Public

LFC 2024 Annual Report

30 September 2025

National Energy System Operator

Great Britain

NESO
National Energy System Operator

Public

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1. Executive Summary

The 2024 Load-Frequency Control (LFC) annual report has been prepared according to the UK Statutory Instrument, Electricity Network Codes and Guidelines (System Operation and Connection) (Amendment etc.) (EU Exit) Regulations 2019 (S.I. 2019/533)(Schedule 1) that reflect amendments on Article 16 of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (SOGL).

The LFC report aims to present the results of the frequency quality evaluation criteria for the synchronous area and LFC block, and the FCR obligations and the initial FCR obligations of the GB power system for each month of the preceding two years. Additional details include a description and the date of implementation of any mitigation measures and ramping requirements to alleviate deterministic frequency deviations in which the GB power system was involved during the last preceding year.

In 2024, the GB power system reached their frequency quality target. The present report provides data and explanations of any mitigation measures where applicable.

2. Introduction

The load-frequency control (LFC) annual report is a requirement of the Commission Regulation (EU) 2017/1485 of 2 August 2017, which established a guideline on electricity transmission system operation (SOGL).

Article 16 of SOGL requires Transmission System Operators (TSOs) of each European Union Member State to provide ENTSO-E with the necessary data and information for the preparation and creation of the LFC annual report. ENTSO-E is required to publish the annual report. Under the UK Statutory Instrument, Electricity Network Codes and Guidelines (System Operation and Connection) (Amendment etc.) (EU Exit) Regulations 2019 (S.I. 2019/533)(Schedule 1) that reflect amendments on Article 16 of the Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (SOGL), National Energy System Operator (NESO) has the obligation to prepare and publish the annual load-frequency control (ALFC) report for the GB synchronous area.

The objectives of the report include:

a) the identification, graphical representation, and associated monitor for the GB synchronous area and LFC block.

b) the frequency quality evaluation criteria results for the GB synchronous area and LFC block.

c) the description and date of implementation of any mitigation measures and ramping requirements to alleviate deterministic frequency deviations in which NESO was involved during the preceding year.

d) the FCR obligation and the initial FCR obligation of NESO for each month of the preceding two years.

2.1 Synchronous Area and LFC Block Identification

In this section, the requirements of SOGL Article 16(2)(a), (b) and (c) are reported with the goal of identifying the LFC block, LFC area, and monitoring area in the GB power system. The synchronous area included in this document is Great Britain, as shown in Table 1. GB SA identification of LFC blocks and graphically in Figure 1. Great Britain Synchronous Area and LFC Block. below. The LFC block and LFC block monitor are reported in Table 1. GB SA identification of LFC blocks

Figure 1. Great Britain Synchronous Area and LFC Block.

According to Article 133 of the SOGL, all TSOs of a synchronous area shall, in the synchronous area operational agreement, appoint one TSO of that synchronous area as the synchronous area monitor. The synchronous area monitor shall implement the data collection and delivery process of the synchronous area referred to in Article 132 of the SOGL and implement the criteria application process referred to in Article 129 of the SOGL.

Furthermore, the synchronous area monitor shall collect the frequency quality evaluation data of its synchronous area and perform the criteria application process, including the calculation of the frequency quality evaluation criteria, once every three months and within three months after the end of the analysed period.

According to Article 118 of the SOGL, the associated monitor for the GB synchronous area is NESO (formerly National Grid ESO).

Table 1. GB SA identification of LFC blocks

LFC Block	LFC Area	LFC Block Monitor	Country
GB	NESO	NESO	Great Britain

3. Frequency Quality Evaluation

3.1 Introduction and target parameters

To maintain the power system frequency within secure limits, NESO shall maintain the balance between load and generation on a short-term basis. The first step of balancing actions is the application of Frequency Containment Reserves (FCR). These reserves are activated quickly (typically within 30 s), stabilising the power system frequency and ensuring that the frequency deviation will not further increase. The Frequency Containment Process (FCP) will stabilise the frequency with an offset from 50 Hz, but it is the change of speed of the rotating masses, inertia, that ensures the frequency change is damped so that FCR is able to contain and stabilise the frequency at a value close to 50 Hz.

