
Supporting document to the GB
Synchronous Area Operational
Methodologies developed in
accordance with Article 118 of
Commission Regulation (EU)
2017/1485 of 2 August 2017
establishing a guideline on electricity
transmission system operation

14 September 2018

Disclaimer

This explanatory document is provided by NGET for information purposes only and accompanying the NGET proposal for the GB Synchronous Area Operational Methodologies document in accordance with Article 118 of Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system.

Contents

Introduction.....	5
General information about the Synchronous Area Operational Methodologies and the document for GB	6
Subject matter and scope.....	6
Governance and implementation within GB.....	7
Methodologies from Article 118 that are subject to National Regulatory Authority (OFGEM) approval.	10
Methodologies from Article 118 that are NOT subject to National Regulatory Authority (OFGEM) approval.....	11
Timeline for the initial SAOM development process	13
Revisions to the SAOM for GB.....	13
TITLE 2 - Explanatory text to accompany each agreement Article in the SAOM document that is subject to NRA approval.....	14
SAOM Article 3 - SOGL Article 118(a) - “the dimensioning rules for FCR in accordance with Article 153;”	14
SAOM Article 4 - SOGL Article 118(b) - “additional properties of FCR in accordance with Article 154(2);”	15
SAOM Article 5 - SOGL Article 118(c) - “the frequency quality defining parameters and the frequency quality target parameters in accordance with Article 127;”	16
SOGL - ANNEX III	17
SAOM Article 6 - SOGL Article 118(m) - “for the GB synchronous areas, measures to ensure the recovery of energy reservoirs in accordance with to Article 156(6)(b);”	19
SAOM Article 7 – for the CE and Nordic synchronous areas, the minimum activation period to be ensured by FCR providers in accordance with Article 156(10);	20
SAOM Article 9 – SOGL Article 118(t) – “if applicable, for synchronous areas other than CE, limits for the exchange of FCR between the TSOs within the same synchronous area in accordance with SOGL Article 163(2);”	21
SAOM Article 10 - SOGL Article 118 (y) for the GB synchronous areas, the methodology to determine the minimum provision of reserve capacity [within the GB synchronous area] on FCR in accordance with SOGL Article 174(2)(b);.....	21
SAOM Article 11 - SOGL Article 118(z) - “the methodology to determine limits on the amount of exchange of FRR between synchronous areas defined in accordance with Article 176(1) and the methodology to determine limits on the amount of sharing of FRR between synchronous areas defined in accordance with Article 177(1); and”	22

SAOM Article 12 - SOGL Article 118(aa) - “the methodology to determine limits on the amount of exchange of RR between synchronous areas defined in accordance with Article 178(1) and the methodology to determine limits on the amount of sharing of RR between synchronous areas defined in accordance with Article 179(1).”	23
TITLE 3 - Explanatory text to accompany each Article in the SAOM document that is not subject to NRA approval.....	23
SAOM Article 13 - SOGL Article 118 (d) for the Continental Europe (‘CE’) and Nordic synchronous areas, the frequency restoration control error target parameters for each LFC block in accordance with Article 128;	23
SAOM Article 14 - SOGL Article 118 (e) the methodology to assess the risk and the evolution of the risk of exhaustion of FCR of the synchronous area in accordance with Article 131(2);.....	24
SAOM Article 15 - SOGL Article 118 (f) the synchronous area monitor in accordance with Article 133;	24
SAOM Article 16 - SOGL Article 118 (g) the calculation of the control program from the netted area AC position with a common ramping period for ACE calculation for a synchronous area with more than one LFC area in accordance with Article 136;	25
SAOM Article 17 - SOGL Article 118 (h) if applicable, restrictions for the active power output of HVDC interconnectors between synchronous areas in accordance with Article 137(1);	25
SAOM Article 18 - SOGL Article 118 (i) the LFC structure in accordance with Article 139;.....	25
SAOM Article 19 - SOGL Article 118 (j) if applicable, the methodology to reduce the electrical time deviation in accordance with Article 181;	27
SAOM Article 20 - SOGL Article 118 (k) whenever the synchronous area is operated by more than one TSO, the specific allocation of responsibilities between TSOs in accordance with Article 141; ...	27
SAOM Article 21 - SOGL Article 118 (l) operational procedures in case of exhausted FCR in accordance with Article 152(7).....	27
SAOM Article 22 - SOGL Article 118 (n) operational procedures to reduce the system frequency deviation to restore the system state to normal state and to limit the risk of entering into the emergency state in accordance with Article 152(10);.....	29
SAOM Article 23 - SOGL Article 118 (o) the roles and responsibilities of the TSOs implementing an imbalance netting process, a cross-border FRR activation process or a cross-border RR activation process in accordance with Article 149(2)	30
SAOM Article 24 - SOGL Article 118 (p) requirements concerning the availability, reliability and redundancy of the technical infrastructure in accordance with Article 151(2);	30
SAOM Article 25 - SOGL Article 118 (q) common rules for the operation in normal state and alert state in accordance with Article 152(6) and the actions referred to in Article 152(15);	31
SAOM Article 26 - SOGL Article 118 (r) for the CE and Nordic synchronous areas, the minimum activation period to be ensured by FCR providers in accordance with Article 156(10);	Error!
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SAOM Article 27 - SOGL Article 118 (s) for the CE and Nordic synchronous areas, the assumptions and methodology for a cost-benefit analysis in accordance with Article 156(11); Error! Bookmark not defined.	

SAOM Article 28 - SOGL Article 118 (u) the roles and responsibilities of the reserve connecting TSO, the reserve receiving TSO and the affected TSO as regards the exchange of FRR and RR defined in accordance with Article 165(1);..... 31

SAOM Article 29 - SOGL Article 118 (v) the 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 defined in accordance with Article 166(1); 31

SAOM Article 30 - SOGL Article 118 (w) 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 between synchronous areas defined in accordance with Article 171(2); 32

SAOM Article 31 - SOGL Article 118(x) - “the methodology to determine limits on the amount of sharing of FCR between synchronous areas defined in accordance with Article 174(2);” 33

SAOM Article 32 – Timescales for implementation.....**Error! Bookmark not defined.**

Introduction

1. The Commission Regulation (EU) 2017/1485 of 2 August 2017 establishing a guideline on electricity transmission system operation (hereafter "**SOGL**") was published in the official Journal of the European Union on 25 August 2017 and entered into force on 14 September 2017. The SOGL sets out guidelines regarding requirements and principles concerning operational security, as well as the rules for determining common load-frequency control processes and control structures and to maintaining a frequency quality level of the synchronous area.
2. Article 118 of SOGL requires the development of Synchronous Area Operational Methodologies (hereafter "**SAOM**") for Great Britain by 12 months after entry into force. Those elements of the SAOM also referenced in Article 6(3) of the SOGL are subject to public consultation in accordance with Article 11 of the SOGL, prior to NRA approval.
3. The supporting document has been developed to provide interested parties with greater descriptive information and explanation of the methodology text contained in the SAOM.
4. It is recommended that the GB LFC Block Operating Methodologies document and its associated Supporting Document be considered alongside the SAOM text. Additionally, it is useful to consider the "Determination of LFC Blocks, for the Synchronous Area GB".
5. When considering how some processes and restrictions might apply cross-border to HVDC interconnectors between GB and other areas, it may be necessary to consider the contents of the neighbouring TSOs LFC Operational Methodologies and their Synchronous Area Operational Methodologies.

