is a TSO that continuously monitors the deviation between Synchronous Time and Universal Coordinated Time (UTC).

B-7-1-1-1 FREQUENCY SET-POINT VALUE

The frequency set-point value has to be calculated by the Time Monitor out of the sum of the nominal frequency 50 Hz and the time correction Frequency Offset and is valid for all hours of the next day, starting at 00:00 or as agreed otherwise by the Synchronous Area Monitor. All TSOs have to apply the transmitted frequency set-point value in their frequency restoration controller for the full next day.

B-7-1-2 MEAN FREQUENCY VALUE

The Time Monitor measures the Electrical Time Deviation, defined as the time discrepancy between Synchronous Time and UTC. The Time Monitor establishes and distributes accordingly the frequency set-point to all LFC blocks of the Synchronous Area. In case of an exceptional range of discrepancy as described below, the Time Monitor should trigger the applicable escalation process.

B-7-1-3 RANGE OF DISCREPANCY

B-7-1-3-1 TOLERATED RANGE OF DISCREPANCY

A discrepancy between Synchronous Time and UTC is tolerated within the range of ± 20 s (without need for time control actions).

B-7-1-3-2 CORRECTION RANGE OF DISCREPANCY

The discrepancy between Synchronous Time and UTC is within the range of ± 20 s and ± 60 s for which time control actions have to be applied.

B-7-1-3-3 EXCEPTIONAL RANGE OF DISCREPANCY

Under exceptional conditions the discrepancy between Synchronous Time and UTC is beyond the range of ± 60 s and exceptional time correction frequency offsets may be applied as described below.

B-7-1-4 TIME DEVIATION CALCULATION

The Time Deviation between Synchronous Time and UTC has to be calculated for 10 a.m. each day by the Time Monitor. The relevant time zone is the Central European Time (CET = GMT+1), applying daylight saving.

B-7-1-5 TIME CORRECTION FREQUENCY OFFSET

The Frequency Offset determined by the Time Monitor with respect to the ranges of discrepancy is as follows:

- if the Electrical Time Deviation is within the Tolerated Range of Discrepancy, the Frequency Offset for time correction has to be set to zero;
- if the Electrical Time Deviation is outside of the Tolerated Range of Discrepancy and Synchronous Time is behind UTC, the Frequency Offset has to be set to +10 mHz;
- if the Electrical Time Deviation is out of the Tolerated Range of Discrepancy and Synchronous Time is ahead of UTC, the Frequency Offset has to be set to –10 mHz.

B-7-1-5-1 EXCEPTIONAL TIME CORRECTION FREQUENCY OFFSETS

Only under exceptional conditions outside the Exceptional Range of Discrepancy may Frequency Offsets larger than 10 mHz for the time correction of the Synchronous Time be applied. These Frequency Offsets are set by the Time Monitor.

In this case, The Time Monitor may investigate the cause of the discrepancy and provide a report to the respective governance body for further actions.

B-7-1-6 TIME CORRECTION NOTICE

The information for the time correction that has to be applied shall be forwarded by the Time monitor to all LFC Blocks of the Synchronous Area every day by 10:15 a.m. UCT or as agreed otherwise by the Synchronous Area Monitor. The LFC Blocks forward this information to their underlying LFC Areas without delay.

B-7-1-6-1 CONTENT OF THE TIME CORRECTION NOTICE

Each notice has to contain the time deviation, the time correction Frequency Offset, and the date and duration for the time correction.

B-7-1-6-2 NOTICE TRANSMISSION

The Time Correction Notice shall be transmitted by using secure and reliable electronic communication that allows a half-automated procedure.

B-7-1-6-3 OUTSTANDING TIME CORRECTION NOTICE

In case the Time Deviation information or Time Correction Notice is missing, TSOs shall apply the nominal frequency of 50 Hz as frequency set-point value for aFRP until they receive the outstanding notice. In parallel, TSOs shall take action to receive the correct information from the Time Monitor.

B-8 ALLOCATION OF RESPONSIBILITIES BETWEEN THE TSOs ACCORDING TO ARTICLE 118(1)(K) SO GL (MANDATORY)

The responsibilities for the achievement of the objectives of the SO GL, are allocated as follows:

- each TSO shall be responsible for the operation of the FCP for its Initial FCR obligation according to Article 153(2)(d) of the SO GL;
- each TSO shall be responsible for the activation and availability of its Initial FCR Obligation according to Article 153(2)(d) of the SO GL;
- each TSO shall endeavour to fulfil the frequency quality target parameters in accordance with Article 127 of the SO GL.

B-9 OPERATIONAL PROCEDURES TO REDUCE FREQUENCY DEVIATION ACCORDING TO ARTICLE 118(1)(N) SO GL (MANDATORY)

B-9-1 EXTRAORDINARY PROCEDURE IN CASE OF ALERT STATE DUE TO A VIOLATION OF SYSTEM FREQUENCY LIMITS

B-9-1-1 GOAL OF THE PROCEDURE

According to Article 118(1)(n) of the SO GL, the procedure for long-lasting deviations from nominal frequency (as defined in Article *B-6 Load-Frequency Control Structure*) regarded as Alert State⁹ due to a violation of System Frequency limits shall guarantee

- The mandatory sharing of relevant operational information between the TSOs in case of significant steady-state Frequency Deviations which are considered to be a risk for Operational Security because of imminent potential cascading effects like load shedding or generation disconnection, and
- The reduction of respective Frequency Deviations with predefined/pre-prepared and coordinated countermeasures.

B-9-1-2 REMEDIAL ACTIONS IN THE SCOPE OF THIS PROCEDURE

Any Remedial Action to significantly reduce the ACE, i.e. Frequency Deviation, in order to return to Normal State shall encompass measures compliant with security rules according to the SO GL Part II Operational Security.

B-9-1-3 DECLARATION OF ALERT STATE

The Coordination Centres shall monitor the System Frequency and determine the Stages according to the limits defined in Figure 1 which are based on the System States defined in Article 152 of the SO GL.

B-9-1-3-1 DETERMINED STAGES

The following stages both correspond to Alert State according to Article 18(2) of the SO GL:

- Stage 1: a continuous Frequency Deviation of more than 100 mHz over a time period of more than 5 minutes or a continuous Frequency Deviation of more than 50 mHz over a time period of more than 15 minutes.
- Stage 2: a continuing Frequency Deviation of more than 100 mHz over a time period of more than 10 minutes or a continuous Frequency Deviation of more than 50 mHz either over a time period of 20 minutes or manually triggered after Stage 1 took place. Each LFC

⁹ This procedure does not directly refer to the local Alert State of a TSO with respect to Article 18 of the SO GL. Nevertheless, it can be derived from this requirement that a respective local Alert State of at least one Impacting TSO correlates with the synchronous area wide Alert State considered in the SO GL Part IV LFC&R and in this procedure.

area can ask for this manual trigger by contacting the responsible Coordination Centre. In case there are contradicting requests from TSOs, the Coordination Centre shall decide on appropriate actions and trigger of Stage 2.

In case of a long lasting remarkable imbalance of a TSO which does not (yet) trigger Stage 1 or Stage 2, but is not expected to be compensated in the foreseeable future or in case of detection of an expected risky imbalance situation, the TSO with long lasting remarkable imbalance or any TSO affected that has serious concerns regarding its own system by this long lasting imbalance has the right to ask for a manual trigger at any time by contacting the responsible Coordination Centre. The Coordination Centre shall decide on appropriate actions and trigger of Stage 1 or Stage 2.

GL SO: Alert State and Emergency State Extraordinary Procedure: Stage 1 and 2

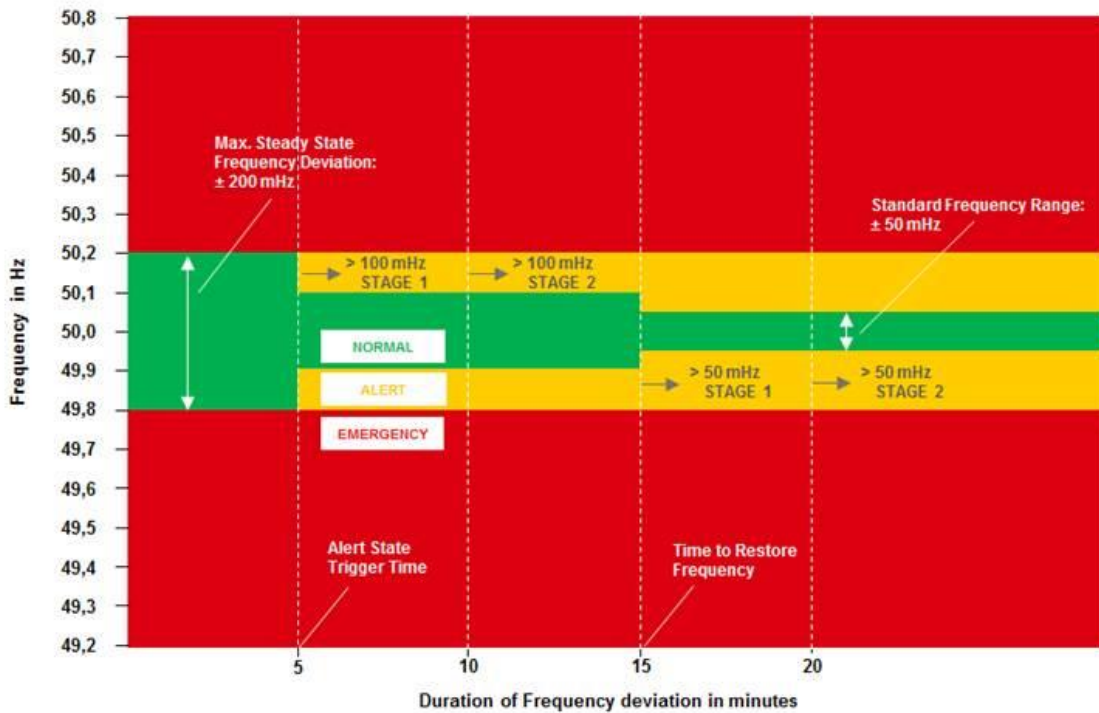


Figure 7: Illustration of Stage 1 and Stage 2 based on the System States of the SO GL.

