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NESO reply to consultation comments

NESO acknowledged all the comments from SSE Generation and had a follow-up meeting to clarify their questions and concerns. The key discussion points and subsequent actions from the meeting are summarised as follows.

- **Simultaneous events and inertia management**

SSE Generation raised concerns about simultaneous faults, such as those caused by offshore ships' anchors, and how they align with the 102 GVA.s reduced minimum inertia policy. NESO clarified that analysis and current policy do not consider simultaneous faults as a risk. The analysis utilises statistical views from historical cascading or multiple-generation tripping events to calibrate the likelihood of simultaneous occurrences. However, it does not consider the root causes of these historical events due to their complex nature. The reduced minimum inertia requirement will be supported by increased fast response services to manage frequency security effectively.

To address SSE Generation's question regarding how the system would perform if the historical events happened under a lower inertia level, NESO presented the hypothetical analysis to 2023 and 2025 simultaneous events, and explained how different inertia levels would have impacted the frequency response. The analysis showed that reducing inertia to 102 GVA.s would result in a slight drop in frequency nadir but still be higher than 48.8 Hz LFDD operation triggering level due to the additional response measures we would have procured under reduced minimum inertia level. We also explained that since FRCR 2024 policy, we have been holding additional DC-L responses, which helps cover majority of the simultaneous events even with lower inertia levels. FRCR 2025 recommends increasing the additional response from 100 MW to 200 MW.

- **Additional DC-L volume extended analysis**

Based on the feedback from SSE Generation and similar comments from other consultation responses, We have extended our analysis in DC-L, increasing the additional volume from the current 300 MW to 500 MW, and have presented the data with a granularity of 50 MW. Our conclusion and recommendation remain unchanged, that the risk vs. cost analysis showed that 200 MW is a balanced option, covering most risks without significantly increasing costs. The updated analysis will be included in the final FRCR 2025 report when submitting the SQSS Panel and Ofgem. In the meeting, NESO also explained that significantly increasing the DC volume in a single attempt could

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have a substantial impact on other balancing service markets, which involve the same participants.

- **Risks associated with new HVDC technology**

SSE Generation raised concerns about new HVDC technology and their potential risks relevant to frequency control. NESO explained that current approach to consider asset failure is statistical, relying on historical data to support assumptions in their models. Risks associated with new technologies and new assets are evaluated at the development, design, and connection stages, where frequency analysis similar to the FRCR model will be conducted to understand potential risks. Together with other operability analyses, feedback will be provided to the new design and connection project, and mitigations, such as code modifications if applicable, could be introduced. The new risks will be incorporated into future FRCR mode I and policy update.

- **Modelling and analysis for GSR030**

SSE Generation inquired FRCR's engagement and input to GSR030 development, which proposes to expand the infrequent infeed loss from 1320 MW to 1800 MW and different arrangements for HVDC technology. NESO confirmed that the team has been leading the frequency modelling and analysis in the working group by using a model similar to the one used in FRCR. The increased infeed loss is not considered in FRCR 2025 but will be included in future FRCR when it becomes valid via the GSR030 proposal.

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The NESO would like to thank you for the participation in the FRCR 2025 consultation process. We appreciate all the comments and feedback. Please find our response to your valuable input below.

No	Questions	Comments	NESO Response
7	Do you agree that the FRCR 2025 has been prepared appropriately? Please elaborate...	We welcome the steps NESO has taken to prepare the report, including commissioning Accenture to perform an independent view. To be fully satisfied with the process would have involved NESO providing Accenture with a wider scope of works. The current scope focused on ensuring robust process governance, documenting and adhering to methodologies and verifying the reproducibility of model results. Expanding this scope to encompass a comprehensive assessment of the principles and risks associated with network operation and the transition to Net Zero would have facilitated a more holistic independent evaluation.	<p>Whilst we fully acknowledge a holistic view of system operation is preferable, FRCR focuses system frequency risk versus cost, other operability work streams look at the wider operability effects of the transmission to net zero, such as Operability Strategy Report.</p> <p>Within current FRCR scope, in your view, what could be the extended scope look like?</p>
8	Do you believe there has been sufficient industry engagement in preparing FRCR 2025? Please specify further suggestions.	Partially. While there were numerous webinars and engagements at specific forums, such as the SQSS Panel, we believe it would be beneficial to publish a comprehensive list of the questions and comments collected during these engagements, along with responses detailing the actions taken to address them. This approach would enhance transparency and assist stakeholders in determining their support for the recommended outcomes of the process.	<p>Thank you for your comment. Currently all Q&As from past technical webinars and consultation webinar have been published on the NESO website under FRCR section. FRCR relevant discussions and actions from past SQSS panel meetings can also be found from the SQSS Panel meeting minutes. Following our meeting, individual responses to FRCR 2025 consultation, NESO responses and follow-up actions to conduct further analysis, update final report and/or introduce wider discussions, wherever are</p>