General information about the Synchronous Area Operational Methodologies and the document for GB

Subject matter and scope

1. The Synchronous Area Operational Agreement (SAOM) for Great Britain contains:
 - a. Title 2: Those Articles referenced in both SOGL articles 118 and 6(3). These are subject to OFGEM approval and public consultation from SOGL Article 11.
 - b. Title 3: Those Articles referenced in SOGL Article 118 but not found in SOGL Article 6 or 11. These Articles are those which require no formal approval from OFGEM and for which there is no legal obligation on the ESO to consult publicly before the texts enter in force and are published.
2. The SOGL refers to the individual texts as 'Methodologies'. To all intents and purposes there is no practical implementation distinction between an 'agreement', a 'methodology' or 'terms and conditions'. This can be inferred from Article 6 cross-referencing articles 118 and 119, which refer to the texts as 'methodologies', whilst article 6 itself considers them to be methodologies, terms and conditions. The origins of the name 'agreement' comes from the need in those parts of Europe where control areas are operated in a coordinated manner and for which an 'agreement' is required between those performing the system operator function(s) there.
3. The SOGL regulation considers some texts to apply to certain geographies: the SAOM is considered a GB specific text. Article 118 specifies that "all [competent] TSOs of each synchronous area shall jointly develop common proposals for..." indicating that it is the relevant electricity system operator(s) of each synchronous area to develop proposals. Some texts however, most especially the ramping-restrictions texts, have cross-border significance and it is easier to seek informal alignment of rules and texts in the neighbouring areas' operational methodologies prior to implementation.
4. The structure of the SOGL specifies several sub-divisions of system operator function, with shared roles and lead roles in each geography and level in the hierarchy. This is explained in the separate methodology for the 'Determination of LFC Blocks, for the Synchronous Area GB'. For GB there are no subdivision of roles, responsibilities and activities for the system operator function and all of these are assigned to a single ESO function.
5. Many of the texts in the SAOM make references to GB electricity codes. It is necessary to ensure alignment of GB regulation and electricity codes with roles, responsibilities, structures, processes and data management rules of the EU guidelines of which SOGL is one example. The agreements including the SAOM is an extension to the EU guideline but of GB relevance and under the GB regulatory authority, OFGEM. Many of the processes, rules and structures that need to be defined in the agreements are already defined within GB electricity codes and to avoid duplication and unnecessarily complex ongoing change management it is felt appropriate to keep the level of detail in the methodologies to a minimum and to refer to the GB regulation where at all possible. It is by referring to

referenced document, read in the context of this supporting document that the specific understanding of how the methodology is to implemented may be determined.

Governance and implementation within GB

1. OFGEM is the sole competent Regulatory Authority for the SAOM of Great Britain. Some parts of the SOGL regulation refer to the NRA or National Regulatory Authority.
2. Between the time of the obligations for drafting these agreements and a short period after they become applicable, the license for the electricity system operation role and function within GB will be unbundled from National Grid Electricity Transmission plc (NGET) and transferred to an independent electricity system operator, National Grid Electricity System Operator (NGESO) on 1st April 2019¹. To make this document easier to read and for easier ongoing management and regulation of the SAOM the term “ESO” is used whenever describing the license holder responsible for operating the National Electricity Transmission System (also referred to as the NETS) and in relation to the fulfilment of the security and operating standards set forth in the SOGL and complementary obligations set forth in the GB electricity codes. For avoidance of doubt “ESO” in the SAOM refers to NGET at the time of drafting and will refer to National Grid Electricity System Operator Limited
3. OFGEM determined in the “GB TSO responsibility mapping document”² published on 14th September 2018, that SOGL Article 118 is the sole responsibility of the ESO function in GB to draft. Purely for clarity it may be noted that the sub-division of TSO roles between network asset owner functions and operator functions is not always present in other parts of the European Union.
4. The SOGL determines that there are two paths for approvals in the SAOM (Article 118):
 - a. Those agreements from SOGL Article 118 developed by the ESO for GB which are referenced in SOGL Article 6(3) concerning NRA approval are subject to a public consultation from SOGL Article 11 and then NRA (OFGEM) approval. These are contained in Title 2 of the SAOM document (see the next section for a list);
 - b. Those agreements from SOGL Article 118 not requiring OFGEM approval or public consultation will be drafted by the ESO. These agreements are found in Title 3 of the SAOM document.
 - c. The SAOM document will be published at the end of the drafting and approval process according to SOGL Articles 8, 183, 184 on the ENTSO-E website where specified otherwise on the ESO’s website.
5. Whilst the SAOM includes agreements specific to the security considerations of exchanged and shared services via HVDC interconnectors with other synchronous areas, these agreements only consider the GB implications on security and effective operation of the

¹ <https://www.ofgem.gov.uk/publications-and-updates/future-arrangements-electricity-system-operator-response-consultation-so-separation>

² The TSO mapping document for assigning SOGL TSO roles to individual license holders as SO, TO, IC, OFTO within GB. This mapping used a former acronym for this regulation, namely TSOG:
<https://www.ofgem.gov.uk/publications-and-updates/decision-assignment-transmission-system-operator-obligations-under-guideline-electricity-transmission-system-operation-regulation-within-gb>

Load Frequency Control Structure and not the needs of other synchronous areas. This having been said, the interconnector operation and active power interchange across the HVDC interconnectors must take account of restrictions placed on them by GB operational agreements and those from other connecting areas and even wider areas in the case where those areas LFC processes interact with the cross-border power exchange and service exchange.

- a. Example: Ramping Restrictions may be specified in the GB SAOM and GB LFCBOA; whilst additional restrictions may be specified within the analogous operational agreements of the connecting areas.
 - b. Example: Cross Border Exchange service for Replacement Reserves may have design features determined by the specific needs or restrictions placed on the service by one or more of the participating areas. These may impact the interaction of the individual area or the general architecture of the exchange platform. For example each participating Synchronous Area may in the SAOM specify limits for the sharing or exchange of RR with other areas.
6. GB shall (subject to discussions in Grid Code working-group GC-0114, which are ongoing at the time of writing) continue to have multiple reserve and response services operated using multiple control processes; a design which allows for greater optimization of needs and technical capabilities of providers and an architecture expressly permitted by the EBGL.
- a. The European Balancing Guideline (EBGL)³ partner regulation to SOGL recognizes there to be multiple specific and standard products. A reserve product from EBGL is the commercial and market embodiment that extends the technical reserve service requirements of SOGL. SOGL only considers the technical characteristics of a service and its relationship to control processes designed to meet frequency quality standards.
 - b. To explain that multiple control processes map into three types of SOGL defined control structures (FCP, FRP and RRP) and that these control structures create the need for SOGL defined reserve categories with common purpose but into which specific services with their distinct technical and service criteria fit.
 - c. The title of the 'agreements' within the SAOM consider the principles that each Synchronous Area has its own frequency quality standards (SOGL articles 127 and 128); that the ESOs of each Synchronous Area according to the Load Frequency Control structure (SOGL articles 139 to 141) must according to their Process Responsibility Structure (in GB the single ESO is responsible for all aspects where relevant) design an appropriate Process Activation Structure. (This is developed later in this document in the SAOM article 18). It is these national and cross-border control process types which then direct the needs of specific reserve categories.
 - d. Each reserve type must have a size requirement or 'Capacity' defined and used in control planning and operations across different time horizons. In reserve contracting timescales this 'Capacity' is the same as the value used to determine the TSO need for contracted reserve & response services in each reserve category.

³ EBGL – European Balancing Guideline - <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32017R2195>

This 'need' in terms of capacity and flexibility may in-turn be sub-divided into several control process and related reserve & response services according to their role in the SOGL (Article 140) 'Process Activation Structure' (SAOM Article 18) and the capabilities of providers and technologies that service them.

- e. Since the needs of the system and combined capacity and flexibility offering will change with time within the control areas; SOGL determined to give the ESOs of each area the flexibility to determine their own control process structures and to set their own technical rules and limits concerning service structure, data provision, aggregation, minimum technical requirements and control capabilities of these services. Rules requiring the security needs and limits to cross border active power transfers (whether market flows or cross border reserve services) are also a prerequisite to setting-up and operating such arrangements.
- f. Going forwards it is therefore necessary for the ESO to maintain a published mapping of GB reserve and response services to SOGL reserve categories and for prospective providers to prequalify against SOGL reserve category as well as specific service requirements.
- g. The flexibility to setup and operate a variety of services in each SOGL defined LFCR active power reserve category and use of technical capabilities and 'other' non-LFCR services (e.g. voltage regulation) allow the ESO to meet security requirements set out in the SOGL, NETS SQSS and Grid Code and to provide a more efficient and effective use of resources thereby better controlling electricity delivery costs to consumers.

Methodologies from Article 118 that are subject to National Regulatory Authority (OFGEM) approval.