B-9-1-4 ACTIONS TO BE TAKEN IN STAGE 1

In case a frequency deviation of more than 200 mHz occurs, the Emergency State is reached. Any corresponding actions and procedures are described in the Policy on Emergency and Restoration.

In case of Stage 1 the Coordination Centres shall identify the Impacting TSOs based on the ACE and contact immediately their control rooms by phone or teleconference.

The responsibility for launching the teleconferences through the Coordination Centres changes according to a monthly rotation.

B-9-1-4-1 IDENTIFICATION OF IMPACTING TSOs

An Impacting TSO means a TSO that is predominantly responsible for a Frequency Deviation that triggers Stage 1 or Stage 2 of the Extraordinary Procedure in case of Alert State according to the determined criteria.

A TSO shall be identified as Impacting TSO in case the following conditions are fulfilled in ENTSO-E Awareness System (EAS):

- the TSOs with an ACE exceeding the threshold of 375 MW¹⁰ and
- the TSO has declared Alert State.

In case the threshold is exceeded by a TSO that has not declared Alert State the Coordination Centre shall contact the TSO asking for respective confirmation.

Alternatively, a TSO may declare to be an Impacting TSO by proactively contacting a Coordination Centre.

In case the EAS is not available, the Coordination Centre shall identify the Impacting TSOs based on the online observation data or any other available information.

B-9-1-4-2 INFORMATION PROVIDED BY THE IMPACTING TSOs

The Impacting TSOs shall inform the Coordination Centre about:

- The estimated reason for the imbalance
- The Remedial Actions that have already been taken;
- The time period when these actions are expected to become effective;
- If these actions are expected to be sufficient to solve the frequency deviation and
- Which further actions are planned.

This first contact aims at clarifying from each Impacting TSO if some actions have been already set up, the delay for these actions and if these actions are expected to be sufficient in order to solve the frequency deviation. The Impacting TSOs are expected to set up all the measures that are possible regarding their own rules (market and security) in order to avoid the second step of this procedure as much as possible.

B-9-1-4-3 TAKING NOTE OF INFORMATION IN STAGE 1

The Coordination Centre shall take note of the information as described in the chapter on *Identification of Impacting TSOs and Information provided by the Impacting TSOs* above and send a respective e-mail to the Impacting TSO, to TSOs that activate remedial actions as part of the Extraordinary Procedure in case of Alert State (the Supporting TSOs) and to the other Coordination Centre as soon as possible.

B-9-1-4-4 MANUAL TRIGGERING OF STAGE 2

In case the Impacting TSO(s) expect(s) its/their taken and planned Remedial Actions will not be sufficient and an improvement of the System Frequency cannot be observed by the Coordination Centre, the Coordination Centre shall start the measures corresponding to Stage 2 without delay. Alternatively, the Impacting TSOs may ask the Coordination Centre for the immediate initiation of Stage 2.

¹⁰ Threshold calculated as 1/8 of the reference incident of the synchronous area for more than 30 consecutive minutes

B-9-1-5 ACTIONS TO BE TAKEN IN STAGE 2

B-9-1-5-1 PHONE CONFERENCE

In case of Stage 2 the Coordination Centre shall immediately start a phone conference with all relevant Supporting TSOs. If necessary, the Impacting TSOs may join the conference.

The phone conference shall be possible without prior scheduling or prior connection request.

B-9-1-5-2 FURTHER REMEDIAL ACTIONS

As a result of the phone conference, one or more further Remedial Actions to return to Normal State shall be agreed by the participating TSOs. Possible Remedial Actions are e.g.:

- activation of additional¹¹ aFRR by means of enforcing the frequency restoration controller to activate additional reserves, i.e. manually overwriting / adjusting the exchange program while – for example – using virtual tie-lines or cross-border schedules;
- activation of additional mFRR or RR;
- mutual emergency assistance services

For the evaluation of the appropriate Remedial Actions the following aspects shall be taken into account:

- the Imbalance and expected duration of the Imbalance;
- the amount of available Active Power Reserves in the different LFC Blocks;
- the expected activation time;
- impacts on the load flows based on simulations within the related observability areas or the last available merged snapshots (every 15 minutes) and on the expected location of generation units or loads which are planned to be used to compensate the Imbalance;
- specific boundary conditions, e.g. risk of entering into Emergency State due to tripping of solar power generation, etc.

B-9-1-5-3 DOCUMENTATION OF STAGE 2

The Coordination Centre shall document the agreed Remedial Actions and send as soon as possible a respective e-mail to the Impacting TSO, the Supporting TSOs, the other Coordination Centre as well as to further TSOs for information.

B-9-1-5-4 EX POST ANALYSIS

The Coordination Centre shall distribute a report in case of Stage 2 events latest one week after the events. Furthermore, the Synchronous Area Monitor performs a detailed analysis in the internal Quarterly Reports.

B-9-1-5-5 DATA PROVISION

All TSOs shall provide the following data:

- real-time input of LFC;
- available remaining aFRR and mFRR;
- available RR (amount and activation time).

¹¹ Additional means in addition to the Active Power Reserves activation used for the compensation of the LFC Blocks of the Supporting TSOs.

B-10 ROLES AND RESPONSIBILITIES OF THE TSOs IMPLEMENTING AN IMBALANCE NETTING PROCESS, A CROSS-BORDER FRR ACTIVATION PROCESS OR A CROSS-BORDER RR ACTIVATION PROCESS ACCORDING TO ARTICLE 118(1)(o) SO GL (MANDATORY)

B-10-1 ROLES RELATED TO IMBALANCE NETTING, CROSS-BORDER ACTIVATION OF RESERVES, EXCHANGE OF RESERVES AND SHARING OF RESERVES

In accordance with Article 118(1)(o), (u), (v) and (w) of the SO GL, the Parties hereby define the roles of TSOs implementing or affected by an Imbalance Netting Process, a Cross-Border FRR Activation Process, a Cross-Border RR Activation Process, an exchange of Reserves or sharing of Reserves.

B-10-1-1 IMPLEMENTING TSOs

TSOs implementing an Imbalance Netting Process, a cross-border aFRR Activation or mFRR Activation Process, a cross-border RR Activation Process, exchange of Reserves or sharing of Reserves which shall commonly develop the platforms for these processes and sign an operational procedure agreement per process, are defined as Implementing TSOs. According to Article 118(1)(u), the Reserve Receiving TSO and the Reserve Connecting TSO, as well as according to Article 118(1)(v) and (w) the Control Capability Receiving TSO and the Control Capability Providing TSO, is also defined as Implementing TSO.

Any TSO of the Synchronous Area CE shall have the right to join the existing Imbalance Netting Process, a cross-border aFRR or mFRR Activation Process, a cross-border RR Activation Process, exchange of Reserves or sharing of Reserves when this TSO:

- fulfils requirements of the relevant process platform
- signs the relevant operational procedure agreement per process and
- notifies the process according to the *Notification Process* described below

B-10-1-2 AFFECTED TSOs

A TSO may declare itself as affected (Affected TSO) when this is based on an Operational Security Analysis and within one month after notification to the SG CSO in accordance with Article 150(2) of SO GL.

B-10-2 RESPONSIBILITIES RELATED TO IMBALANCE NETTING, CROSS-BORDER ACTIVATION OF RESERVES, EXCHANGE OF RESERVES AND SHARING OF RESERVES

In accordance with Article 118(1)(o), (u), (v) and (w) of the SO GL, all TSOs of the Synchronous Area CE hereby define the responsibilities of TSOs implementing or affected by an Imbalance Netting Process, a cross-border FRR Activation Process, a cross-border RR Activation Process, an exchange of Reserves or sharing of Reserves.

B-10-2-1 NOTIFICATION PROCESS

B-10-2-1-1 NOTIFICATION

TSOs of Synchronous Area CE that are willing to implement an Imbalance Netting Process, a cross-border aFRR or mFRR Activation, a cross-border RR Activation Process, an exchange of Reserves or sharing of Reserves shall send a notification to the SG CSO at least three months before exercising their right to implement, in accordance with Article 150(1) of the SO GL.