The second step is assigned to Frequency Restoration Reserves (FRR) which replace FCR and restore the frequency to the target frequency. SOGL defines two types of FRR: automatic (aFRR) and manual (mFRR). FRR is activated by an automatic control device or by manual activation, which reduces the Frequency Restoration Control Error (FRCE) to zero. For aFRR, this control device usually is called a Load-Frequency Controller (LF-Controller). The LF-Controller is physically a process computer that is implemented in the NESO's control centre systems (SCADA/EMS/AGC) and collects FRCE measurements every 4–10s, thus providing—in the same time cycle—automated instructions to balancing service providers that are connected by data communication links.

The Frequency Restoration Process (FRP), aFRR and mFRR, restores frequency by replacing the power from the FCR. This principle is applicable for normal imbalances such as the activation of a light bulb, the start of a train, or the sudden outage of a large power plant. Market behaviour, such as the stop and start of production units at hour shift, will also create a power imbalance and result in frequency deviations.

All frequency deviations are recorded carefully for further analyses. SOGL defines processes for the calculation and the evaluation of frequency data, and the required parameters for the GB synchronous area and LFC block (defined in SOGL in Articles 127–131 and in Annex III–V) are presented below in Table 2 and Table 3.

Table 2. Frequency quality defining parameters of the GB synchronous area, as shown in Annex III Table 1 of the SOGL.

Data item	GB
Standard frequency range	±200 mHz
Maximum instantaneous frequency deviation	800 mHz
Maximum steady-state frequency deviation	500 mHz
Time to recover frequency	1 minute
Frequency recovery range	±500 mHz
Time to restore frequency	15 minutes
Frequency restoration range	±200 mHz
Alert state trigger time	10 minutes

Table 3. Frequency quality target parameters of the GB synchronous area, as shown in Annex III Table 2 of the SOGL.

Data item	GB
Maximum number of minutes outside the standard frequency range	15 000

Considering the aforementioned information for the GB synchronous area during operation in a normal state or an alert state, the following values are reported on a monthly basis for the instantaneous frequency data:

i. The mean value.

ii. The standard deviation.

iii. The 1st, 5th, 10th, 90th, 95th and 99th percentiles.

iv. The total time during which the absolute value of the instantaneous frequency deviation was larger than the standard frequency deviation, distinguishing between positive and negative instantaneous frequency deviations.

v. The total time during which the absolute value of the instantaneous frequency deviation was larger than the maximum instantaneous frequency deviation, distinguishing between positive and negative instantaneous frequency deviations.

vi. The number of events in which the absolute value of the instantaneous frequency deviation of the synchronous area exceeded 200% of the standard frequency deviation and the instantaneous frequency deviation was not returned to the frequency restoration range for the GB synchronous area within the time to restore frequency. The data distinguish between positive and negative frequency deviations.

vii. The number of events for which the absolute value of the instantaneous frequency deviation was outside of the frequency recovery range and was not returned to the frequency recovery range within the time to restore frequency, distinguishing between positive and negative frequency deviations.

For the LFC block of the GB synchronous area, during operation in a normal state or alert state and in accordance with Article 18(1) and (2), the following data are presented on a monthly basis and for a data-set containing the average values of the FRCE of the LFC block over time intervals with a length of one minute: the number of events for which the absolute value of the FRCE exceeded the maximum steady-state frequency deviation and the FRCE was not returned to 10% of the maximum steady-state frequency deviation within the time to restore frequency, distinguishing between positive and negative FRCE.