Methodologies, conditions and values included in the SAOM in SOGL Article 118 referenced in Article 6(3) thus requiring OFGEM approval:

SOGL Article ref	In the SAOM for GB	SOGL Article 118 text
118(a); 6(d)(ii)	Y	the dimensioning rules for FCR in accordance with SOGL Article 153;
118(b); 6(d)(iii)	Y	the additional properties of the FCR in accordance with SOGL Article 154(2);
118(c); 6(d)(i)	Y	the frequency quality defining parameters and the frequency quality target parameter in accordance with SOGL Article 127;
118(m); 6(d)(iv)	Y	for the GB synchronous areas, the measures to ensure the recovery of energy reservoirs in accordance with Article SOGL 156(6)(b);
118(r); 6(d)(v)	N	for the CE and Nordic synchronous areas, the minimum activation period to be ensured by FCR providers in accordance with Article 156(10);
118(s); 6(d)(vi)	N	for the CE and Nordic synchronous areas, the assumptions and methodology for a cost-benefit analysis in accordance with Article 156(11);
118(t); 6(d)(vii)	N	for synchronous areas other than CE and if applicable, the limits for the exchange of FCR between TSOs in accordance with SOGL Article 163(2);
118(x); 6(d)(viii)	Y	for the GB synchronous areas, the methodology to determine the minimum provision of reserve capacity on FCR between synchronous areas, defined in accordance with Article SOGL 174(2)(b);
118(z); 6(d)(ix)	Y	limits on the amount of exchange of FRR between synchronous areas defined in accordance with SOGL Article 176(1) and limits on the amount of sharing of FRR between synchronous areas defined in accordance with SOGL Article 177(1);
118(aa); 6(d)(x)	Y	limits on the amount of exchange of RR between synchronous areas defined in accordance with SOGL Article 178(1) and limits on the amount of sharing of RR between synchronous areas defined in accordance with SOGL Article 179(1);

Methodologies from Article 118 that are NOT subject to National Regulatory Authority (OFGEM) approval.

In the table below are ‘agreements’ (methodologies, conditions and values) included in the SAOM in SOGL Article 118 that are not referenced in Article 6(3) or by connection in Article 11 and therefore not legally requiring public consultation nor OFGEM regulatory approval. (note that the ESO has chosen to consult on all these with industry in a transparent and open basis in line with GB RIIO regulation principles on a voluntary basis).

SOGL Article ref	In the SAOM for GB	SOGL Article 118 text
118(d)	N	for the Continental Europe (‘CE’) and Nordic synchronous areas, the frequency restoration control error target parameters for each LFC block in accordance with SOGL Article 128;
118(e.)	Y	the methodology to assess the risk and the evolution of the risk of exhaustion of FCR of the synchronous area in accordance with SOGL Article 131(2);
118(f)	Y	the synchronous area monitor in accordance with SOGL Article 133;
118(g)	N	the calculation of the control program from the netted area AC position with a common ramping period for ACE calculation for a synchronous area with more than one LFC area in accordance with SOGL Article 136;
118(h)	N	if applicable, restrictions for the active power output of HVDC interconnectors between synchronous areas in accordance with SOGL Article 137;
118(i)	Y	the LFC structure in accordance with SOGL Article 139;
118(j)	Y	if applicable, the methodology to reduce the electrical time deviation in accordance with SOGL Article 181;
118(k)	N	whenever the synchronous area is operated by more than one TSO, the specific allocation of responsibilities between TSOs in accordance with SOGL Article 141;
118(l)	Y	operational procedures in case of exhausted FCR in accordance with SOGL Article 152(7);

118(n)	Y	operational procedures to reduce the system frequency deviation to restore the system state to normal state and to limit the risk of entering into the emergency state in accordance with SOGL Article 152(10);
118(o)	Y	the roles and responsibilities of the TSOs implementing an imbalance netting process, a cross-border FRR activation process or a cross-border RR activation process in accordance with Article SOGL 149(2);
118(p)	Y	requirements concerning the availability, reliability and redundancy of the technical infrastructure in accordance with SOGL Article 151(2);
118(q)	Y	common rules for the operation in normal state and alert state in accordance with SOGL Article 152(6) and the actions referred to in SOGL Article 152(15);
118(u)	N	the roles and responsibilities of the reserve connecting TSO, the reserve receiving TSO and the affected TSO as regards the exchange of FRR and RR defined in accordance with SOGL Article 165(1);
118(v)	N	the 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 defined in accordance with Article SOGL 166(1);
118(w)	Y	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 between synchronous areas defined in accordance with Article SOGL 171(2);
118(y)	Y	for the GB and IE/NI synchronous areas, the methodology to determine the minimum provision of reserve capacity on FCR in accordance with Article SOGL 174(2)(b);

Timeline for the initial SAOM development process

1. According to SOGL Article 118(1), the agreement text drafting must be completed and submitted to the NRA by SOGL EIF+12months, 14th September 2018;
2. For those Articles referenced in SOGL Article 6(3), SOGL Article 11 states that these must also undergo a public consultation which must be open for at least 1 month (to be conducted from 5th April to 18th May 2018 for GB);
3. The ESO has voluntarily elected to conduct a 2nd public consultation, this version of the SAOM document will contain revised proposals to Part-A incorporating changes derived from stakeholder comments and proposals submitted during the 1st public consultation on version 1 and also to provide visibility of the additional texts being proposed in Part-B. (This second consultation will be conducted from 23rd July to 23rd August 2018 for GB);
4. SOGL 6(7) states that the NRA will take no longer than 6 months to issue its decision on the TSO proposed SAOM text. (SOGL EIF+18months);
5. SOGL Article 118(2) specifies that the TSO must conclude any required revisions to the SAOM by 1 month after the NRA has issued its opinion on the document (SOGL EIF+19months);
6. SOGL Article 184 specifies that the SAOM must be notified to the NRA or where applicable other relevant NRAs no later than 1 month before the SAOM enters into force (SOGL EIF+20months);
7. SOGL Article 118(2) specifies that the SAOM will enter into force no later than 3-months after the proposed text has been approved by the NRA (SOGL EIF+21months);
8. SOGL Article 184 specifies that the SAOM must be provided to ENTSO-E for publication no later than 1-week after its entry into force;

Revisions to the SAOM for GB

1. The process of changing these agreements depends on whether they are subject to NRA approval or not.
 - a. Those items in Title 2 of the SAOM requiring OFGEM approval, for which a revision is desired, require review by the NRA according to SOGL Article 7.
 - b. Those items in Title 3 of the SAOM not requiring OFGEM approval, for which a revision is desired, will be amended and published by the ESO.

In both of the above cases, where the methodologies interact with GB industry codes, there will need to be close coordination of any proposed modification and application of both national industry code governance and SOGL change governance as appropriate.

TITLE 2 - Explanatory text to accompany each agreement Article in the SAOM document that is subject to NRA approval

AOM Article 1 - SOGL Article 118(a) - “the dimensioning rules for FCR in accordance with Article 153”

1. GB response services used for frequency containment must act collectively to halt a frequency movement created by an imbalance between power entering and leaving the electricity system. The most significant factor is the chance of a disconnection of equipment connecting a large source of injection or large point of off-take of electricity from the electricity system.
2. The National Electricity Transmission System (NETS) is designed in accordance with GB electricity code, National Electricity Transmission System Security and Quality of Supply Standard (NETS SQSS) section 2.5. This sets forth Limits to Loss of Power Infeed Risks, against secured events listed in NETS SQSS section 2.6, at the infrequent infeed loss risk of 1800MW.
3. Whilst 1800MW is the theoretical maximum infeed loss which can occur when units of that MW size are connected to the network and operating at their maximum operating level, it would be uneconomical to secure against this whilst there is no operating equipment capable of triggering such a loss connected to the NETS. For this reason, the Grid Code in section BC1.5.4 sets out the requirements for reserve holding with BC1.5.4(b) identifying specific secured losses which must be covered at any given time. Additionally, these reserves are used manage the imbalance of generation and demand in real time including market imbalance and the ramping of generators and interconnectors.
4. At any time the ESO must ensure that the combined technical characteristic of all GB response services meet the technical characteristic needed to meet the FCR dimensioning requirements of SOGL article 153.
5. The ESO must ensure that there is the right level of FCR procured to meet the time varying FCR capacity requirement. The ESO determines in advance the FCR requirement across the range of potential system conditions using statistical and mathematical models which are regularly reviewed. Using this predetermined range of requirements the ENCC study the prevalent system conditions and select the relevant requirement. This is then regularly updated to reflect changes in system conditions and needs through to real time.
6. The ESO requirements vary according to: system demand, system inertia, the largest potential loss of infeed & demand and prevailing system conditions. Network connectivity, congestion and inherent risks and limitations of assets may also warrant the ESO adjusting the total holding, location and distribution of holding of FCR amongst service providers.
7. A baseline of Balancing Services for FCR is procured ahead of real time where they can demonstrate an expected cost saving against mandatory services. This includes the monthly tenders for dynamic and static Firm Frequency Response (FFR), and other optional contracts.
8. Closer to real time, the ESO makes an assessment on the basis of system operability and economics of the appropriate balance between actively managing the magnitude of credible losses of infeed and demand, the amount of system inertia and the requirement for FCR.