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			applicable, will be submitted to the SQSS Panel and Ofgem and published on NESO website.
9	Overall, do you agree that the FRCR 2025 represents the appropriate level of development in determining the way that the NESO will balance cost and risk in maintaining frequency security while operating the system at a reduced inertia down to 102 GVA.s? Please use the boxes below for the bullet points.	To ensure the appropriateness of the process, it would have been prudent to evaluate the new policy position against major historical events on the GB transmission system. Specifically, applying the recommended 102GVA policy to all significant outages, including those in 2008, 2019, 2023, and 2025, would provide valuable insights into the policy's effectiveness (i.e. would 102GVA have been sufficient for stable system operation in each of these 4 outage events). This approach would better inform whether the policy remains robust when tested against relevant historical data.	<p>We have conducted additional analysis to 2025, 2023 and 2019 events by assuming the system inertia was at 102 GVA.s. Please refer to the appendix for details. The analysis will be included in the final FRCR 2025 report when submitting to the SQSS Panel and Ofgem.</p> <p>Those analysis were highly hypothesis and indicative, as system conditions, e.g. minimum inertia policy, LoM volumes, and market conditions, e.g. dynamic services development, have been changed significantly in the past 5 years.</p>
10	Do you agree with the recommendation to reduce minimum inertia requirement down to 102 GVA.s?	Determining an appropriate level of risk is not the responsibility of the non-network stakeholders. This decision should be made by NESO and Ofgem, based on their understanding of market liquidity, costs and their risk appetite, on behalf of consumers, concerning security of supply. The non-network stakeholders lack visibility into market liquidity and do not bear the responsibility for assessing what constitutes a reasonable level of risk for consumers.	Thank you for your feedback.
11	Do you agree with the recommendation to secure all BMU-only events (including	In recommending the 102GVA policy, NESO has opted not to account for simultaneous events. This decision appears to be based on the 1 in 9999-year residual risk, as indicated on slide 11 of the	Please refer to the appendix for the hypothetical analysis of 2025 simultaneous event.

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	<p>consequential RoCoF)? If not, please explain why.</p>	<p>consultation webinar slides, and the level of market liquidity.</p> <p>However, both the August 2019 and March 2025 events were simultaneous occurrences. We recommend revisiting the analysis supporting the exclusion of simultaneous events, particularly in light of the most recent event which occurred after the NESO's FRCR work, i.e. this consultation. If the NESO conclusion remains that simultaneous events should not be covered by reserve capacities, it is essential for NESO to provide a clear rationale for their decision.</p>	<p>If this event occurred in 2024, together with historic records, the occurrence of simultaneous events considered in FRCR would change from 3.5 to 3.67 per year. We might see a slight increase in 49.2 Hz and 48.8 Hz event probability. This however does not change our recommendation regarding simultaneous event security.</p> <p>Whilst securing for simultaneous events are not recommended in this year's FRCR, the additional procurement of DC recommended covers a reasonable volume of simultaneous losses to a degree at which NESO deems an appropriate risk vs. cost profile. With additional 200 MW DC-L procurement at 102 GVA.s minimum inertia, the residual risk of a 48.8 Hz event was reduced from 1 in 25.82 years to 1 in 30 years.</p>
12	<p>Do you agree with the recommendation to procure additional DC-Low service provision by 200 MW ? If not, please explain why.</p>	<p>The recommendation was formulated by evaluating the procurement of an additional 100MW, 200MW, and 300MW of DC-low from the market. According to Table 6 in the FRCR Report 2025, the differences between these procurement levels are as follows:</p> <p>? Procuring 200MW costs an additional £1.62 million over 100MW, reducing the residual risk of a 49.5Hz event by 0.61 times per year and a 49.2Hz event by 10 years.</p> <p>? Procuring 300MW costs an additional £1.61 million over 200MW, reducing the residual risk of a</p>	<p>Thanks for the comments. We have conducted additional analysis to evaluate the effectiveness of different DC-L volumes. Please see the appendix for more information. Please note, with the additional analysis, our recommendation of procuring additional 200 MW DC-L remains.</p> <p>Please also note, since FRCR process establishment, the SQSS requires the transient frequency deviation outside the statutory limits, i.e. 49.5 and 50.5 Hz to be infrequent whilst FRCR sets out more rigid requirement on 49.2 and 48.8 Hz events. Between 200 and 300 MW additional</p>