B-10-2-1-2 NOTIFICATION OF ADDITIONAL PROCESSES

TSOs of Synchronous Area CE that are willing to implement an Additional Process (different from processes in accordance with Article 118(1)(o), (u), (v) and (w)) according to with cross-border implications which is in line with the SO GL shall:

- perform a study to investigate the impacts of the new process on the Operational Security of the synchronous area CE.
- in order to request a trial phase for the new process, send the study report and the additional restrictions (see chapter on *Trial Phase* below) to SG CSO and RG CE, at least three months in advance of the implementation; the RG CE shall decide on initiating the trial phase and apply the additional restrictions.

B-10-2-2 IMPLEMENTATION OF OPERATIONAL PROCEDURES FOR LIMITATION OF IMBALANCE NETTING AND CROSS-BORDER ACTIVATION OF RESERVES

B-10-2-2-1 AGREEMENT ON OPERATIONAL PROCEDURES

In accordance with Article 150(3) of the SO GL, upon the request of the Affected TSO the TSOs implementing Imbalance Netting or cross-border activation of reserves and the Affected TSO shall agree on Operational Procedures enabling the Affected TSO:

- to perform Operational Security Analysis in real-time, and
- to limit Imbalance Netting power interchange, Frequency Restoration power interchange and Replacement Power interchange.

The agreed Operational Procedures shall include the rules for possible limitations and reasons for the limitations which shall be provided by the Affected TSO.

The TSOs implementing Imbalance Netting or cross-border activation of reserves and the Affected TSOs shall notify the SG CSO about their operational procedure agreement and possible adaptations to the originally notified process.

B-10-2-3 LIMITS FOR EXCHANGE AND SHARING OF RESERVES

Each Affected TSO has the right to request tighter limits because of:

- exchange of FCR within or between the Synchronous Area;
- exchange of aFRR, mFRR or RR within or between the Synchronous Area;
- sharing of aFRR, mFRR or RR within or between the Synchronous Area.

In this case the TSO shall notify the Synchronous Area Monitor about these limits.

B-10-3 TRIAL PHASE

A Trial Phase is only required for processes that have potential impact on system security. In case one or more TSOs submit a new process proposal every proposing TSO is obliged to perform an assessment on potential impact on system security. In case where system security impact is detrimental, RG CE or SOC (in case of inter-Synchronous Area impacts) shall decide whether a Trial Phase shall be performed.

B-10-3-1 TRIAL PHASE FOR IMBALANCE NETTING, CROSS-BORDER ACTIVATION OF RESERVES, EXCHANGE OF RESERVES AND SHARING OF RESERVES PROCESSES

The relevant TSO involved in an Imbalance Netting Process, a cross-border aFRR Activation or mFRR Activation Process, a cross-border RR Activation Process, an exchange or sharing of Reserves between LFC Blocks within or between Synchronous Areas shall foresee a trial phase of at least one year.

The Trial Phase shall include a regular reporting. The regular report shall be delivered each 6 months (or as otherwise agreed by SG CSO) and provided to the SG CSO with at least the statistical evaluation of ACE, cross-border power interchange, possible impact on the Frequency Quality as well as evaluation of operational procedures.

The SG CSO shall decide about the successful completion of the Trial Phase based on the evaluations provided by the regular report.

B-10-3-2 TRIAL PHASE FOR ADDITIONAL PROCESSES

In case a Trial Phase for an Additional Process has been approved by the RG CE according to the *Notification of Additional Processes*, the SG CSO shall:

- report every three months to the RG CE
- evaluate the impact of the process on Operational Security at the end of the trial phase
- inform the RG CE about the final results and recommend a final decision to the RG CE.

The RG CE shall decide on the implementation of the process.

B-11 REQUIREMENTS CONCERNING THE AVAILABILITY, RELIABILITY AND REDUNDANCY OF THE TECHNICAL INFRASTRUCTURE ACCORDING TO ARTICLE 118(1)(P) SO GL (MANDATORY)

B-11-1 RELIABILITY

The frequency restoration controller of aFRR shall be operated on-line and shall have a very high reliability. The tools for activation of mFRR and RR shall be operated on-line and shall have a very high reliability as well. A hot-stand-by-backup system must be available to take over the control function in case of an outage or fault of the main system. This requirement applies as well for all European platforms performing cross-border Imbalance Netting or a cross-border FRR and RR activation process.

B-11-1-1 RELIABILITY OF MEASUREMENTS

Measurements must be transmitted in a reliable manner, i.e. redundant/parallel data links, to the frequency restoration controller. The used communication protocols must allow detecting invalid values and missing or invalid measurement values shall cause an alarm.

For each LFC Area of Synchronous Area CE, the related TSO shall have frequency measurements from at least two different geographical locations available within this LFC Area.

B-11-2 REDUNDANCY

B-11-2-1 TSO CONTROL ROOMS REDUNDANCY

The control room functions shall be backed up to face any damage to the main installations. This shall be activated within less than three hours and tested at least once a year.

B-11-2-2 MANUAL CONTROL CAPABILITY

In case of deficiency of the automatic frequency restoration controller, manual control of reserves must be possible.

B-11-2-3 METERING AND MEASUREMENT TRANSMISSION TO OPPOSITE SIDE

The operating TSOs of a tie-line shall agree on a common primary measurement, whose measured value shall be used in the load frequency controller of the concerned TSOs. A secondary measurement shall be used as backup and shall be available in parallel to the primary measurement in case the active power-flow can exceed 50 MW. Accuracy and cycle times for the secondary measurements must fulfil the same characteristics as the primary measurements.

B-11-3 AVAILABILITY

B-11-3-1 DATA RECORDING

Each TSO of Synchronous Area CE shall perform continuous recordings with a measurement period equal to or shorter than 10 s of all values needed for monitoring of the input and response of the frequency restoration controller and for analysis of normal operation and incidents in the Synchronous Area. These values include:

- the frequency measurement,
- the total active power flow measurement and
- the power exchange set-point value.

B-11-3-2 SHARING OF INFORMATION

The TSO shall inform in real-time all TSOs within the Synchronous Area CE about its Wide Area State of the system. In case of not being in Normal State, the constrained TSO shall provide more details on critical operational conditions and at minimum to the interconnected TSOs, expected time to come back to Normal State and shall call for help if needed (refer to bi-multilateral TSOs agreements). The constrained TSO shall communicate the information via the following ways:

- EAS,
- preformatted messages (Fax, e-mail, web-based, etc.),
- phone calls to complement messages.

B-11-3-3 INTER-TSO CONTACT LISTS FOR SYSTEM OPERATION

Inter-TSO agreements shall include a list of functional positions directly involved in the system operation to be contacted at any time with phone numbers, fax numbers and e-mail addresses that shall be provided by all TSOs of the Synchronous Area CE and regularly updated. This list includes desks of control rooms and the relevant staff. All critical information about real-time operation shall be sent to these TSO counterparts.

B-12 COMMON RULES FOR THE OPERATION IN NORMAL STATE AND ALERT STATE ACCORDING TO ARTICLE 118(1)(q) SO GL (MANDATORY)

As all common rules for the operation in Normal State and Alert State, the target of load-frequency-control is to reduce Frequency Deviations. Those rules refer to the rules for operational procedures to reduce Frequency Deviation according to *B-9 Operational Procedures to Reduce Frequency Deviation*.

Additionally, and to prevent entering Emergency State, the TSO shall endeavour to conclude Mutual Emergency Service Agreements. These agreements should not be limited to TSO agreements within the Synchronous Area but also between Synchronous Areas.

In case of a long lasting remarkable Imbalance of a TSO which does not (yet) trigger Stage 1 or Stage 2, but is not expected to be compensated in the foreseeable future or in case of detection of an expected risky Imbalance situation, the TSO with long lasting remarkable Imbalance or any TSO affected by this long lasting Imbalance, has the right to ask for a manual trigger at any time by contacting the responsible Coordination Centre. The Coordination Centre shall decide on appropriate actions and trigger of Stage 1 or Stage 2.

In case a Frequency Deviation of more than 200 mHz occurs, Emergency State is reached. Any corresponding actions and procedures are described in the Policy on Emergency and Restoration.

B-13 ROLES AND RESPONSIBILITIES OF THE RESERVE CONNECTING TSO, THE RESERVE RECEIVING TSO AND THE AFFECTED TSO AS REGARDS THE EXCHANGE OF FRR AND RR ACCORDING TO ARTICLE 118(1)(u) SO GL (MANDATORY)

In accordance with Article 165(1) of the SO GL all TSOs of the Synchronous Area CE hereby define the roles and responsibilities of the Reserve Connecting TSO, the Reserve Receiving TSO and the Affected TSO for the exchange of FRR and/or RR. The roles and responsibilities as well as the notification processes and operational procedures are described in *B-10 Roles and Responsibilities of the TSOs implementing an Imbalance Netting Process, a cross-border FRR Activation Process or a cross-border RR Activation Process*.

B-14 ROLES AND RESPONSIBILITIES OF THE CONTROL CAPABILITY PROVIDING TSO, THE CONTROL CAPABILITY RECEIVING TSO AND THE AFFECTED TSO FOR THE SHARING OF FRR AND RR ACCORDING TO ARTICLE 118(1)(v) SO GL (MANDATORY)

In accordance with Article 166(1) of SO GL, all TSOs of the Synchronous Area CE hereby define the roles and responsibilities of the Control Capability Providing TSO, the Control Capability Receiving TSO and the Affected TSO for sharing FRR/RR. The roles and responsibilities as well as the notification processes and operational procedures are described in *B-10 Roles and Responsibilities of the TSOs implementing an Imbalance Netting Process, a cross-border FRR Activation Process or a cross-border RR Activation Process*.