3.2 Frequency Performance

Figure 2 and Figure 3 in this Section present the frequency performance for Great Britain for the years 2023 and 2024. Input values for frequency are based on instantaneous frequency values. Based on the input values, mean value, standard deviation and percentiles were calculated. Moreover, any time periods and events where the system frequency was outside of predefined ranges were also indicated. For data points where the frequency was outside of the 200 mHz – 800 mHz range, time is measured in minutes.

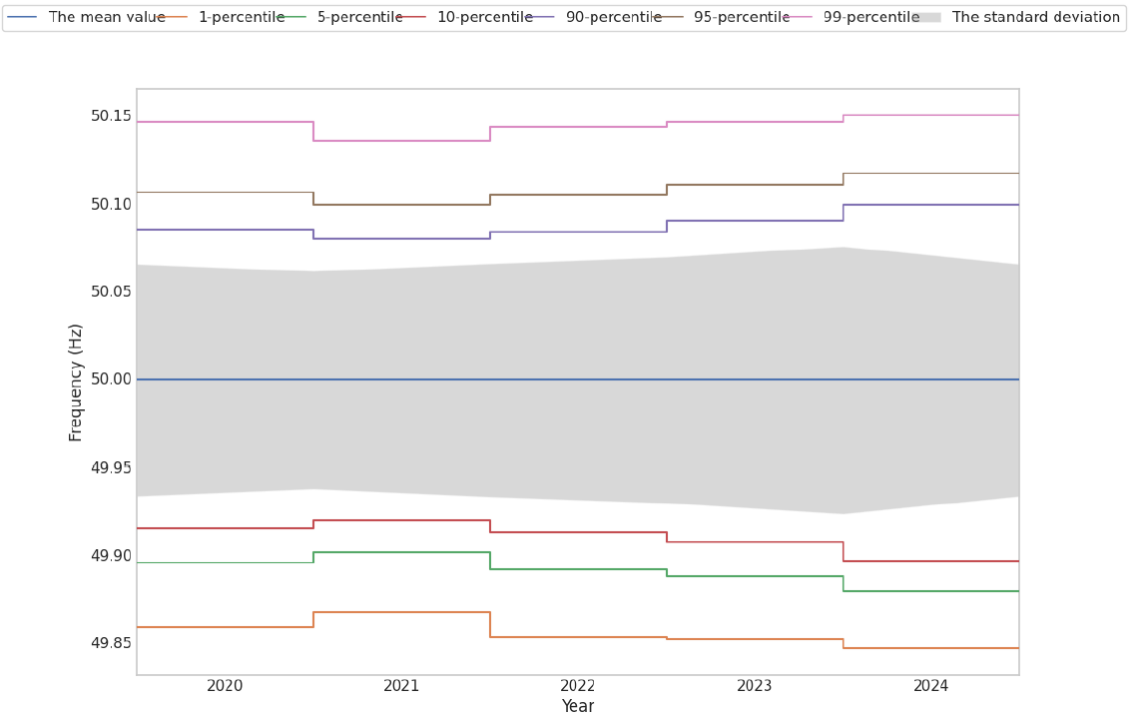

Figure 2. Annual frequency percentiles and standard deviation in Great Britain 2020–2024.