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		<p>49.5Hz event by 1.35 times per year and a 49.2Hz event by 5 years.</p> <p>Procuring 300MW offers greater benefits for 49.5Hz events and half the benefit for 49.2Hz events. To validate the 200MW recommendation, it would be prudent to test the procurement of 400MW to determine if the recommendation remains robust.</p>	<p>DC-L, the residual risks at 49.5 Hz will be between 1.85 times per year and 0.5 times per year. Both these figures are infrequent.</p>
13	Do you have any other comments to the recommendations?	No.	
14	In your view, what should the future FRCR focus on?	<p>With the expansion of the network to incorporate new nuclear facilities, further interconnectors and the potential development of large offshore networks with offshore hubs, it is likely that the largest loss of infeed may need to be revised. We recommend that future FRCR assessments evaluate the potential impacts of losing a larger volume of generation and/or interconnection than currently planned and determine the associated consequences. Additionally, we would also recommend that advances in HVDC technology be included, i.e. Interoperability and circuit breakers, to assess whether any potential failures of them should be mitigated.</p>	<p>FRCR models appropriate levels of losses as needed for the duration of the FRCR study, i.e. 2025-26 and 2026-27 as per FRCR 2025 scope. The largest infeed loss and outfeed loss are determined under the SQSS and Grid Code in connection planning phase, and NESO has separate working group in reviewing those requirements in collaborating with the industry. Once the new levels of largest loss are deemed valid under the SQSS and Grid Code, future FRCR will factor those in the analysis. If future FRCR deem larger losses non-securable with the minimum inertia policy or too costly to manage it, there is always the ability to alter the FRCR recommendations to adjust for that when the time comes.</p> <p>NESO will need to understand potential risks introduced by any new and evolving technologies during their connection phases.</p>

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			Some of the analysis will involve using FRCR model to understand risks relevant to frequency control and wider system operability. We will factor those into future FRCR work once the risk is well materialised. In the meantime, we will introduce additional measures if an emerging risk is experienced / observed from real-time operation, e.g. SSO event.
15	Do you foresee any issues that may arise from moving the obligation to produce the FRCR to a NESO License Condition rather than an Annex to the NETS SQSS?	<p>Transferring the obligation from the SQSS to a License Condition poses the risk of diminishing industry oversight and governance. The current arrangements facilitate robust industry engagement on this very important topic, which not only enhances the quality of recommendations but also helps the industry gain a deeper understanding of network risks.</p> <p>If this obligation is moved to a license condition, the level of engagement and governance would need to be defined by Ofgem, potentially resulting in reduced engagement. For instance, NESO License Condition C16 SSEP currently requires NESO to engage with parties they deem interested. Should a similar outcome be applied to FRCR, then it would result in a less efficient system and not be in the best interest of consumers.</p>	<p>Thank you for your feedback. We will collate all the feedback through this consultation and discuss further with the SQSS Panel and Ofgem. We shall communicate further update or run a separate consultation if any changes to current arrangement is proposed.</p>
16	If the obligation to produce the FRCR and the governance rules surrounding that process are moved to NESO's	Yes.	Thank you for your feedback.