9. Market parties are made aware of the FCR capacity that The ESO has determined through the report required as part of the Electricity Transparency Regulation in Article 17(1)(b) and through obligations to publish information coming from SOGL Article 187. This information will be published on the [ENTSO-E market information transparency platform](#).

SAOM Article 2 - SOGL Article 118(b) - “additional properties of FCR in accordance with Article 154(2);”

1. SOGL has an architecture of reserve categories of with the concept of Minimum [common] Technical Requirements which all reserve services mapped into the FCR category must fulfil. SOGL introduces the concept of ‘FCR Technical Minimum Requirements’ (SOGL Article 154) and ‘Provision’ (SOGL Article 156) which may be extended or overridden within this text for each Synchronous Area.
 - a. This is to facilitate the coordination of control and interoperability of services defined by multiple TSOs. This methodology permits the electricity system operators of the synchronous area to agree on common additional properties for all relevant FCR services in use within the same Synchronous Area.
 - b. In the specific GB application, where there is only one LFC Block and one electricity system operator, it makes more sense to keep these additional properties to a minimum. This permits the maximum possible flexibility at an individual service level as today. This flexibility provides the full range of control needs of the SO. Furthermore, this approach is also more adaptable to the evolution in system requirements and technological capability changes needed as new controllable producers, consumers and storage become available and as markets and control architectures evolve.
2. At the time of writing this document, the reserve services architecture is being discussed in the Grid Code working group GC0114⁴. The intention of the SOGL drafting team and NGET interpretation is as follows:
 - a. SOGL was drafted with the concept of multiple technical reserve services delivered through EBGL defined product (commercial/market structures) at the disposal of the ESO to operate the Process Activation Structure (SOGL Article 140) and to maintain Frequency Quality (SOGL Articles 127 & 128).
 - b. The ESO has chosen not to define any additional properties for the Frequency Containment Reserves (FCR) category at this time, since the existing GB framework of reserve services sits within the broader Reserve categories of SOGL. For clarity:
 - i. GB response services map into the SOGL FCR category
 - ii. SOGL does not use the term ‘response’; both GB ‘reserve’ and GB ‘response’ are considered to be specific instances of SOGL reserve services.
 - iii. Those GB services meeting the technical characteristic requirement of SOGL FCR are considered to fit that category

⁴ <https://www.nationalgrid.com/uk/electricity/codes/grid-code/modifications/gc0114-system-operation-guideline-prequalification>

- iv. The ESO may develop this article in the SAOM to permit additional services into the FCR category in the future.

SAOM Article 3 - SOGL Article 118(c) - “the frequency quality defining parameters and the frequency quality target parameters in accordance with Article 127”

1. This Article of the SAOM defines the frequency quality target values which the ESO must endeavour to meet and to maintain.
 - a. This Article permits the ESO to override the default values are found in SOGL Article 127 and the associated SOGL Annex III table, that were developed in drafting.
 - b. Evolving system conditions of the electricity system may require these values to be changed.
2. The values in this Article agree and align with operating practices and targets originating for the NETS SQSS and Grid Code that pre-date the SOGL regulation. Not all of the detail expressed within the SOGL is explicitly stated within the GB codes; however the operational processes and practices that GB codes require and inspire, are fully aligned with SOGL (indeed SOGL was drafted from the perspective of the existing practice which was deemed effective and appropriate).
3. The design of existing GB electricity codes and the SOGL sets frequency control targets for the ESO and these become the drivers for the resultant SOGL, “Basic Structure” in article 139, 140 and referenced articles. The Process Activation Structure of the Synchronous Area and the specific Capacity and Dimensioning needs in each reserve category must be developed to meet these requirements.
4. The Frequency Quality defining parameters and frequency quality target parameters for GB are shown in the table below. These are aligned with regulatory parameters also found in the NETS SQSS.
 - a. The NETS SQSS specifies in the Terms and Definitions of section 11 many of the ‘Unacceptable Frequency Conditions’; such an unacceptable condition exists if “a transient frequency deviation on the MITS [Main Interconnected Transmission System] persists outside the above statutory limits and does not recover to within 49.5Hz to 50.5Hz within 60 seconds.” This states that under normal conditions the frequency should be within these limits of $\pm 500\text{mHz}$ and when an imbalance occurs the frequency should be brought back inside this range within 1 minute. This has been re-encoded within the SOGL.
 - b. The Grid Code in CC.6.1.2 stipulates that “The Frequency of the National Electricity Transmission System shall be nominally 50Hz and shall be controlled within the limits of 49.5 - 50.5Hz unless exceptional circumstances prevail.” A parallel statement in the NETS SQSS states the GB has “statutory limits of 49.5Hz to 50.5Hz” These gives the time-to-recover-frequency limit and the 49.5Hz and 50.5Hz limits which under SOGL become both the ‘maximum Steady-state frequency deviation’ and the ‘Frequency Recovery Range’ targets. Whiles in SOGL the nominal frequency is also stated to be 50Hz .

SOGL - ANNEX III

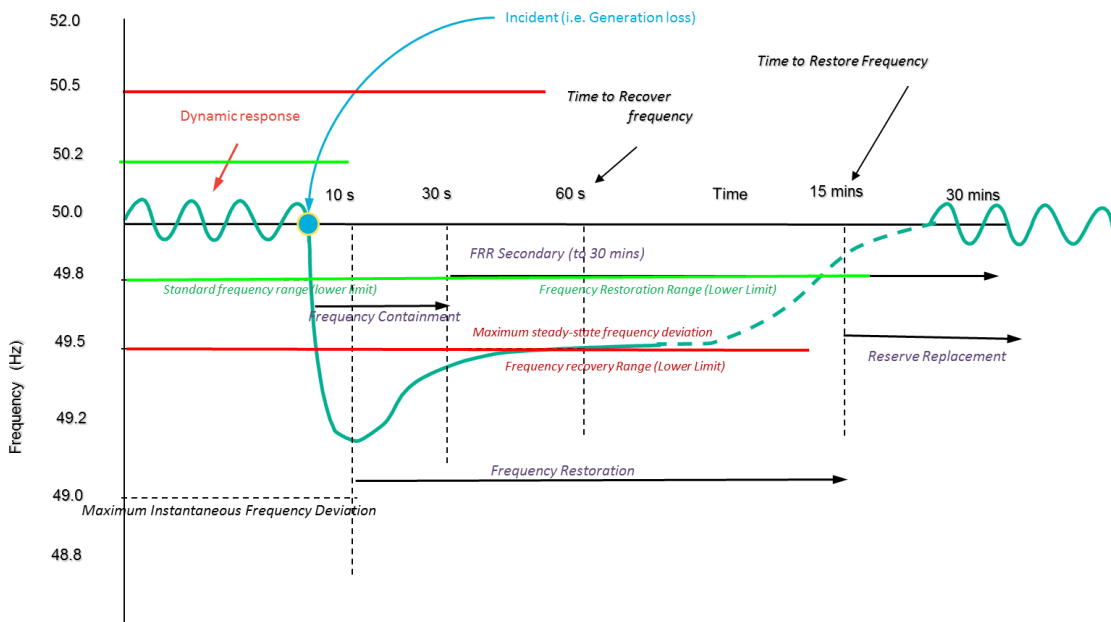
Frequency quality defining parameters referred to in Article 127:	GB	Present in NETS SQSS or Grid Code
standard frequency range	±200 mHz	
maximum instantaneous frequency deviation	800mHz	
maximum Steady-state frequency deviation	500 mHz	NETS SQSS Section 11 Unacceptable Frequency Conditions; Grid Code CC.6.1.2
time to recover frequency	1 minute	NETS SQSS Section 11 Unacceptable Frequency Conditions
Frequency Recovery Range	±500 mHz	NETS SQSS Section 11 Unacceptable Frequency Conditions
time to restore frequency	15 minutes	
frequency restoration range	±200 mHz	
alert state trigger time	10 minutes	

Table 1 Frequency quality defining parameters of the GB synchronous area

Frequency quality target parameters referred to in Article 127.	GB
maximum number of minutes outside the standard frequency range [per year based on a frequency measurements at a one second resolution].	15000

Table 2 Frequency quality target parameters of the GB synchronous area

GB Frequency Quality target parameters



5. The above diagram shows an illustration of frequency behaviour that obeys the rules of SOGL and GB electricity codes.
- The illustrative hypothetical incident shown is less than the largest infeed loss that could occur (we know this since the frequency moved less than 800mHz; assuming that there was not any other reason to dimension higher than covering the largest-loss). The largest infeed loss is known under SOGL as the “Reference Incident” when considering FCR (and Dimensioning incident when considering FRR and RR) since the SO is obliged to size its FCR holding with the correct technical response characteristics so as to contain, such a MW loss with a fall of 800mHz.
 - The 800mHz “maximum steady state deviation” measured from the nominal frequency of 50Hz defines limits of 49.2Hz for the lower bound and 50.8Hz at the upper bound. It is the Frequency Containment Process utilizing Frequency Containment Reserve Services, operated by the ESO, that slows and stops this frequency disturbance (this can be any number of GB or cross-border response services which when combined meet the overall FCR technical requirements that act to arrest the frequency movement following an incident). This SOGL compliance practice is also in-line with GB electricity codes and ESO operational practice which pre-dates the SOGL.
 - The next frequency target obligation is to bring the frequency inside the Frequency Recovery Range within 1 minute, Time-to-recover-frequency. The Frequency Containment Process and Frequency Restoration Process together achieve this target.
 - The next target is to bring the frequency inside the Frequency Restoration Range within the 15-minutes, Time-to-Restore-Frequency. The Frequency Restoration Process utilizing Frequency Restoration Reserve services (and ultimately products) is used to do this.