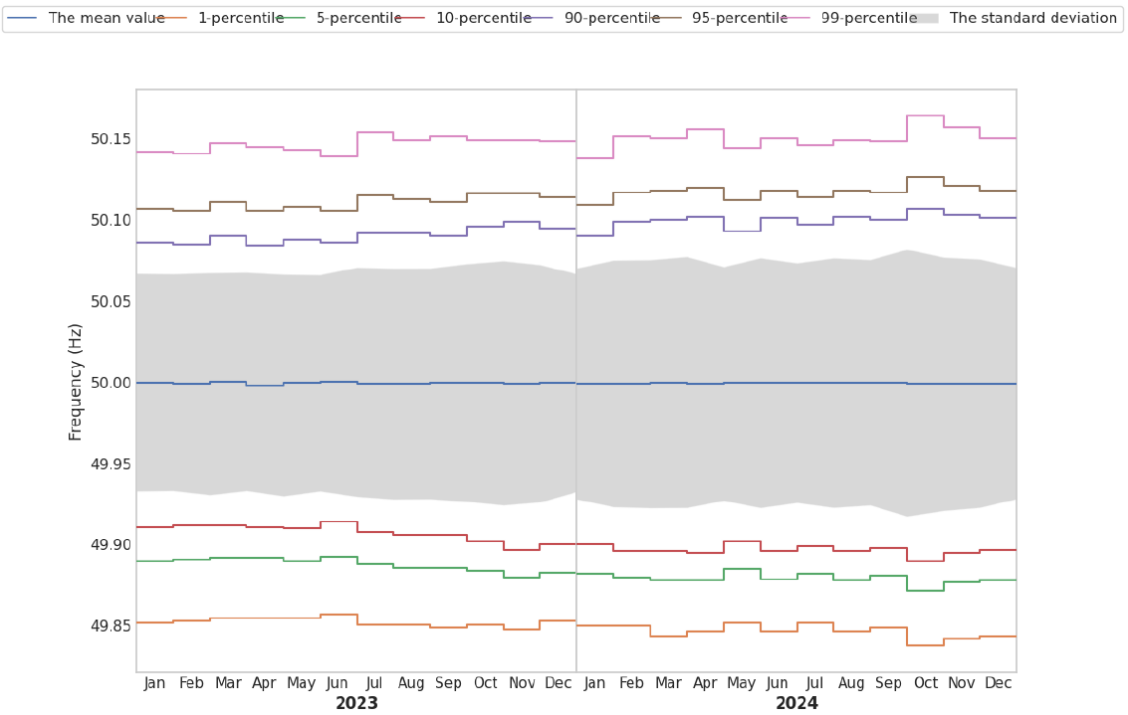

Figure 3. Monthly frequency percentiles and standard deviation in Great Britain for 2023 and 2024.

In Figure 4 and Figure 5, the accumulated minutes outside standard ranges are presented for the years 2023 and 2024, respectively. The frequency quality target parameter, as defined in the SOGL, is 15000 minutes per year for each synchronous area. The monthly target parameter can be considered as 1/12 of this value, that is, 1250 minutes.

The graphs below show that the frequency quality was exceptionally good and that all target parameters from SOGL were fulfilled in the Great Britain Synchronous Area during the respective years.

The yearly trend shows that only a few minutes were observed where the frequency was outside the standard frequency range of +/- 200mHz for GB.