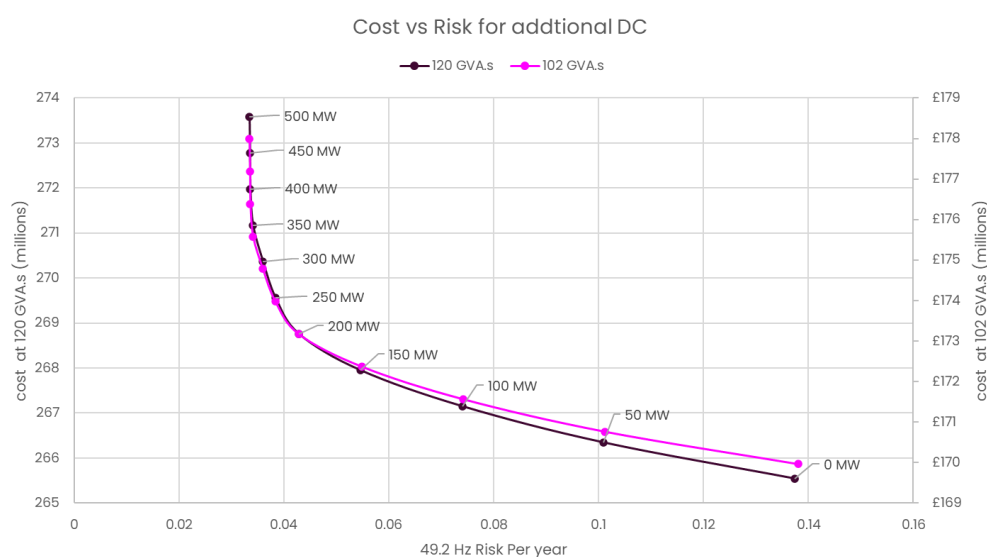
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	License, do you believe that the NETS SQSS Panel should continue to provide oversight?		
17	If your answer to question 16 is "Yes", to what extent should this oversight be? For example, should it include technically assessing the recommendations and approving/rejecting it, or should it be limited to confirming that the governance process has been followed correctly?	It should be to include technically assessing the recommendations and approving/rejecting it. This is the only way to engage with the principles behind the process and the outcomes to allow sufficient challenge by industry to ensure the most efficient system outcome and the highest benefit for consumers.	Thank you for your feedback. We will discuss with the SQSS Panel.

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Appendix 1 – Extended simulation for overholding DC

Additional scenarios are simulated to cover 0 –500 MW additional DC holding with 50 MW step at 102 GVA.s and 120 GVA.s inertia requirement, shown as below. It can be seen that the two curves largely overlap and extend to the left side as the DC is increased to 500 MW. The incremental benefit becomes very small once the 200–300 MW range is surpassed. There is a discussion about whether 200, 250, or even 300 MW is the optimal choice. However, 200 MW remains a viable option.



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Appendix 2 – Case study on minimum inertia policy's impact on 14th March 2025 event.

System inertia was reported as 276.4 GVA.s at the time of the event. The minimum inertia requirement was set at 120 GVA.s. Since the total system inertia was 276.4 GVA.s, which exceeded the minimum requirement, no additional actions were necessary to increase the system inertia. We can now consider several hypothetical questions:

- ***What if the minimum inertia requirements during the event was 102 GVA.s instead of 120 GVA.s?***