- e. The last element in the process chain is to correct the background Energy Balance and relieving activated FCR and FRR reserves by the Reserve Replacement process utilizing Replacement Reserve services.
6. The Frequency quality target parameters from SOGL article 127, set a general measure of frequency quality in that the total number of aggregated seconds for which the system frequency is outside of the standard frequency range should not exceed 15000 minutes per calendar year.
- a. A number of factors related to the general performance of connected generation, demand, interconnectors etc. combined with the equipment trips, the choice of control actions of the SO as well as the effective performance of reserve providers all influence statistical frequency quality.
 - b. The ESO will monitor fulfilment of these quality criteria at least annually (SOGL Article 127(9)).
 - c. Where these target values are not met the 'Mitigation Process' (SOGL Article 138) will be triggered to consider causing factors and what if anything in the control structures and obligations on industry parties, including the SO, might need to change. Any measures taken will also be published under SOGL Article 16(e).

SAOM Article 4 - SOGL Article 118(m) - “for the GB synchronous areas, measures to ensure the recovery of energy reservoirs in accordance with to Article 156(6)(b)”

1. The specific SOGL subject matter for this article is not crystal clear and for this reason the ESO has sought to answer the points raised by SOGL article 118(m), 156(6) and 156(6)(b).
 - a. SOGL article 156(6)(b) requires the SO to “exclude the FCR providing unit defining the reference incident... from the dimensioning process”. Because the disconnection of this unit would cause the largest frequency loss, ensuring that there is sufficient capacity from Frequency Containment Reserve services such that the Frequency Containment Process, can contain endeavour to ensure that the electricity system frequency does not go outside the maximum instantaneous frequency deviation of 800mHz. The requirement is for the unit to be excluded from the dimensioning process, and not for it to be excluded from FCR provision, so it can still be used during this period to cover frequency deviations caused by other contingencies.
 - b. Article 156(6) more generally, requires the ESO to ensure that the loss of an FCR providing unit does not endanger the system. The loss of the FCR providing unit will in and of itself cause an energy imbalance in the system and result in the frequency to move, depending on whether this was providing infeed or offtake. The other active FCR service providers will cover this contingency and contain the frequency. However, if the capacity and overall technical characteristic of the remaining group of FCR service providers no longer meets the dimensioning requirements, the ESO will need to contact one or more other providers to actively make up the short-fall in FCR provision. This corrective moves offline FCR capacity into an armed/active mode to meet the real-time dimensioning requirements of the system.

- c. Article 118(m) considers the risk of there no longer being enough response capability from providers that have an active FCR service, but which have no remaining technical capability to deliver. Two examples of providers running out of energy should they or the ESO not manage the state of charge would be conditions such as batteries that had run out of charge or hydro-stations with no more available water. Within the SOGL the ability to back up service provision for a period of time is described in terms of the 'energy reservoir'. In some industry texts this is also described as 'state of charge management', especially in the context of batteries.
 - i. In GB these energy reservoirs are managed by the service providers. Service providers must factor limitations such as limited energy reserves into their service offering to the ESO.
 - 1. For Grid users/plant covered by Grid Code CC.A.3.1 then CC.A.3.5 states - "When a Generating Unit or CCGT Module or Power Park Module or DC Converter has responded to a significant Frequency disturbance, its response capability must be fully restored as soon as technically possible. Full response capability should be restored no later than 20 minutes after the initial change of System Frequency arising from the Frequency disturbance". [Quote from Grid Code, Issue 5, revision 22].
 - ii. For new services and changes to existing services, the ESO works with the industry to ensure that service design allows for the service provider to manage energy reservoirs and so minimise the risk of depletion. In unforeseen circumstances a provider would communicate a depletion of the service to us. The ESO will replace the depleted service with an equivalent while the energy reservoir is in recovery.
 - iii. In procuring against the GB dimensioning requirements for FCR services, the ESO takes into account the potential unavailability, caused by factors such as breakdown or depletion of energy reservoirs, to ensure there is sufficient FCR to ensure operational security.

Not in the GB SOAM – SOGL Article 118(r) “for the CE and Nordic synchronous areas, the minimum activation period to be ensured by FCR providers in accordance with Article 156(10)”

- 1. This article is not applicable to the GB SAOM defining no requirements for the GB synchronous area.

Not in the GB SOAM – SOGL Article 118(s) – “for the CE and Nordic synchronous areas, the assumptions and methodology for a cost-benefit analysis in accordance with Article 156(11)”

- 1. This article is not applicable to the GB SAOM defining no requirements for the GB synchronous area.

Not in the GB SAOM – SOGL Article 118(t) – “if applicable, for synchronous areas other than CE, limits for the exchange of FCR between the TSOs within the same synchronous area in accordance with SOGL Article 163(2)”

1. Since there is a single GB ESO, there are by definition no other control areas and no other operators with which to setup exchange FCR with.
 - a. This Article does not apply in GB because of the LFC Block structure where there is a single TSO with the responsibility of being the GB electricity system operator for a single LFC Area that is contiguous with the LFC Block and Synchronous Area.
 - b. The complexity in the structure of the SOGL code with regards separation of aspects to the ESO roles for vertical and horizontal coordination is required to cater for continental European operations. This is explained in the separate methodology for the “Determination of LFC Blocks for the synchronous area, GB”, to allow for the complex coordination effort required between system operators of the Continental Europe and Nordic areas, responsibilities are spread across geographical regions and in hierarchical structures using the terminologies of LFC Area, LFC Block and Synchronous Area. Within GB however all structures are concurrent. There is a single ESO responsible for all operational security decision functions arising from the SOGL and from GB industry codes.
 - c. GB does exchange FCR with other LFC Blocks of other Synchronous Areas and security limits do apply to that activity; but this is not the scope and subject of this Article and hence not included here.

SAOM Article 5 - SOGL Article 118 (y) – “for the GB synchronous areas, the methodology to determine the minimum provision of reserve capacity [within the GB synchronous area] on FCR in accordance with SOGL Article 174(2)(b)”

1. Article 174(2) requires the ESO (the single operator TSO in GB) to have method or approach that ensures that it does not overly rely on ‘shared’ or ‘exchanged’ FCR provision from other synchronous areas. Equipment failures that might interrupt delivery; infrequent but hypothetical simultaneous need for the same reserve capacity to be activated in both areas (should the system operators of either area reduce the local holding substantially due to sharing); utilization of GB FCR to help correct a frequency deviation will under sharing reduce the response technical capability of the total reserves to manage a GB issue. The GB ESO evaluated each of these issues in determining the scale of service that it is appropriate to share/exchange and hence how much capacity must be provided from within GB.
2. The security principles required from SOGL relating to determining the secure limits to sharing and exchange and GB reserve/response holding are not different from current practice derived from GB industry codes. The SO must consider the availability and reliability of the provider and impact of its other operational activities on the effectiveness of delivery and in the ESO being able to meet the frequency standards. The SAOM thus describes both current practice and how this meets the SOGL requirements.
3. The referenced SOGL Article asks us to specify a value or rule for determining the minimum amount of FCR that must be provided from within the Synchronous Area for security

standards to be met for secure and reliable delivery of the Frequency Containment Process within GB.