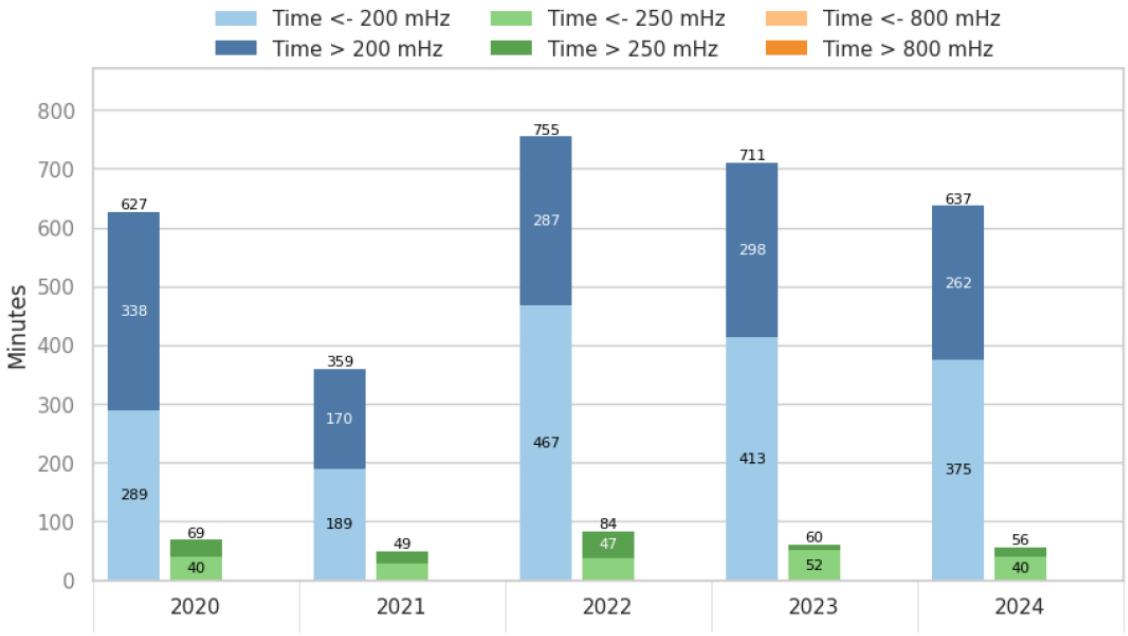

Figure 4. Annual number of minutes outside the standard ranges in Great Britain for 2020–2024.

The monthly trend shows that only a few minutes were observed where the frequency was outside the standard frequency range of +/- 200mHz for GB.

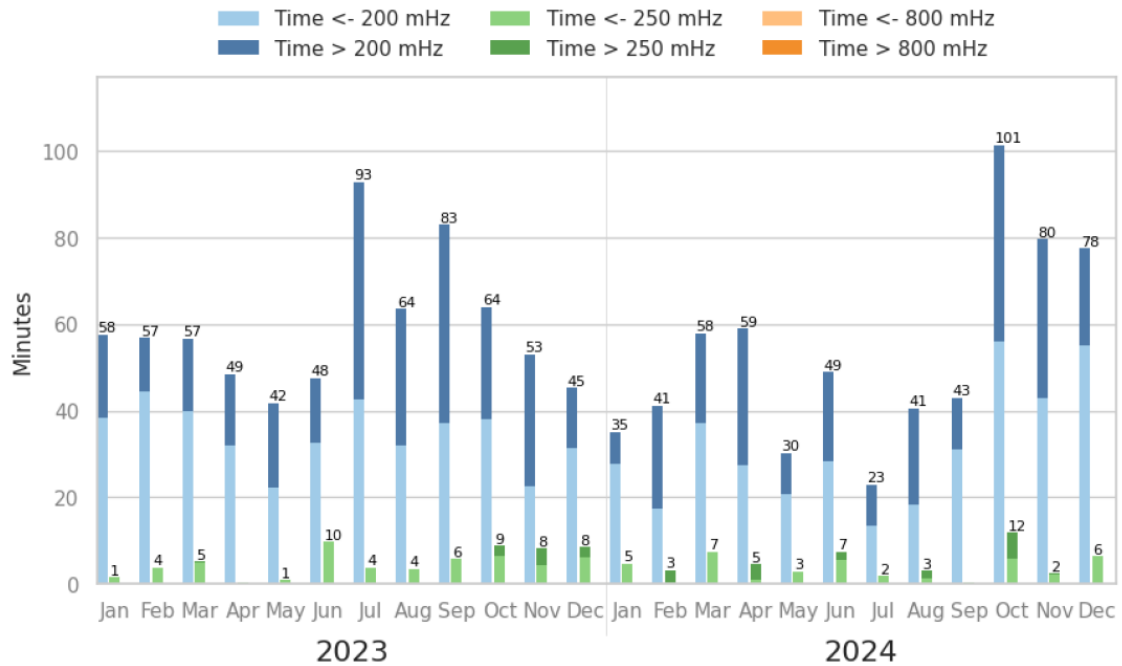

Figure 5. Monthly number of minutes outside the standard ranges in Great Britain for 2023 and 2024.