B-15 ROLES AND RESPONSIBILITIES OF THE RESERVE CONNECTING TSO, THE RESERVE RECEIVING TSO AND THE AFFECTED TSO FOR THE EXCHANGE OF RESERVES BETWEEN SYNCHRONOUS AREAS, AND OF THE CONTROL CAPABILITY PROVIDING TSO, THE CONTROL CAPABILITY RECEIVING TSO AND THE AFFECTED TSO FOR THE SHARING OF RESERVES ACCORDING TO ARTICLE 118(1)(w) SO GL (MANDATORY)

In accordance with Article 171(2) of SO GL all TSOs of the RG CE hereby define the roles and responsibilities of the Reserve Connecting TSO, the Reserve Receiving TSO and the Affected

TSO for the exchange of Reserves between Synchronous Areas and of the Control Capability Providing TSO, the Control Capability Receiving TSO and the Affected TSO for the sharing of Reserves. The roles and responsibilities as well as the notification processes and operational procedures are described in *B-10 Roles and Responsibilities of the TSOs implementing an Imbalance Netting Process, a cross-border FRR Activation Process or a cross-border RR Activation Process*.

B-16 TECHNICAL DESIGN OF THE FREQUENCY COUPLING PROCESS ACCORDING TO ARTICLE 172(2) SO GL (MANDATORY)

All TSOs of each Synchronous Area jointly define three classes of frequency services, namely FCR Exchange, Frequency Netting and Frequency Optimisation.

B-16-1 FCR Exchange

FCR Exchange is a process agreed between two Synchronous Areas where one Synchronous Area delivers FCR to the other. In such a case it shall be fulfilled that:

- the providing Synchronous Area shall provide the FCR subject to FCR Exchange in addition to its own initial FCR dimensioning obligation according to SO GL Article 173(3) and
- the receiving Synchronous Area (via the TSO or via the sourced BSPs) shall have a back-up process in case the service fails.

B-16-2 Frequency Netting

Frequency Netting is a process agreed between two or more Synchronous Areas that reduces counter-activations of FCR only when the Synchronous Areas have Frequency Deviations which have an opposite sign. Frequency Netting hence always improves the instantaneous frequency quality of all participating Synchronous Areas in case there are Frequency Deviations with opposite signs.

B-16-3 Frequency Optimisation

Frequency Optimisation is a process agreed between two or more Synchronous Areas that improves overall frequency quality by mutual FCR support between Synchronous Areas. This is arranged such that the frequency in all Synchronous Areas are used and optimised to ensure that the sum of the absolute Frequency Deviations is minimised. The objective function of Frequency optimisation applies different weights to the Synchronous Areas, with no Synchronous Areas having a zero weight and the weightings being agreed by all Synchronous Areas. Frequency Optimisation hence improves the average frequency quality of those Synchronous Areas involved.

All Synchronous Areas willing to implement any of those services with RG CE shall send a notification to the SG CSO three months in advance in accordance with Article 150(1) of the SO GL.

B-17 METHODOLOGY TO DETERMINE LIMITS ON THE AMOUNT OF EXCHANGE AND SHARING OF FCR BETWEEN SYNCHRONOUS AREAS ACCORDING TO ARTICLE 173(4) AND ARTICLE 118(1)(X) SO GL (MANDATORY)

B-17-1-1 EXCHANGE OF FCR BETWEEN SYNCHRONOUS AREAS

In accordance with Article 173(4) of the SO GL all TSOs of the Synchronous Area CE hereby establish the limits on the amount of Exchange of FCR between Synchronous Areas.

B-17-1-1-1 EXCHANGE OF FCR BETWEEN SYNCHRONOUS AREAS WHERE THE SYNCHRONOUS AREA CONTINENTAL EUROPE IS THE RESERVE CONNECTING SYNCHRONOUS AREA

The maximum total exchanged FCR amount between Synchronous Area CE and the other Synchronous Areas shall not exceed the following security limits for Synchronous Area CE:

- Aggregated FCR activation of all FCR units or groups subject to the exchange with adjacent Synchronous Areas induces a disturbing Frequency Deviation that is limited to a maximum of 10 mHz, which corresponds to a limit in power according to the K-Factor of the Synchronous Area CE. The SG SF shall calculate this limit on a yearly basis.

B-17-1-1-2 EXCHANGE OF FCR BETWEEN SYNCHRONOUS AREAS WHERE THE SYNCHRONOUS AREA CE IS THE RESERVE RECEIVING SYNCHRONOUS AREA

The exchange of FCR between Synchronous Areas where the Synchronous Area CE serves as the Reserve Receiving Synchronous Area shall consider the following constrains:

- All Reserve Receiving TSOs of a LFC Block involved in an exchange of FCR between Synchronous Areas shall ensure that at least 30 % of their total combined Initial FCR Obligations are physically provided inside their LFC Block.
- FCR exchange is limited to a maximum of 5 % of the FCR dimensioning amount (according to Article 156(6) of the SO GL) of the Reserve Receiving Synchronous Area for each reserve transfer HVDC link.

B-17-1-2 SHARING OF FCR BETWEEN SYNCHRONOUS AREAS

In accordance with Article 118(1)(x) of the SO GL all TSOs of the Synchronous Area CE hereby establish the limits on the amount of sharing of FCR between synchronous areas.

B-17-1-2-1 SHARING OF FCR BETWEEN SYNCHRONOUS AREAS WHERE THE SYNCHRONOUS AREA CONTINENTAL EUROPE IS THE RESERVE CONNECTING SYNCHRONOUS AREA

The maximum total shared FCR amount between Synchronous Area CE and the other Synchronous Areas shall not exceed the following security limits for Synchronous Area CE:

- Total activated shared FCR with an adjacent Synchronous Area induces a disturbing Frequency Deviation that is limited to a maximum of 10 mHz, which corresponds to a limit in power according to the K-Factor of the Synchronous Area CE. The SG SF shall calculate this limit on a yearly basis.

B-17-1-2-2 SHARING OF FCR BETWEEN SYNCHRONOUS AREAS WHERE THE SYNCHRONOUS AREA CE IS THE RESERVE RECEIVING SYNCHRONOUS AREA

Sharing of FCR Capacity where Synchronous Area CE is the Reserve Receiving Synchronous Area shall not be allowed.

C METHODOLOGIES, CONDITIONS AND VALUES AGREED AMONG THE PARTIES

The following section includes all methodologies, conditions and values which are jointly developed and agreed among the Parties.

C-1 NOMINATION OF SPECIAL ROLES

C-1-1 NOMINATION OF DECISION BODY/BODIES

The decision making body for this policy is the RG CE. For inter-Synchronous Area matters SOC shall act as the decision making body.

C-1-2 NOMINATION OF SUB-GROUPS, WORKING-GROUPS AND SUPPORTING BODIES

The RG CE shall appoint in accordance with Article 10 of the SAFA as well as the RG CE Terms of Reference individual or a subset of TSOs, competent sub-groups or Working groups to perform the relevant processes or calculations as stated in this Policy. In this context RG CE shall at least, including but not limited to, appoint the following special roles:

- Coordination Centres;
- Time Monitor;
- Supporting TSOs for the Extraordinary Procedure (according to Article B-9);
- Sub-Group or Working-Group for Reporting;
- Sub-Group or Working-Group for Determination of the K-Factor;
- Sub-Group or Working-Group for FCR Dimensioning;
- Sub-Group or Working-Group for Calculation of the FRCE target parameters.

C-2 INFORMATION EXCHANGE, REPORTING AND TRANSPARENCY

C-2-1 INFORMATION EXCHANGE

All TSOs shall provide the requested data, which the sub-group or Working-group for Reporting needs to fulfil their reporting and transparency obligations.

C-2-1-1 Frequency Restoration, Replacement Reserves, and Activation Time

All TSOs of an LFC BLOCK shall inform the relevant sub-group or Working-group for Reporting about the following parameters for the LFC BLOCK:

- a. the amount of positive aFRR;
- b. the amount of negative aFRR;
- c. the amount of positive mFRR;
- d. the amount of negative mFRR;
- e. the amount of positive RR;
- f. the amount of negative RR
- g. the full activation time of the aFRR;
- h. the full activation time of mFRR;
- i. the size of the Dimensioning Incident; and
- j. the maximum amount of Sharing of aFRR, mFRR and RR.

k. the maximum amount of Exchange of aFRR, mFRR and RR.

In case no single number can be given, the range and the expected mean value of the parameter shall be given.

The calculation of the parameters shall be based on a suitable dimensioning methodology according to Article 157 of the SO GL. The recommendation for aFRR dimensioning is

- that the positive aFRR is larger than the 1st percentile of the difference of the 1-minute average ACEol and the 15 minute average ACEol of the LFC BLOCK, and
- that the negative aFRR is larger than the 99th percentile of the difference of the 1-minute average ACEol and the 15 minute average ACEol of the LFC BLOCK.