- a. For dynamic operations, it is more logical to determine how much FCR capacity is required; to look at the physical and security limits on FCR exchange and sharing, from which a residual amount within GB remains. The Article is written from this perspective. The structure of the text in the SAOM lays out the above in paragraph 2 of this Article to explain that it is in-fact a residual number.
- b. The limits for exchange and sharing on each interconnector is considered in paragraph 3. This stipulates that each service on each interconnector is considered in terms of:
 1. Aspects of the NETS SQSS (and also rules set-forth in SOGL dimensioning) that would require the ESO to limit use of the cross-border service, such as whether the interconnector is the largest-loss. (the links to these parts of NETS SQSS are provided this document's explanation of FCR dimensioning).
 2. the limitations preventing delivery of the service,
 - a. such as remaining physical capacity on an interconnector which may be on outage or
 - b. interconnector transfers that are already close to physical capacity limits, delivering market contracted energy or other SO derived services.
 3. Looking at FCR shortfall in the case of Sharing, the capacity being utilized by the Reserve Connecting TSO in the other LFC Block for their local needs and therefore not being available to the GB ESO to meet needs here.
 - a. The reliability of the interconnector service being available when required and how this affects the delivery of the frequency containment process (SOGL article 142) to cover issues such as the chance of the interconnector infrastructure failing.
4. The ESO will publish the total capacity it procures ahead of time and also information about the capacity in compliance with SOGL Article 187. Cross border capacities will be published in accordance with SOGL Article 190.

SAOM Article 6 - SOGL Article 118(z) - “the methodology to determine limits on the amount of exchange of FRR between synchronous areas defined in accordance with Article 176(1) and the methodology to determine limits on the amount of sharing of FRR between synchronous areas defined in accordance with Article 177(1)”

1. SOGL Article requires the ESO to specify limits on the exchange of FRR and limits on sharing of FRR. The ESO does this as part of a more comprehensive analysis of dimensioning and to what degree it may rely on each service and each service provider

and providing unit or module based upon a combination of technical information, provided information and historical performance.

2. This article is considering the category of Frequency Restoration Reserves; however the security principles are no different to those explained in the supporting text to article 10, paragraphs 2 and 3 above (which considers FCR).

SAOM Article 7 - SOGL Article 118(aa) - “the methodology to determine limits on the amount of exchange of RR between synchronous areas defined in accordance with Article 178(1) and the methodology to determine limits on the amount of sharing of RR between synchronous areas defined in accordance with Article 179(1)”

1. SOGL Article requires the ESO to specify limits on the exchange of FRR and limits on sharing of FRR. The ESO does this as part of a more comprehensive analysis of dimensioning and to what degree it may rely on each service and each service provider and providing unit or module based upon a combination of technical information, provided information and historical performance.
2. This article is considering the category of Replacement Reserves; however the security principles are no different to those explained in the supporting text to article 10, paragraphs 2 and 3 above (which considers FCR).

TITLE 3 - Explanatory text to accompany each Article in the SAOM document that is not subject to NRA approval

Not in GB SAOM - SOGL Article 118 (d) – “for the Continental Europe (‘CE’) and Nordic synchronous areas, the frequency restoration control error target parameters for each LFC block in accordance with Article 128”

1. This is not applicable to this document. The Frequency Restoration Control Error performance for GB are published in the SOGL in Article 128 and associated Annex IV table.
2. For clarity the range and interpretation for GB is as follows:
 - a. The level 1 FRCE range is 200MHz (but may be made larger at some point according to article 128(5) and would be a published ‘methodology’ if the ESO were to change it). The level 2 FRCE range is 500MHz (but may be made larger at some point according to article 128(5) and would be a published ‘methodology’ if the ESO were to change it).
 - b. SOGL Article 128(6), in combination with the values in the Annex IV table, states that the GB frequency may not be outside the level 1 FRCE range for more than 3% of time-intervals in a year and not outside the level 2 FRCE range for more than 5% of time-intervals in a year.

- i. Time Interval is considered to mean 1-second (i.e. one frequency value per second).

SAOM Article 8 - SOGL Article 118 (e) – “the methodology to assess the risk and the evolution of the risk of exhaustion of FCR of the synchronous area in accordance with Article 131(2)”

1. There are obligations in the Grid Code on certain grid users in GB to deliver FCR services ('Primary' and 'High') :
 - a. The obligation for certain grid users to have the capability to provide certain FCR services (namely 'Primary' and 'High') to the ESO can be found in the Grid Code CC.A.3, CC.6.3.7, CC.6.3.12, CC.6.3.13, CC.6.3.14, and BC3.5.1. The CC.A.3 details which plant the obligation falls to as well as plant operating range, minimum frequency response profile, testing and repeatability of response. Specific exclusions are included in CC.6.3.7(f) and also in BC3.5.4(e) and (f).
 - b. The obligation for certain grid users to make certain FCR services at the disposition of the ESO is detailed in the Grid Code in BC 3 (more specifically BC3.5, BC3.6 and BC3.7)
 - i. All plant identified in BC3.5.2 that is producing active power must provide Limited Sensitivity Mode frequency services as defined in Grid Code CC.6.3.3 and ECC.6.3.3.
 - ii. All plant identified in BC3.5.4(a) must offer to provide FCR services and accept instructions to make such services active. At the time of writing, this covers the GB FCR services known as “Primary” and “High”.
 1. *For Note: the GB response service “Secondary” fits in the FRR category and thus the obligation to provide this service is defined in the LFC Block Operational Methodologies document in Article 13.*
2. On longer multi-month timescales the ESO can assess the risk of a shortfall in FCR [installed] capacity from the connection records and can evaluate how the availability of FCR capable plant and FCR service offerings are expected to evolve with time.
3. The ESO assesses the evolution in needs of the GB electricity system and the availability and capability of FCR providers taking actions appropriate to the time-horizon to make capacity available and ensure that dimensioning requirements can be met.

SAOM Article 9 - SOGL Article 118 (f) - “the synchronous area monitor in accordance with Article 133”

1. Each Synchronous Area requires a Synchronous Area Monitor is a nominated system operator from that area who is responsible for collecting frequency data and evaluating the frequency performance of the electrical system in order to derive a number of statistical metrics for reporting and publication. The ESO, as the sole electricity system operator in

the GB synchronous area will perform this function; collecting and publishing the statistical data defined in SOGL article 131.

Not in the GB SOAM - SOGL Article 118 (g) - “the calculation of the control program from the netted area AC position with a common ramping period for ACE calculation for a synchronous area with more than one LFC area in accordance with Article 136”

1. This Article does not apply in GB because of the LFC Block structure where there is a single TSO with the responsibility of being the GB electricity system operator for a single LFC Area that is contiguous with the LFC Block and Synchronous Area.

Not in the GB SAOM - SOGL Article 118 (h) if applicable, restrictions for the active power output of HVDC interconnectors between synchronous areas in accordance with Article 137(1);

1. Control of HVDC ramping is presented in both SOGL articles 118(1)(h) and 119(1)(c). This difference is only significant in Synchronous Areas which have more than one LFC Block and hence more than one system operator. In those areas there are different partitions of responsibilities in the Process Responsibility Structure (SOGL article 141). The text from SOGL article 118 (also SOGL article 137(1)) focuses on the impact of ramping on the frequency quality and the Frequency Restoration Process and SOGL article 119 (also SOGL articles 137(3)&(4)) considers the impact of HVDC ramping on the Frequency Restoration Control Error and the Frequency Restoration Process. In GB where there is only one system operator in one LFC Block there is no need for a distinction and one set of rules, defined in one text may cater for both requirements. **For this reason, in GB it is proposed that Ramp Rate Restrictions for HVDC interconnectors initially be drafted as part of the LFC Block Operational Agreement under SOGL article 119(1)(c).**

SAOM Article 10 - SOGL Article 118 (i) the LFC structure in accordance with Article 139;

1. The SOGL requires the TSOs of a synchronous area to define which operator does what in the hierarchy of responsibilities (SOGL article 141) and also which of the optional control processes are to be used in the synchronous area and LFC Blocks (SOGL article 140).
2. At this point I would invite the readers to also consider the “Determination of LFC Blocks, for the GB synchronous area” methodology which explains that within GB all aspects of the LFC hierarchy are concurrent and that there is a single electricity system operator, The ESO, who operate all control processes defined in the Process Activation Structure.
3. The Process Activation Structures of each Synchronous Area and LFC Block may vary according to technical need and market design. These control processes form the link

between the Frequency quality and defining parameters, which the processes service to meet, and the SOGL reserve categories and services/products they contain, which are used by the processes. [See this document article 5].