4. FRC Data

4.1 Introduction

The annual report on load-frequency control provides information on the FCR obligations and the initial FCR obligations of NESO, covering each month of at least two previous calendar years. Furthermore, the SOGL requests that companies report two separate values regarding FCR with the following definitions:

a) FCR obligation refers to the portion of all the FCR that falls under the responsibility of NESO; and
b) Initial FCR obligation refers to the amount of FCR allocated to NESO on the basis of a sharing key.

Initial FCR obligation is reported on a monthly basis as an average value of FCR in MWs for the reported month. For TSOs that have the same value of initial FCR obligation for the whole year, TSO reports the same value for all months for the reported year. Otherwise, if the initial FCR obligation is not constant during a period, the TSO reports an average value of the FCR on a monthly level for the reported year.

4.2 NESO (GB TSO)

In Table 4 and Table 5 below, the FCR is presented from January (I) to December (XII) for 2023 and 2024. The FCR requirement for the Synchronous Area of GB is dynamic and it varies over a day; therefore, it is represented as a historical monthly MW average. In calculating the 'Average monthly FCR', the record spot FCR values are averaged over the monthly period. The amount of FCR obtained inside the area of NESO is also given as a percentage.

Table 4. FCR statistics for Great Britain for 2023.

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Monthly FCR [MW]	1256	1235	1051	1105	1187	1289	1666	1469	1498	1542	1301	1530
FCR obtained inside the area of TSO [%]	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Table 5. FCR statistics for Great Britain for 2024.

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average Monthly FCR [MW]	1262	1255	1341	1709	1652	1796	1675	1903	1712	1396	1328	1508
FCR obtained inside the area of TSO [%]	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Glossary

AGC	Automatic Generation Control
ALFC	Annual Load-Frequency Control
EMS	Energy Management System
ENTSO-E	European Networks of Transmission System Operators for Electricity
EU	European Union
FC	Frequency Containment Process
FCR	Frequency Containment Reserves
FRCE	Frequency Restoration Control Error
FRP	Frequency Restoration Process
FRR	Frequency Restoration Reserves
aFRR	automatic Frequency Restoration Reserves
mFRR	manual Frequency Restoration Reserves
GB	Great Britain
LFC	Load-Frequency Control
LF-Controller	Load-Frequency Controller
NESO	National Energy System Operator
SCADA	Supervisory Control And Data Acquisition
SOGL	System Operator Guideline
TSO	Transmission System Operator

5. Appendix 1. Synchronous Area Data – Great Britain

Table 6. GB SA Performance for year 2023.

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sepr	Oct	Nov	Dec	Yr
The mean value	50.00003	49.99910	50.00048	49.99826	49.99962	50.00027	49.99917	49.99929	49.99980	49.99959	49.99936	49.99971	49.99956
The standard deviation	0.06704	0.06679	0.06838	0.06724	0.06829	0.06663	0.07059	0.07113	0.07111	0.07320	0.07522	0.07311	0.06989
1-percentile	49.852	49.853	49.855	49.855	49.855	49.857	49.851	49.851	49.849	49.851	49.848	49.853	49.85250
5-percentile	49.890	49.891	49.892	49.892	49.89	49.893	49.888	49.886	49.886	49.884	49.88	49.883	49.88792
10-percentile	49.911	49.912	49.912	49.911	49.91	49.914	49.908	49.906	49.906	49.902	49.897	49.9	49.90742
90-percentile	50.086	50.085	50.09	50.084	50.088	50.086	50.092	50.092	50.09	50.096	50.099	50.095	50.09025
95-percentile	50.107	50.106	50.111	50.106	50.108	50.106	50.115	50.113	50.111	50.116	50.116	50.114	50.11075
99-percentile	50.142	50.141	50.147	50.145	50.143	50.139	50.154	50.149	50.151	50.149	50.149	50.148	50.14642
Time > 200 mHz	19	13	17	17	20	15	50	32	46	26	30	14	298
Time < -200 mHz	38	44	40	32	22	33	43	32	37	38	23	31	413
Time > 800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time < -800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
No.of events freq.dev > 400 and > 200 mHz within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq.dev < -400 and < -200 mHz within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq.dev > 500 mHz and > 1 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq.dev < -500 mHz and > 1 min	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 7. GB SA Performance for Year 2024.