C-2-1-2 Additional Indicator on Dimensioning

To monitor whether an LFC-Block fulfils the dimensioning criteria defined in Article 157 (2) h and j of the SO GL, the TSOs of a LFC-Block shall calculate the number of 15 minutes time intervals for which the average value of the Open-Loop ACE was larger than the sum of the procured balancing capacity or the sum of the balancing energy volume for the own LFC-Block and inform the sub-group or Working-group for Reporting about this on a quarterly basis. Within this calculation, the TSOs shall take into account the activated balancing energy bids from common activation platforms.

C-2-1-3 Load-Frequency Control Performance

Each LFC BLOCK MONITOR shall deliver its ACE values, calculated according to Article 134 of the SO GL, to the sub-group or Working-group for Reporting. The 15 minutes average calculated ACE values shall be based on a sample interval of at least 10 s.

The sub-group or Working-group for Reporting shall collect the contribution of every LFC BLOCK and prepare the data for analysis.

C-2-2 REPORTING

C-2-2-1 Observation of Outages

Each TSO of a LFC AREA shall record instantaneous power Imbalances exceeding 1000 MW (ΔP_a) such as forced outages in production or consumption. The data has to include:

- Location and type of the incident.
- The time of the incident (t_0) with a time resolution of 1 s; the corresponding time stamp has to be verified by matching the occurrence of the incident to the corresponding change of frequency; if necessary the time stamp shall be adjusted accordingly.
- The magnitude of the instantaneous power Imbalances in MW (ΔP_a) with a resolution of 1 MW.
- The computed Frequency Deviation Δf with a resolution of 1 mHz, whereby this value shall be calculated as the difference between the mean values of frequency before and after the incident. Δf shall be equivalent to the average value of frequency in the interval $[t_0+10s, t_0+30s]$ minus the average value of the frequency in the interval $[t_0-10s, t_0]$.
- Computed network power characteristic $\lambda_u = \Delta P_a / \Delta f$.

TSO that have detected such an incident shall inform the sub-group or Working-group for Reporting.

C-2-2-2 Event driven Frequency Deviation report

The sub-group or Working-group for Reporting shall prepare an event driven Frequency Deviation report in case of a Frequency Deviation of more than 100 mHz from nominal frequency. The report shall include:

- Cause of the Frequency Deviation.
- The time of the incident (t_0) with a time resolution of 1 s; the corresponding time stamp has to be verified by matching the occurrence of the incident to the corresponding change of frequency; if necessary the time stamp shall be adjusted accordingly.
- The magnitude of the instantaneous power Imbalances in MW (ΔP_a) with a resolution of 1 MW.
- The computed Frequency Deviation Δf as described in C.2.2.1.
- Computed network power characteristic $\lambda_u = \Delta P_a / \Delta f$.

C-2-2-3 Quarterly report on Load Frequency Control

The sub-group or Working-group for Reporting shall prepare a quarterly report on load frequency control of the previous quarter containing:

- the Frequency quality evaluation criteria in accordance with Article 131 of the SO GL,
- the additional indicator defined in C-2-1-3,
- overview of events and duration where Δf was larger than 75 mHz and where Δf was larger than 100 mHz,
- the triggered Frequency Deviation incidents including the Frequency Deviation report mentioned in C-2-2-1 and C-2-2-2 and
- Ex post analyses according to activation of Extraordinary Procedure in case of Alert State due to a violation of system frequency limits as defined in B-9.

C-2-2-4 Internal reporting of LFC Blocks persistently contributing to Frequency Deviations

The sub-group or Working-group for Reporting shall initiate an internal reporting procedure, in case a LFC Block persistently contributes to Frequency Deviations that deviate from normal behaviour. For example, non-compliance to the time to restore frequency, failure of the frequency restoration controller, severe violation of Operational Security.

The internal reporting shall include three escalating steps. These steps shall be followed consecutively, if no significant improvement can be observed.

- a. Step 1: The relevant LFC BLOCK shall prepare a report and possible measures for the improvement. The report, including an analysis of the potential operational and/or market causes, must be prepared within 30 business days after the date of the related request of the sub-group or Working-group for Reporting.
- b. Step 2: If no improvement is observed, the respective LFC Block shall analyse the reasons and may propose additional measures to the sub-group or Working-group for Reporting. The latter shall inform the RGCE about the implementation of the measures defined during the first escalating step and possible new measures.
- c. Step 3: The sub-group or Working-group for Reporting shall analyse the situation. If no improvement is expected or no operational measures are available, the issue is escalated to the RGCE.

C-2-2-5 Annual Report on Load-Frequency Control

The sub-group or Working-group for Reporting shall compile the annual report on Load-Frequency Control in accordance with Article 16 of the SO GL.

The report shall also contain:

- the additional indicator defined in C-2-1-3,
- overview of events and duration where Δf was larger than 75 mHz and where Δf was larger than 100 mHz and
- the triggered Frequency Deviation incidents including the Frequency Deviation report mentioned in C-2-2-1 and C-2-2-2.

C-2-2-6 Monitoring of LFC Block contribution to deterministic frequency deviations

To limit the extent of deterministic frequency deviations to the frequency deviation target of 75 mHz, individual target limits for FRCE (according to B-6, in case of coordinated FRR activation FRCE results from the coordinated FRCE calculation) for each LFC Block are defined in article C-9. For monitoring purposes, a deterministic frequency deviation is a frequency deviation above 75 mHz over a period of 15 sec, taking place in a time frame between [h-1]:55 and [h:05]. The sub-group or working-group for reporting shall monitor the contribution of LFC Blocks to deterministic frequency deviations.

The monitoring of contribution of LFC-Blocks to deterministic frequency deviations shall be based on instantaneous FRCE measurements with a maximum measurement interval of 10 seconds. The value taken into account shall be the instantaneous FRCE of the LFC Block at the maximum frequency deviation during the deterministic frequency deviation (between H-05 minutes and H+05 minutes where H is a round hour).

These measurements shall be compared to the respective contribution limit per LFC Block ($CL_{LFCblock}$), as defined in C-9. The TSOs of a LFC Block shall make best efforts not to exceed the respective contribution targets in terms of the instantaneous FRCE data in more than 30% of the hours with deterministic frequency deviations higher than 75 mHz in a quarter of a year.

The quarterly LFC report pursuant to C-2-2-3 shall include the percentage of time where the instantaneous FRCE exceeds the contribution target during deterministic frequency deviations of more than 75 mHz (from nominal value).

C-2-3 TRANSPARENCY

The sub-group or Working-group for Reporting together with ENTSO-E Secretariat shall design the process necessary to ensure the availability of information according to Articles 183 to 190 SO GL.

C-2-3-1 Transparency of Load Frequency Control Reports

The sub-group or Working-group for Reporting together with ENTSOE-E Secretariat shall publish:

- the annual report of the previous year by 30 September and
- the quarterly report within 3 months after the last time-stamp of the measurement period and at least four times a year.

C-2-3-2 Transparency on FCR, FRR and RR

The sub-group or Working-group for Reporting together with ENTSO-E Secretariat shall publish:

- the total amount of FCR for SYNCHRONOUS AREA CE and the Initial FCR Obligation per TSO at least 1 month before their applicability;
- an outlook of reserve capacities of FRR and RR of each LFC BLOCK for the next year by 30 November and
- within 30 days, the actual reserve capacities of FRR and RR of each LFC BLOCK of the previous quarter.

C-2-3-3 Transparency on SHARING and EXCHANGE of reserves

The sub-group or Working-group for Reporting together with ENTSO-E Secretariat shall publish annually:

- the compilation of agreements for sharing of FRR and RR for each LFC Block, including the identity of the LFC Blocks and the share of the reduced FRR and RR where an agreement for sharing exists,
- the information on sharing of FCR between SYNCHRONOUS AREAS, including the amount of shared reserve capacity between the TSOs that entered into an agreement as well as the effect of the sharing on the reserve capacity of these TSOs and
- the information on exchange of FCR, FRR and RR.

C-3 DETERMINATION OF THE K-FACTOR

C-3-1 K-FACTOR OF THE SYNCHRONOUS AREA CE

The sub-group or Working-group for Determination of the K-Factor shall determine the K-Factor of the SYNCHRONOUS AREA CE on a yearly basis in accordance with Article 156(2) of the SO GL.

The determination shall be based on the observed outages as stipulated in C.2.2.1. The sub-group or Working-group for Determination of the K-Factor shall analyse the reported data and shall:

- Verify the values of Δf reported by the TSOs in which LFC BLOCK the incident happened by comparing it with the values reported by the other TSOs of the Synchronous Area. In case of remarkable differences – at least when the absolute difference between the Δf of the LFC BLOCK where the event happened and the Δf of any other TSO of the Synchronous Area is larger than 0.015 Hz – the sub-group or Working-group for Determination of the K-Factor shall determine which value of Δf to be used for the calculation of the K-Factor.
- Discard
 - Incidents registered around the hour shift [h-5min; h+5min],
 - Incidents with a calculated Δf below 25 mHz and

- All values outside the 2.5 percentile and 97.5 percentile range to avoid distortion of the result because of not reliable data.
- Determine the total K-Factor by calculating the average value of the remaining events/samples of a period of at least three years. In case the number of remaining events is below 30, the time period has to be extended accordingly.
- Set a minimum value for the K-Factor which is based on the data observed during the previous 5 years. In case the calculated K-Factor is below this minimum value the minimum value shall be used instead.