4. Within the Process Activation Structure there the mandatory processes are a Frequency Containment Process; a Frequency Restoration Process. SOGL considers the Reserve Replacement Process to be optional according to the needs and market design of the given LFC Area and LFC Block. Similarly, the cross-border processes are also optional under SOGL.

a. GB has the mandatory Frequency Containment Process:

- i. The purpose of this process is to prevent the rapid rise or fall of frequency following a sudden imbalance between injection and off-take from the electricity system. The FCP prevents the maximum deviation exceeding 800mHz and returns to inside the frequency recovery range within the time to recover frequency;
- ii. Frequency response services are used to fulfil the SOGL requirements of the Frequency Containment Process for GB. These may be from GB or cross border sources. They may be from static or dynamic sources and have different response characteristics. The ESO seeks to use a mix of sources to optimise security and risk in an economic and efficient manner for the consumer.

b. GB has the mandatory Frequency Restoration Process:

- i. The purpose of this control process is to return the system frequency to a value inside the frequency restoration range within the time to restore frequency;
- ii. Frequency response and reserve services which have a total activation process time of longer than 10s and less than 15 minutes and used for LFCR purposes are considered to be in this category.
- iii. Slower frequency response and faster GB reserve services are used to operate the SOGL Frequency Restoration Process for GB. These may be from GB or cross border providers. They may have different activation and duration characteristics. The ESO seeks to use a mix of sources to optimise security and risk in an economic and efficient manner for the consumer;
- iv. Within GB there is, at the time of drafting, no automatic Frequency Restoration Process according the definition of this process in SOGL Article 145(4). Currently no GB services nor cross-border services meet this definition and therefore must be considered 'manual' including any GB response service which reaches full activation more than 10seconds after the TSO need (to place it in the FRR category) and which may be driven by a frequency governor or sensor rather than being TSO directly despatched.

c. GB has the optional Frequency Restoration Process:

- i. This is the slowest SOGL control process which enables the ESO to correct the energy position of the system and as SOGL states in Article 144 "to progressively restore activated FCR and FRR";

- ii. Reserve services used uniquely for this purpose or which have a total process activation time (i.e. the combined delays from steps in decision making by all parties and communication time between parties as well as technical delay and ramping of equipment) slower than 15 minutes are considered to be in this category.

5. Cross Border FRR and RR activation processes:

- a. A number of 'cross-border-balancing' services exist today and more are planned in line due to new connection opportunities and EBGL related developments. By the nature of the security considerations the ESO in place (prior to SOGL) to consider the positive impacts and potential risks of FRP and RRP and link through to meeting frequency quality targets, the ESO already has checks relative to dimensioning and 'agreements' with interconnector operators and TSOs from other areas relative to the operation of those services. These practices were used to form the security model that informed the SOGL legal drafting and existing services are compliant with this.
- b. All cross-border services between system operators need meet the SOGL framework and requirements defined in the SOGL articles 146 – 150; 171 – 180.

SAOM Article 11 - SOGL Article 118 (j) - “if applicable, the methodology to reduce the electrical time deviation in accordance with Article 181”

1. The obligation to maintain system electric time is found in the Grid Code in BC3.4.3. According to which, NGET takes reasonable endeavours to maintain system time to within 10 seconds of Universal Time. However, the ESO has discretion as to what actions it will take and when.

Not in the GB SAOM - SOGL Article 118 (k) - “whenever the synchronous area is operated by more than one TSO, the specific allocation of responsibilities between TSOs in accordance with Article 141”

1. This Article does not apply in GB because the synchronous areas is operated by a single system operator. The LFC Block Determination methodology explains this. Consequently, all responsibilities found within article 141 are allocated to the ESO.

SAOM Article 12 - SOGL Article 118 (l) - “operational procedures in case of exhausted FCR in accordance with Article 152(7)”

1. As a background: SOGL Article 152 considers the how evolving 'system states' affect operation of Load Frequency Control. Article 152(7) is concerned with the ensuring that the ESO has sufficient mechanisms and measures to maintain and regain sufficient FCR to meet the dimensioning requirement. In the case of significant short-fall in FCR reserves the system frequency would become uncontrollable and could result in a black-out. To

avoid this the TSOs are mandated to specify mechanisms and procedures in their synchronous area.

2. Within GB the ESO has related this Article to measures in the GB industry codes that significantly reduce the risk of there being insufficient or exhausted FCR capacity in operational timescales and secondly the ESO has related this Article with the operational activities required to deal with the issue in operational timescales should there be a significant risk of FCR erosion that would lead to exhaustion and cannot be controlled using mechanisms defined in the 'normal' operational and market processes. These principles are present within the GB industry frameworks:

- a. Ensuring sufficient capacity is made available to the ESO:

- i. The obligation for certain grid users to have the capability to provide certain FCR services (namely 'Primary' and 'High') to the ESO can be found in the Grid Code CC.A.3, CC.6.3.7, CC.6.3.12, CC.6.3.13, CC.6.3.14, and BC3.5.1. The CC.A.3 details which plant the obligation falls to as well as plant operating range, minimum frequency response profile, testing and repeatability of response. Specific exclusions are included in CC.6.3.7(f) and also in BC3.5.4(e) and (f).

- ii. The obligation for certain grid users to make certain FCR services at the disposition of the ESO is detailed in the Grid Code in BC 3 (more specifically BC3.5, BC3.6 and BC3.7)

1. All plant identified in BC3.5.2 that is producing active power must provide Limited Sensitivity Mode frequency services as defined in Grid Code CC.6.3.3 and ECC.6.3.3.

2. All plant identified in BC3.5.4(a) must offer to provide FCR services and accept instructions to make such services active. At the time of writing, this covers the GB FCR services known as "Primary" and "High".

- a. *For Note: the GB response service "Secondary" fits in the FRR category and thus the obligation to provide this service is defined in the LFC Block Operational Methodologies document in Article 13.*

- b. Emergency measures taken in operational timescales in the case where FCR is eroded below the dimensioning requirement:

- i. The GB electricity system operator, The ESO, continuously monitors the electricity system's immediate and future needs in terms of Frequency Containment Reserve dimensioning requirements. The ESO also reviews the physical and contractual availability of FCR capable units and groups as well as their status.

- ii. Where additional FCR capacity is required, either because of changing circumstances or because of equipment failure the SO will act to ensure that the need for FCR matches the available FCR.

- iii. Where possible this will be performed by calling upon units or groups that are immediately ready to provide FCR following the 'activation' of their

frequency sensitive controllers. If this is not possible or due to other operational factors it is not appropriate, then it is possible for the system operator to use other services to adjust the status and availability of a providing unit or group such that the current or future availability of FCR is changed. The system operator may also use services to adjust the system's requirement for FCR; for example by reducing the largest loss on the system or by changing operating plant configuration to change the system's inertia.

- iv. Where the above can be achieved through commercially tendered and offered services these will be used. However, where this is not possible, emergency instructions will be utilised to instruct any controllable equipment to a position where it may provide an FCR service or to adjust the overall status of the system to a point where less FCR is needed. In an extreme case this may involve disconnection of generation, interconnection or demand.
 1. The Grid Code defines in OC6.5 operations requiring demand-control including issuing of warnings and then issuing demand control instructions. Network Operators must follow the ESO's instructions as defined in OC6.7.1
 2. More generally the ESO may issue system warnings as defined in OC7.4.8 and require emergency actions as defined in BC2.9

SAOM Article 13 - SOGL Article 118 (n) – “operational procedures to reduce the system frequency deviation to restore the system state to normal state and to limit the risk of entering into the emergency state in accordance with Article 152(10)”

1. The approach to FRR and RR management by the GBSO is such that every endeavour is taken to ensure that requirements and risks are managed ongoing and that a point of critically reduced or no FCR is ever reached. The GB electricity system operator will always make sure that they cater FCR for the largest single imbalance (generation/demand) (reference incidence) based on system conditions. “Ex. Pool of generators on a double circuit” which varies as per system conditions(outages), system demand & synchronised generation (G59 & non G59 trip relays) which constitute system inertia, based on all of the criteria above the GB system operator will calculate the deviation “delta f” at all timescales to contain the frequency for any unforeseen reference incidents. In the case of a frequency deviation, The GB electricity system operator will take prompt action to reduce the Frequency Restoration Control Error (ie understood in terms of MW imbalance or Δf) as quickly as possible by redespaching generation, load and interconnectors to ensure that the system does not remain in an alert state due to frequency deviations for extended periods. The preferred instruction priority is to use market tools (without eroding FCR & where possible restoring FCR against synchronised FRR units) and if these are depleted to issue system warnings to the GB market & use emergency despatch instructions (where no commercial offering is available) & manual load shedding by voltage control.