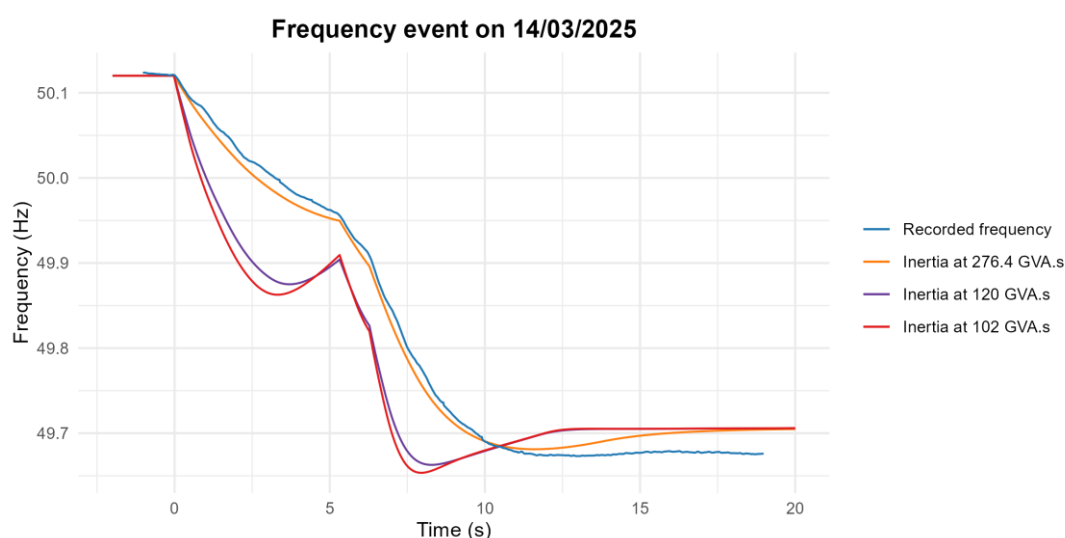
Since the minimum inertia requirement sets only the bottom threshold and does not intentionally reduce inertia, the total system inertia of 276.4 GVA.s satisfies both the 102 GVA.s and 120 GVA.s minimum requirements. Therefore, there would be no expected differences in this event if the minimum inertia requirement were lowered to 102 GVA.s.

However, there would be some difference if the system raw inertia were below the threshold where additional actions are needed.

- ***What if the minimum inertia requirements during the event was 102 GVA.s instead of 120 GVA.s, AND system raw inertia was below the threshold***

If the system's raw inertia falls below the threshold, additional actions would be needed to meet the minimum inertia requirements. Response holdings would be adjusted according to the inertia to ensure that the largest infeed loss can be accommodated. In this scenario, the Dynamic Containment holding would remain unchanged because the static Firm Frequency Response (sFFR) holding of 185 MW did not meet the requirement of 250 MW, necessitating additional Dynamic Containment to fulfil the recovery requirement.

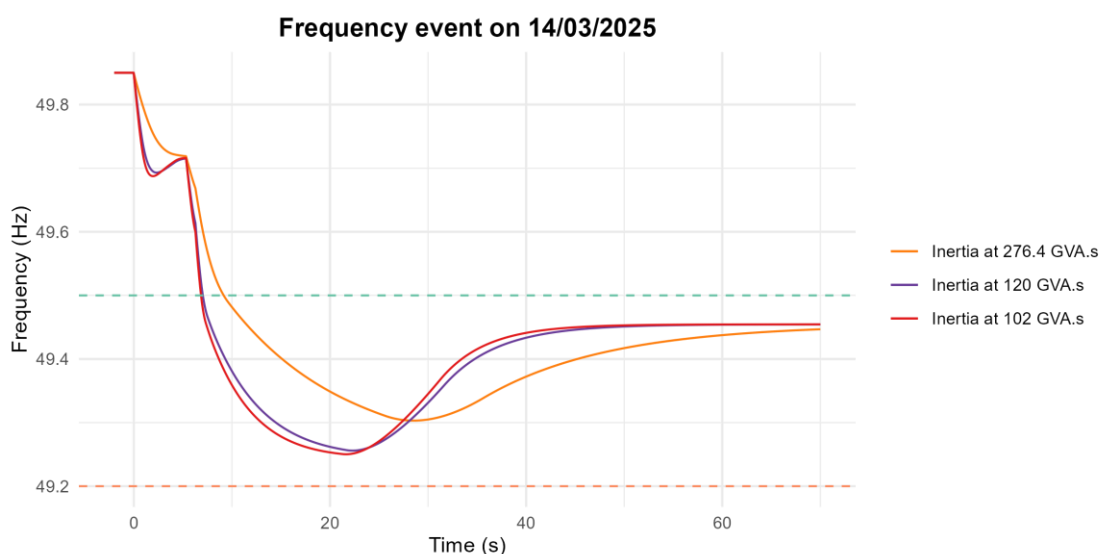
The figure below illustrates the expected frequency curves when the system inertia is either 120 GVA.s or 102 GVA.s. With lower system inertia, the frequency nadir will decrease but will still be contained within 49.5 Hz, while the stabilised frequency remains consistent.