C-3-2 K-FACTOR OF THE LFC BLOCKS

The sub-group or Working-group for Determination of the K-Factor shall determine the initial K-Factor for each LFC BLOCK ($K_{r,i}$) based on the INITIAL FCR OBLIGATION according to Article 156(3) of the SO GL.

All TSOs shall adapt their $K_{r,i}$ in case of EXCHANGE of FCR within the Synchronous Area of CE according to the actual amount of exchange.

The TSOs participating in an Exchange of FCR between Synchronous Areas acting as the Reserve Connecting TSO shall increase their $K_{r,i}$ according to the actual amount of exchange, whereas the Reserve Receiving TSOs shall not change its $K_{r,i}$ in accordance with C-6-3. A TSO is entitled to increase its $K_{r,i}$ to reflect additionally available FCR which exceeds the INITIAL FCR and additional self-regulation of generation or load for the calculation of the ACE according to Article 143(3) of SO GL. In such a case, the respective TSO shall provide the sub-group or Working-group for Determination of the K-Factor with appropriate information about this procedure. With the exemption of FCR cross-border exchange processes it is not allowed to decrease the $K_{r,i}$ below the initial value.

C-3-3 ADAPTATION OF THE K-FACTOR OF THE LFC BLOCKS IN CASE OF EXCHANGE OF FCR WITHIN THE SYNCHRONOUS AREA

The individual K-Factors ($K_{r,i}$) in MW/Hz of the RESERVE CONNECTING TSO and the RESERVE RECEIVING TSO have to be adapted according to the following formula:

$$\Delta K_{r,i} [\text{MW/Hz}] = \Delta P_{p,i} [\text{MW}] / 0.2 [\text{Hz}] = 5 * \Delta P_{p,i} [\text{MW/Hz}]$$

$\Delta P_{p,i}$ = Amount of exchanged FCR, positive for the RESERVE CONNECTING TSO and negative for the RESERVE RECEIVING TSO.

$\Delta K_{r,i}$ = Correction value of the $K_{r,i}$, positive for the RESERVE CONNECTING TSO and negative for the RESERVE RECEIVING TSO.

C-4 PROCESS OF FCR DIMENSIONING

C-4-1 APPLICATION OF THE DIMENSIONING APPROACH

The sub-group or Working-group for FCR Dimensioning shall apply the rules regarding the FCR dimensioning for the RG CE on a yearly basis in accordance with Article 153 (2a, 2bi, 2c, 2d) of SO GL.

This calculation shall include:

- the total FCR capacity for the Synchronous Area CE;
- the Initial FCR Obligation for all TSOs of each LFC Area.

C-4-1-1 Distribution of FCR

The sub-group or Working-group for FCR Dimensioning shall monitor the distribution of FCR between LFC AREAS on an annual basis.

C-4-1-2 Contribution to FCR

Each LFC Area shall contribute to the compensation of an imbalance proportionally to its respective initial FCR Obligation.

C-5 ONLINE OBSERVATION

The task of online observation is performed during real-time system operation phase primarily by every TSO for its own LFC Block and Area. Furthermore, the Coordination Centres (CCs) observe the entire Synchronous Area by monitoring the LFC input, the ACE value, physical and virtual power flows as well as the Control Program of each LFC Block within their area of responsibility and may store the relevant data to perform ex-post-analyses especially in order to propose improvement measures in case of inconsistencies, insufficient data or poor data quality. The LFC Areas are monitored by their LFC Block as governed by the LFC Block Operational Agreement. If agreed between all TSOs of the LFC Block the CCs can also monitor the LFC Areas, if the necessary data and information stated in this Article is provided. The main goal is to prevent systematic errors in the context of LFC. This shall be achieved by checking the consistency of LFC variables used by the TSOs for the operation of each individual LFC Block and Area.

In terms of frequency control, the CCs main responsibility is to initiate the appropriate extraordinary procedures in case of triggering the alert state due to violation of system frequency limits as defined in Article B-9. In order to fulfil this responsibility, the CCs need to be able to:

- Observe the system state and system frequency in a continuous manner
- Identify causes of frequency deviations
- Contact the responsible Parties
- Coordinate and monitor measures

This article stipulates the minimum requirements for online observation.

C-5-1 CLARIFICATION OF RESPONSIBILITIES

- The consistency of variables is monitored by each TSO for its own LFC Area, by the LFC block monitor for its LFC Block and additionally by the respective CC for each LFC Block/Area
- The CCs rely on online data provided by the LFC Blocks and Areas to perform the monitoring tasks. The provision of the necessary data is performed according to the hierarchy of the operational area according to figure 4 as set out in B-6-1-1, whereby the LFC Blocks/Areas are responsible for the provision and the quality of the data according to C-5-2.
- The CCs may exchange necessary data, which was provided by the respective LFC Blocks/Areas of CC North and South, to perform their tasks as CC.

- the allocation of LFC Blocks/Areas to the respective CCs is determined by the RG CE.

C-5-2 LIST OF VARIABLES SUBJECT TO ONLINE OBSERVATION

The variables in the table below shall be transmitted by every LFC Block/Area to the Coordination Centres. The transmitted values are the values which are used for load frequency control of the LFC Blocks/Areas:

Variable	Unit	Description	Number of values
Frequency <i>f</i>	Hz	Measured Frequency of the control area/ block, which is used in the LFC for calculating the frequency deviation and subsequently the frequency control error ($K \cdot \Delta f$). Accuracy and sensitivity according to SAFA B6-2-2-1-2 ACCURACY OF MEASUREMENTS : “the accuracy and sensitivity of frequency measurement shall be at least 1 mHz”.	1 value per LFC Area/Block
Frequency set-point <i>f_{set}</i>	Hz	Reference frequency set point of the Synchronous Area in Hz equal to the sum of Nominal Frequency of the Synchronous Area and the Frequency Offset used for Time Control. It is used for the calculation for the frequency deviation and subsequently the frequency control error ($K \cdot \Delta f$).	1 value per LFC Area/Block
K-Factor <i>K</i>	MW/Hz	The K-Factor defined in MW/Hz is an estimation for the change of Active Power output of a LFC Area resulting from a Frequency Deviation, i.e. including FCR, self-regulation, etc.	1 value per LFC Area/Block
Frequency Control Error (FCE)	MW	Calculated as $K \cdot (f - f_{set})$.	1 value per LFC Area/Block
Scheduled total power balance <i>P_{set}</i>	MW	Set point power interchange of a LFC Area/Block calculated from the ramped control program. Only exchange program after market closure should be respected. Other exchanges which are included in Virtual power $P_{int,v}$ (e.g. as Setpoint corrections) shall not be included in P_{set} . Positive in case of export, negative for import.	1 value per LFC Area/Block
Physical total power balance <i>P_{int,ph}</i>	MW	Sum of the measured active power flows over physical tie-lines of the LFC Area/Block. Positive in case of export, negative for import.	1 value per LFC Area/Block
Virtual power <i>P_{int,v}</i>	MW	Sum of the flows over Virtual Tie-Lines of the LFC Area/Block including: Market based schedules which are implemented via virtual Tie-Lines (including generators outside the control area), including correction signals from common optimization platforms for Imbalance Netting, aFRR & mFRR energy exchange, including emergency assistance, compensation of unintended exchange. Negative in case of export, positive for import.	1 value per LFC Area/Block

Variable	Unit	Description	Number of values
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Synchronous Area Framework Agreement for Regional Group Continental Europe

$P_{coop,net,v}$	MW	Correction signal from common optimization platforms for aFRR Imbalance Netting only. Negative in case of export.	1 value per LFC Area/Block
$P_{coop,aFRR,cmo,v}$	MW	Correction signal from common optimization platforms for aFRR exchange (common tendering and activation) Negative in case of export.	1 value per LFC Area/Block
$P_{coop,mFRR,cmo,v}$	MW	Correction signal from common optimization platform for mFRR exchange (common tendering and activation). Negative in case of export.	1 value per LFC Area/Block
Power Control Error (PCE)	MW	Calculated as $(P_{int,ph} + P_{int,v}) - P_{set}$.	1 value per LFC Area/Block
LFC Input	MW	The LFC Input is the opposite of the sum of the Power Control Error and the Frequency Control Error. The LFC Input is the input of the aFRR controller. $LFC_{input} = (-1) \cdot (FCE + PCE)$.	1 value per LFC Area/Block
aFRR Demand	MW	The aFRR demand resembles the imbalance before any (coordinated) aFRR activation or imbalance netting process, but after RR and mFRR activation. It is also used as an input value for the common optimization platform for aFRR exchange. Positive for increase in generation, negative for decrease in generation. aFRR demand is calculated as the sum of the already activated aFRR (P_{aFRR}) and $aFRR_{demand} = P_{aFRR} + LFC_{input} + (P_{coop,net,v} + P_{coop,aFRR,cmo,v})$. This aFRR also represents the sum of all BRP imbalances in the LFC area after RR and mFRR activation.	1 value per LFC Area/Block
Physical border power $P_{border,ph}$	MW	The sum of the measurements of the physical cross-border power flows between two LFC Areas/Blocks. Positive value for export, negative value for import, seen from the TSO sourcing the data.	1 value per LFC Area/Block border
Virtual border power $P_{border,v}$	MW	The sum of the measurements/values of the virtual cross-border power flows between two LFC Areas/Blocks, including: market based schedule which are implemented via virtual Tie-Lines (including generators outside the control area), including emergency assistance. As opposed to $P_{int,v}$ signals from common optimization platforms are not included . Negative value for export, positive for import, seen from the TSO sourcing the data.	1 value per LFC Area/Block border
Set border power $P_{border,set}$	MW	Set-point power interchange between two LFC Areas calculated from the ramped Control Program. Positive value for export, negative value for import, seen from the TSO sourcing the data.	1 value per LFC Area/Block border

Additional recommendation:

When deemed necessary it is recommended to provide, individual, instead of aggregated physical tie-line flows to the CCs in order to better identify the cause of frequency deviation and in case of system split. This shall be done via specific arrangement of the CCs with their TSOs.