- a. The Grid Code defines in OC6.5 operations requiring demand-control including issuing of warnings and then issuing demand control instructions. Network Operators must follow the ESO's instructions as defined in OC6.7.1
- b. More generally the ESO may issue system warnings as defined in OC7.4.8 and require emergency actions as defined in BC2.9

SAOM Article 14 - SOGL Article 118 (o) - “the roles and responsibilities of the TSOs implementing an imbalance netting process, a cross-border FRR activation process or a cross-border RR activation process in accordance with Article 149(2)”

1. As GB does not, at the time of writing, have an automatic frequency restoration (aFRR) process, it is therefore not possible to couple aFRR via imbalance netting with other areas over HVDC.
2. Concerning cross border FRR and RR services:
 - a. Operational agreements between the ESO, other TSOs and interconnector operators since the instigation of services over HVDC. These agreements define provision and utilisation enabling the TSO to manage the service as ‘exchange’ or ‘sharing’. The agreements also have detailed processes for calling-off or ‘activating’ the reserve services within them.
3. Explaining the language of the SOGL in the context of GB cross-border services:
 - a. The reserve receiving TSO (i.e. the TSO of the area that needs to activate reserves) leads the process of commencing the transfer of power between synchronous areas. This activity is coordinated with the interconnector owner/operator and the reserve connecting TSO. The reserve connecting TSO takes action in their own area to ensure no net impact on the security of their own system according to the specific design of that service (e.g. by counter despatching or by forwarding the instruction to a defined reserve provider in their own area).
 - b. The process is designed to ensure the change in MW output of the reserve provider connected to the reserve connecting TSO aligns with the net change in power transfer schedule managed by one or more interconnector owner/operators. Any potential risk or impact upon the process activation structures of each LFC Block is assessed and incorporated into the detailed control assessment activities.

SAOM Article 15 - SOGL Article 118 (p) – “requirements concerning the availability, reliability and redundancy of the technical infrastructure in accordance with Article 151(2)”

1. The reliability of LFCR operation by the ESO depends to a great extent on having reliable information provided electronically about the state of the electrical system via [SCADA](#),

reliable market information about the future generation and demand programs of connected users, reliable computer systems in the control system to process data and assist in decision making and reliable means of communicating instructions to the various controllable assets on the grid. This Article seeks to define the main elements of this.

- i. Information from Grid Code users required is defined in CC.6.5: This includes information sent and received via Control and System Telephony (CC.6.5.3) electronic data systems (see Grid Code CC.6.5.8), facsimile devices (CC.6.5.9) and Bi-lingual Message Facilities. The following ["Guide to EDT, EDL and CT" document](#) provides useful information. Further information can be found on this ["Electrical standards documents"](#) page on the ESO's website.
- ii. The Article also explains that NGET control systems and telecommunications between critical control points uses recognised standards for its architecture to give the level of reliability and availability expected of critical national infrastructure systems.
 1. GE XA/21 standards for SCADA
 2. The [NG TS 3.24.20](#) availability and reliability standard is applied
 3. Communications protocols used are ICCP-1996; IEC101 and GI-74

SAOM Article 16 - SOGL Article 118 (q) – “common rules for the operation in normal state and alert state in accordance with Article 152(6) and the actions referred to in Article 152(15)”

1. This article focuses on the need for coordination between the electricity system operators in each level in the control hierarchy where there is more than one. In GB there is a single ESO. Therefore it is straightforward to state that:
 - a. During a normal state the electricity system will be operated using the control processes already defined in the SAOM Article 18.
 - b. During an alert state (as defined in SOGL article 18) the ESO will follow the procedures defined in SAOM Article 21.

Not in the GB SAOM - SOGL Article 118 (u) – “the roles and responsibilities of the reserve connecting TSO, the reserve receiving TSO and the affected TSO as regards the exchange of FRR and RR defined in accordance with Article 165(1)”

1. This Article does not apply in GB because of the LFC Block structure where there is a single TSO with the responsibility of being the GB electricity system operator for a single LFC Area that is contiguous with the LFC Block and Synchronous Area

Not in the GB SAOM - SOGL Article 118 (v) – “the 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 defined in accordance with Article 166(1)”

1. This Article does not apply in GB because of the LFC Block structure where there is a single TSO with the responsibility of being the GB electricity system operator for a single LFC Area that is contiguous with the LFC Block and Synchronous Area.

SAOM Article 17 - SOGL Article 118 (w) – “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 between synchronous areas defined in accordance with Article 171(2)”

1. These roles and security steps and procedures associated with the offering and activation of reserves cross border are defined in the operational agreements which contain the rules, procedures and practices used between the ESO, the other TSOs of connecting areas/service users and the interconnector operators. The SOGL concerns itself with security and control process implications of making available and transferring reserves from one area to another. The commercial, market and settlement frameworks the surround these are the subject of the Electricity Balancing Guideline (EBGL).
2. Each cross-border reserve service involving the ESO and one or more foreign TSO and one or more HVDC interconnector will have these roles and principles defined in operational agreements. The roles defined in this Article are not ‘static’ but depend on specific activation sequence and which TSO is ‘playing’ the role of connecting, affected or receiving at any given time. The trigger to this sequence can be a simple TSO need or be extended to cover considerations beyond SOGL and the subject of EBGL.
3. Sharing of Reserves is a concept which allows a TSO to take a cross-border activation process into account while organising the availability of the required Active Power Reserves. This means that Sharing of Reserves cannot be technically linked to a specific Reserve Providing Unit or a Reserve Providing Group. Generally speaking, Sharing of Reserves provides a control capability offered by one TSO to another without ensuring the availability of additional corresponding Reserve Capacity (as it is shared it can suffer from a greater number of reasons as to why it may be unavailable; i.e. already in use by another TSO). The Exchange of Reserves provides a control capability and additional corresponding Reserve Capacity at the same time (since the exchanged reserves are now exclusively for the use of the receiving TSO).
4. In order to define clear and consistent responsibilities for TSOs involved in Exchange of Reserves or Sharing of Reserves, the SOGL introduces the respective roles for the involved TSOs.
5. Reserve Connecting TSO and reserve receiving TSO
 - a. In context of Exchange of Reserves the role of the Reserve Connecting TSO does not change but is supplemented with an additional meaning:
 - i. The Reserve Connecting TSO is still the TSO which operates the Monitoring Area, LFC Area or LFC Block to which a Reserve Providing Unit or a Reserve Providing Group is physically connected to while a certain amount

of the Reserve Capacity is required by a different TSO, the Reserve Receiving TSO, to fulfil its dimensioning requirements.

- ii. The Reserve Receiving TSO means the TSO involved in an exchange with a Reserve Connecting TSO and/or a Reserve Providing Unit or a Reserve Providing Group connected to another Monitoring or LFC Area.

6. Control capability providing and control capability receiving TSO:

- a. The roles of Control Capability Providing TSO and Control Capability Receiving TSO are defined as follows:
 - i. Control Capability Providing TSO means the TSO which shall trigger the activation of its Reserve Capacity for a Control Capability Receiving TSO under conditions of an agreement for the Sharing of Reserves.
 - ii. Control Capability Receiving TSO means the TSO calculating Reserve Capacity by taking into account Reserve Capacity which is accessible through a Control Capability Providing TSO under conditions of an agreement for the Sharing of Reserves.
- b. Therefore, the respective terms describe the relationship in context of Sharing of Reserves between two TSOs enabling the NC LFCR to directly and explicitly target the respective obligations without inconsistencies with the roles of the Reserve Connecting TSO, the Reserve Receiving TSO and the Reserve Instructing TSO.
- c. The Control Capability Providing and Receiving TSOs shall follow the Notification Process for the Sharing of Reserves.

7. Affected TSO

- a. In addition to the Reserve Connecting TSO and the Reserve Receiving TSO for the Exchange of Reserves and the Control Capability Providing TSO and Control Capability Receiving TSO for the Sharing of Reserves, any Affected TSO has the right to refuse respectively the Exchange or Sharing of Reserves in the case the activation of the concerned Reserve Capacity would result in power flows in violation with the Operational Security Limits.

SAOM Article 18 - SOGL Article 118(x) - “the methodology to determine limits on the amount of sharing of FCR between synchronous areas defined in accordance with Article 174(2)”

1. The principles guiding this security limitation have already been fully explained in SAOM Article 10