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- **What if the minimum inertia requirements during the event was 102 GVA.s instead of 120 GVA.s, AND system raw inertia was below the threshold, AND initial frequency was 49.85 Hz instead of 50.12 Hz.**

The initial frequency of this event was 50.12 Hz which provides a certain level of buffer to this event. The worst-case scenario would be considering 49.85 Hz as the initial frequency which is implemented in the response calculation process. The figure below shows the expected frequency curves if initial frequency was 49.85 Hz.



The frequency drop can be contained before 49.2 Hz, i.e. no LFDD risk for the worst-case scenario. However, the frequency struggles to recover within 49.5 Hz in 60 second since this event is not a secured loss. If this is the case, Control Room will need to instruct reserve products to bring frequency back within 49.5 Hz and the operational limit.

Note: LFSM-U is not included in the study, with LFSM-U the frequency deviation will be further reduced.

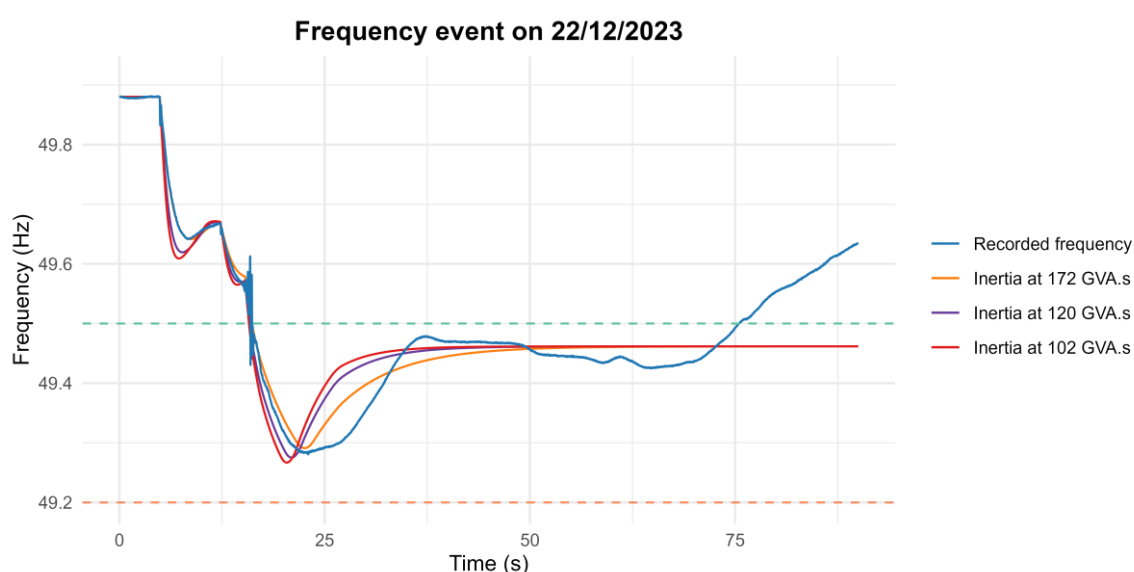
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Appendix 3 – Case study on minimum inertia policy’s impact on 22nd Dec 2023 event.

System inertia was reported as 172 GVA.s at the time of the event. The minimum inertia requirement was set at 140 GVA.s. Since the total system inertia was 172 GVA.s, which exceeded the minimum requirement, no additional actions were necessary to increase the system inertia.

Simulations were conducted for the following hypothetical scenarios:

- 172 GVA.s (actual system inertia)
- 120 GVA.s (inertia policy implemented in 2024)
- 102 GVA.s (reduced inertia level)



The Frequency nadir difference between the 172 and 102 GVAs scenario is 0.026 Hz. None of the scenario will lead a breach of 49.2 Hz threshold. The minimum frequency at 102 GVA.s inertia level is 49.27 Hz.