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sepr	Oct	Nov	Dec	Yr
The mean value	49.99924	49.99906	50.00008	49.99921	49.99968	49.99972	49.99972	49.99994	49.99969	49.99900	49.99938	49.99951	49.99952
The standard deviation	0.07118	0.07596	0.07639	0.07728	0.07204	0.07691	0.07385	0.07683	0.07559	0.08215	0.07800	0.07646	0.07605
1-percentile	49.85000	49.85000	49.84400	49.84700	49.85200	49.84700	49.85200	49.84700	49.84900	49.83800	49.84200	49.84400	49.84683
5-percentile	49.88200	49.88000	49.87800	49.87800	49.88500	49.87900	49.88200	49.87800	49.88100	49.87200	49.87700	49.87800	49.87917
10-percentile	49.90000	49.89600	49.89600	49.89500	49.90200	49.89600	49.89900	49.89600	49.89800	49.89000	49.89500	49.89700	49.89667
90-percentile	50.09000	50.09900	50.10000	50.10200	50.09300	50.10100	50.09700	50.10200	50.10000	50.10700	50.10300	50.10100	50.09958
95-percentile	50.10900	50.11700	50.11800	20.12000	50.11200	50.11800	50.11400	50.11800	50.11700	50.12600	50.12100	50.11800	47.61733
99-percentile	50.13800	50.15100	50.15000	50.15600	50.14400	50.15000	50.14600	50.14900	50.14800	50.16400	50.15700	50.15000	50.15025
Time > 200 mHz	8	24	21	31	10	21	10	22	12	45	37	23	262
Time < -200 mHz	28	17	37	28	21	28	13	18	31	56	43	55	375
Time > 800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
Time < -800 mHz	0	0	0	0	0	0	0	0	0	0	0	0	0
No.of events freq.dev > 400 and > 200 mHz within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq.dev < -400 and < -200 mHz within 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq.dev > 500 mHz and > 1 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of events freq.dev < -500 mHz and > 1 min	0	0	0	0	0	0	0	0	0	0	0	0	0

6. Appendix 2. Block Data – Great Britain

Table 8. GB LFC FRCE Statistic for Year 2023.

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
No.of events: FRCE > 500 mHz and > 50 mHz after 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No.of events: FRCE < -500 mHz and< -50 mHz after 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 9. GB LFC FRCE Statistic for Year 2024.

Data item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yr
No.of events: FRCE > 500 mHz and > 50 mHz after 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0
No.of events: FRCE < -500 mHz and< -50 mHz after 15 min	0	0	0	0	0	0	0	0	0	0	0	0	0

Additionally, the synchronous area of GB is required to report the number of time intervals outside Level 1 and Level 2 FRCE ranges over the course of one year. The GB values are presented in Table 10. The time intervals are aligned with Annex III, Table 1, of the SOGL and the number of time intervals is calculated using the following procedure:

1. If the frequency deviation is ≥ 200 mHz over a 15-minutes period or ≤ -200 mHz over a 15-minute period, this qualifies as a Level 1 event.

2. If the frequency deviation is ≥ 500 mHz over a 1-minute period or ≤ -500 mHz over a 1-minute period, this qualifies as a Level 2 event.

3. The Level 1 FRCE target parameter = 3%, which is 35 040 (periods) × 0.03 = 1 051 periods.

4. The Level 2 FRCE target parameter = 1%, which is 525 600 (periods) × 0.01 = 5 256 periods.

Table 10. GB LFC Number of Time Intervals Outside Range for Years 2023 and 2024.

Data item	2023	2024
Number of time intervals frequency deviates outside +/- 200 mHz	0	0
Number of time intervals frequency deviates outside +/- 500 mHz	0	0