C-5-3 OBSERVATION OF THE LFC INPUTS

- The LFC Input of each LFC Block/Area within the EAS must be equal to the LFC Input which is sent to the CCs. (taking into account the measurement's range of accuracy and delays between SCADA systems)
- Each LFC Block/Area observes its own LFC input within EAS and ensures that it is correct.

C-5-4 OBSERVATION OF CONTROL PROGRAMS

- The sum of Control Programs (scheduled cross-border flows) of all LFC Blocks/Areas in the Synchronous Area must be equal to zero for all relevant periods.

C-5-5 OBSERVATION OF PHYSICAL CROSS-BORDER POWER FLOWS

- The sum of the measurements of the physical cross-border power flows of all LFC Blocks/Areas within the Synchronous Area is equal to zero at any time (taking into account the measurement's range of accuracy and delays between SCADA systems)

C-5-6 OBSERVATION OF FLOWS THROUGH VIRTUAL TIE-LINES

- Each TSO using a Virtual Tie-Line for the exchange of energy between TSOs shall implement an automatic online monitoring or observation methodology to proof the data plausibility (frozen values or data transmission etc.) of the values exchanged on the Virtual Tie-Line to ensure a secure and correct operation of common systems.
- Such methodologies (e.g. saw tooth signal) shall be implemented by respecting the individual specifications of the optimization processes
- It is up to the TSO if a detected error of an implemented methodology will end up in an alert or automatic reaction. In case of a detected error, the involved TSOs according to B-10 of such an optimization process shall be informed.
- After self-checks by the TSOs the outcome of the different optimization processes shall be sent to CCs for consistency checks as described in C5-2.

C-5-7 OBSERVATION OF FREQUENCY DEVIATION

- The CC shall check the consistency of real-time measured frequency of each LFC Block/Area

C-5-8 OPERATIONAL PROCEDURE IN CASE OF INSUFFICIENT DATA, POOR DATA QUALITY AND INCONSISTENCY

- If the data provided by the TSO does not fulfil the quality needed for monitoring or if the results show inconsistencies according to C-5-3 to C-5-7, the respective CC shall contact the corresponding TSO(s) to request improvement. If needed, the predefined escalation process may be started according to Article 5 of Synchronous Area Framework Agreement (SAFA) for Regional Group Continental Europe.

- the corresponding TSO shall act immediately in order to solve the problem.

C-5-9 TECHNICAL CONDITIONS FOR THE EXCHANGE OF RELEVANT OBSERVATION DATA

- the CCs shall receive data from TSOs through the standard ENTSO-E communication system dedicated for data exchange between TSOs
- The data shall be sent separately to the ENTSO-E Awareness System
- Time resolution for each monitored variable shall not exceed 10 seconds

C-6 EXCHANGE AND SHARING OF FCR BETWEEN SYNCHRONOUS AREAS

C-6-1 DEFINITION OF EXCHANGE AND SHARING

All TSOs agree on the definitions and requirements regarding the exchange and sharing of FCR between Synchronous Areas in this Article.

All TSOs of the Synchronous Area CE are generally allowed to provide FCR from FCR units or groups physically connected in its own Synchronous Area to neighbouring Synchronous Areas and to receive FCR from FCR units or groups which are physically connected to an adjacent Synchronous Area within the limits set in B-17.

C-6-1-1 EXCHANGE

The transfer of FCR between Synchronous Areas is considered as an “exchange”, if the reserve connecting TSO ensures its initial FCR dimensioning obligations in addition to the amount of FCR capacity granted to the reserve receiving TSO in the other Synchronous Area. Furthermore, the reserve receiving TSO obtains a priority access on the amount of FCR subject to this exchange (technically the active-power-set-point of HVDC Reserve Transfer Link).

C-6-1-2 SHARING

The transfer of FCR between Synchronous Areas is considered as “sharing”, if the Reserve Connecting TSO provides FCR capacity which is commonly shared among two TSOs of different Synchronous Areas with respective priority access permissions for the Reserve Connecting TSO. Since the priority access remains with the Reserve Connecting TSO, it is not allowed for the TSOs of Synchronous Area CE to use shared FCR from other Synchronous Areas in order to achieve its own FCR dimensioning obligations. For the avoidance of doubts, according to Article 174(2)(a), the Synchronous Area of CE shall ensure that the sum of FCR provided within the Synchronous Area of CE and from other Synchronous Areas as part of exchange of FCR covers at least the reference incident.

C-6-2 GENERAL REQUIREMENTS FOR EXCHANGE AND SHARING OF FCR

- The Exchange and Sharing of FCR between Synchronous Areas shall be physically implemented through Reserve Transfer HVDC Links by shifting the active-power-set-point.
- The Reserve Receiving and Reserve Connecting TSO shall guarantee the continuous capability of Power Interchange through the Reserve Transfer HVDC Links for the Exchange or Sharing of FCR with the exception of a Forced Outage of the Reserve

Transfer HVDC Link during the time period in which it is obliged to allow Exchange or Sharing of FCR.

- Both, Reserve Receiving TSO and Reserve Connecting TSO shall agree on fallback-procedure and the exchange of information in case of changes in the actual availability of the Reserve Transfer HVDC Links.
- All TSOs involved in an exchange or sharing of FCR between Synchronous Areas shall ensure that the active-power response of the Reserve Transfer HVDC Links fulfils at least the FCR technical minimum requirements (as defined in Article 154 of the SO GL) of both Synchronous Areas.
- The exchange and sharing of Reserves of FCR between Synchronous Areas shall be symmetric in product definition in order to limit the impact in case of system split.
- The sub-group or Working-group for Reporting shall monitor the total exchanged or shared FCR between CE and adjacent Synchronous Areas.

C-6-3 REQUIREMENTS FOR EXCHANGE

- All TSOs involved in the Exchange of FCR shall agree in a FCR Exchange Agreement upon their roles and responsibilities according to Article 173(5) and 126 of the SO GL.
- The exchange of FCR invokes a transfer of the FCR obligation from the Reserve Receiving TSO to the Reserve Connecting TSO for the considered Reserve Capacity on FCR according to Article 173 (3) of the SO GL.
- The Reserve Connecting TSO of Synchronous Area CE, as Reserve Connecting LFC Block, shall increase its K-Factor to integrate the exchanged FCR Capacity.
- The Reserve Receiving TSO of Synchronous Area CE, as Reserve Receiving LFC Block, shall not adjust its K-Factor.

C-6-4 REQUIREMENTS FOR SHARING

- All TSOs of the Synchronous Areas involved in the Sharing of FCR shall agree in a FCR Sharing Agreement according to Article 171(5) and 125 of the SO GL upon their roles and responsibilities.
- The Reserve Connecting TSO of Synchronous Area CE, as Reserve Connecting LFC Block, shall not change its K-Factor to consider the shared FCR Capacity.
- Sharing of FCR with a Reserve Receiving TSO in the Synchronous Area CE is not allowed in accordance with B-17.

C-7 COMMON RULES FOR HVDC RAMPING BETWEEN SYNCHRONOUS AREAS

- All TSOs shall ensure that the ramping period defined in Article 3(147) of SOGL, for active power changes on HVDC interconnectors, is consistent with the common ramping period for ACE calculation for the Synchronous Area. This is necessary to ensure minimal Imbalance effects that will impact the Synchronous Area frequency.
- Each TSO shall have the right to deviate from the above and to define local ramping period, ramping rate and maximum Active Power step ramping parameters, so long as they ensure both FRCE quality of the affected LFC blocks and frequency quality/stability of the Synchronous Areas are not worsened.
- All TSOs of an LFC Block shall ensure that their FRR dimensioning is sufficient to comply with their FRCE parameters, taking into account any Imbalances resulting from HVDC ramping parameters that are not equal to the AC control program according to Article B-4.

- Active power adjustments on HVDC resulting from Imbalance netting, frequency coupling as well as cross-border activation of FRR and RR are explicitly permitted to have different ramping periods than that defined in paragraph (1) above.
- The TSO may define in the LFC Block Agreement the ramping rate MW/min in terms of Active Power step in MW over the ramping period defined in paragraph (1) above. Use of a Max Power step or ramping rate management process may be applied so long as this neither results in a deterioration of the FRCE quality in accordance with Article 137(3) for the LFC Block.
- When establishing the common ramping period between two or more Synchronous Areas the ramping period defined in paragraph (1) shall be defined as the longest period in time, which is implemented in these Synchronous Areas.
- When establishing the common Active Power step between two or more Synchronous Areas, the Active Power Step defined in paragraph (3) shall be defined as the smallest value in MW for the Ramping period defined in paragraph (5), which is implemented in these Synchronous Areas. Where a fixed or variable ramping regime is applied then it is the lower of the ramping-rate restrictions needed by either LFC Block or either Synchronous Area that shall apply for that time period.

C-8 LFC BLOCK DETERMINATION FOR NON-EU TSOs

In addition to A-7 of this policy, the following table shall represent the determination of LFC Blocks for the Synchronous Area Continental Europe for Non-EU TSOs.

Country	TSO (full company name)	TSO (short name)	Monitoring Area	LFC AREA	LFC Block
Albania	Operatori i Sistemit të Transmetimit sh.a	OST	OST	OST	AK
Bosnia and Herzegovina	Nezavisni operator sustava u Bosni i Hercegovini	NOS BiH	NOS	NOS	SHB
Kosovo ¹²	KOSTT J.S.C.	KOSTT	KOSTT	KOSTT	AK
Moldova	State Enterprise Moldelectrica	Moldelectrica	Moldelectrica	NPC «Ukrenergo»	UAMD
Montenegro	Crnogorski elektroprenosni sistem AD	Crnogorski elektroprenosni sistem	CGES	CGES	SMM
FYR of Macedonia	Macedonian Transmission System Operator AD	MEPSO	MEPSO	MEPSO	SMM
Serbia	Joint Stock Company Elektromreža Srbije	EMS	EMS	EMS	SMM
Switzerland	Swissgrid AG	Swissgrid	SG	SG	SG

¹² This designation is without prejudice to positions on status, and is in line with UNSCR 1244 and the ICJ Opinion on the Kosovo declaration of independence

Synchronous Area Framework Agreement for Regional Group Continental Europe

Ukraine	PRIVATE JOINT STOCK COMPANY «NATIONAL POWER COMPANY «UKRENERGO»	NPC «Ukrenergo»	NPC «Ukrenergo»	NPC «Ukrenergo»	UAMD
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- AK: Control Block Albania and Kosovo¹²
- SMM: Control Block Serbia, Macedonia, Montenegro
- SHB: Control Block Slovenia, Croatia and Bosnia/Herzegovina
- UAMD: Control Block Ukraine, Moldova

C-9 LIMITS OF LFC BLOCK CONTRIBUTION TO DETERMINISTIC FREQUENCY DEVIATIONS

To limit the extent of deterministic frequency deviations to the frequency deviation target of 75 mHz, individual target limits for FRCE for each LFC Block shall be calculated on a yearly basis, by the sub-group or working-group for reporting. The contribution limits per LFC Block ($CL_{LFCblock}$) are calculated on the basis of a square root formula, as an empiric approach, taking into account the size of individual LFC Block (L_{max}).

$$L_{max} = \frac{120\% \times \left(\frac{\text{Net generation+consumption per LFC-block}}{2} \right)}{8760 h}$$

$$CL_{LFCblock} = \sqrt{10xL_{max} + 150^2} - 150$$

The TSOs of an LFC Block shall make best efforts not to exceed the respective contribution targets in terms of the instantaneous FRCE data in more than 30% of the hours with deterministic frequency deviations higher than 75 mHz in a quarter of a year. If the target is exceeded, the TSOs of the relevant LFC Block shall implement measures to reduce their contribution.

2024 Values

LFC-Block	belonging LFC-Areas	Contribution Target in MW
AK	OST+KOSTT	40
APG	APG	189
SHB	NOS BiH, HOPS, ELES	130
Elia	Elia	225
ESO	ESO	120
SG	SG	170
CEPS	CEPS	197
TNG+TTG+AMP+50HZT+EN+CRE OS	TNG+TTG+AMP+50HZT+EN+CRE OS	729
REE	REE	500
RTE	RTE	651
IPTO	IPTO	149
MAVIR	MAVIR	120
TERNA	TERNA	496
SMM	CGES, MEPSO, EMS	131
TTB	TTB	254
PSE	PSE	348
REN	REN	145

Synchronous Area Framework Agreement for Regional Group Continental Europe

TEL	TEL	159
SEPS	SEPS	90
TEIAS	TEIAS	528
UAMD	Ukrenergo	250

Past Contribution Target values (for analysis and reporting purposes)

2020 Values

LFC-Block	Belonging LFC-Areas	Contribution Target in MW
OST	OST	31
APG	APG	189
SHB	NOS BiH, HOPS, ELES	140
Elia	Elia	208
ESO	ESO	124
SG	SG	184
CEPS	CEPS	202
TNG+TTG+AMP +50HZT+EN+CREOS	TNG+TTG+AMP +50HZT+EN+CREOS	762
REE	REE	585
RTE	RTE	702
IPTO	IPTO	108
MAVIR	MAVIR	116
TERNA	TERNA	501
SMM	CGES, MEPSO, EMS	149
TTB	TTB	270
PSE	PSE, Western WPS	352
REN	REN	158
TEL	TEL	172
SEPS	SEPS	93
TEIAS	TEIAS	509

2021 Values, from 1 January to 15 June

LFC-Block	belonging LFC-Areas	Contribution Target in MW
OST	OST	25
APG	APG	196
SHB	NOS BiH, HOPS, ELES	135
Elia	Elia	225
ESO	ESO	119

Synchronous Area Framework Agreement for Regional Group Continental Europe

SG	SG	187
CEPS	CEPS	202
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	753
REE	REE	585
RTE	RTE	696
IPTO	IPTO	145
MAVIR	MAVIR	119
TERNA	TERNA	502
SMM	CGES, MEPSO, EMS	149
TTB	TTB	273
PSE	PSE, Western WPS	347
REN	REN	151
TEL	TEL	166
SEPS	SEPS	94
TEIAS	TEIAS	511

2021 Values, from 15 June to 31 December

LFC-Block	belonging LFC-Areas	Contribution Target in MW
AK	OST, KOSTT	47
APG	APG	196
SHB	NOS BiH, HOPS, ELES	135
Elia	Elia	225
ESO	ESO	119
SG	SG	187
CEPS	CEPS	202
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	753
REE	REE	585
RTE	RTE	696
IPTO	IPTO	145
MAVIR	MAVIR	119
TERNA	TERNA	502
SMM	CGES, MEPSO, EMS	135
TTB	TTB	273
PSE	PSE, Western WPS	347
REN	REN	151
TEL	TEL	166
SEPS	SEPS	94
TEIAS	TEIAS	511

2022 Values, from 1 January to 6 June

LFC-Block	belonging LFC-Areas	Contribution Target in MW
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Synchronous Area Framework Agreement for Regional Group Continental Europe

AK	OST+KOSTT	37
APG	APG	194
SHB	NOS BiH, HOPS, ELES	132
Elia	Elia	217
ESO	ESO	114
SG	SG	176
CEPS	CEPS	194
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	732
REE	REE	579
RTE	RTE	665
IPTO	IPTO	142
MAVIR	MAVIR	119
TERNA	TERNA	487
SMM	CGES, MEPSO, EMS	137
TTB	TTB	268
PSE	PSE, Western WPS	340
REN	REN	150
TEL	TEL	161
SEPS	SEPS	93
TEIAS	TEIAS	515

2022 Values, from 7 June to 31 December

LFC-Block	belonging LFC-Areas	Contribution Target in MW
AK	OST+KOSTT	37
APG	APG	194
SHB	NOS BiH, HOPS, ELES	132
Elia	Elia	189
ESO	ESO	114
SG	SG	176
CEPS	CEPS	194
TNG+TTG+AMP+50HZT+EN+CREOS	TNG+TTG+AMP+50HZT+EN+CREOS	732
REE	REE	579
RTE	RTE	665
IPTO	IPTO	142
MAVIR	MAVIR	119
TERNA	TERNA	487
SMM	CGES, MEPSO, EMS	137
TTB	TTB	268
PSE	PSE	331
REN	REN	150
TEL	TEL	161
SEPS	SEPS	93

Synchronous Area Framework Agreement for Regional Group Continental Europe

TEIAS	TEIAS	515
UAMD	Ukrenergo	371

2023 Values

LFC-Block	belonging LFC-Areas	Contribution Target in MW
AK	OST+KOSTT	44
APG	APG	192
SHB	NOS BiH, HOPS, ELES	137
Elia	Elia	222
ESO	ESO	121
SG	SG	172
CEPS	CEPS	200
TNG+TTG+AMP+50HZT+EN+CRE OS	TNG+TTG+AMP+50HZT+EN+CRE OS	746
REE	REE	495
RTE	RTE	685
IPTO	IPTO	153
MAVIR	MAVIR	122
TERNA	TERNA	498
SMM	CGES, MEPSO, EMS	138
TTB	TTB	260
PSE	PSE	351
REN	REN	147
TEL	TEL	168
SEPS	SEPS	98
TEIAS	TEIAS	530
UAMD	Ukrenergo	314