At the time of the event, the live frequency control policy was FRCR 2023, which did not require any additional Dynamic Containment beyond the standard requirements. FRCR 2024 recommended holding an additional 100 MW of Dynamic Containment Low, while FRCR 2025 proposes holding an additional 200 MW. Increasing Dynamic Containment holdings would improve the frequency nadir.

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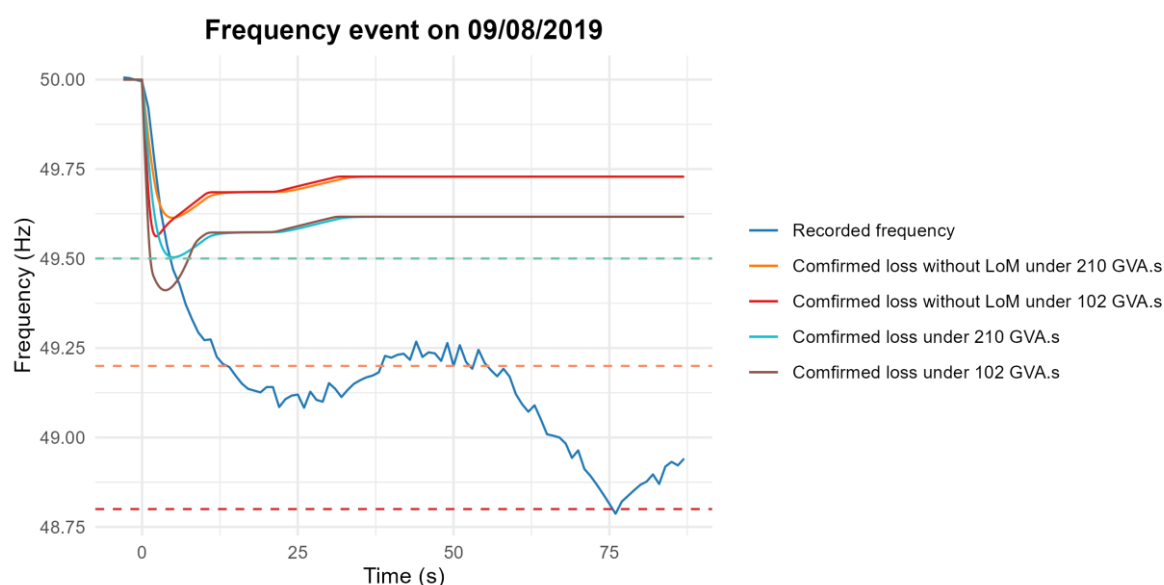
Appendix 4 – Case study on minimum inertia policy's impact on 9th August 2019 event.

System inertia was reported as 210 GVA.s at the time of the event. The minimum inertia requirement was set at 140 GVA.s. Since the total system inertia was 210 GVA.s, which exceeded the minimum requirement, no additional actions were necessary to increase the system inertia.

The ways of managing frequency risks have changed significantly since the time of the event. The Accelerated Loss of Mains Change Programme (ALoMCP) was introduced to reduce the consequential Loss of Mains (LoM) risks. Dynamic Containment service was introduced as a fast-acting response service to arrest the frequency drop.

Simulations were conducted for the following hypothetical scenarios. In the simulations, response holdings are assumed to align with the current frequency control policy, i.e. FRCR 2024.

- Confirmed loss without LoM under 210 GVA.s (Post ALoMCP with the actual inertia of the event)
- Confirmed loss without LoM under 102 GVA.s (Post ALoMCP with the reduced inertia level)
- Confirmed loss under 210 GVA.s (Pre-ALoMCP with the actual inertia of 210 GVA.s)
- Confirmed loss under 102 GVA.s (Pre-ALoMCP with the reduced inertia level)



Additional simulations were performed for the worst-case scenario, where the initial frequency dropped from 50 Hz to 49.85 Hz. With the help of Dynamic Containment, the frequency drop can be arrested before 49.5 Hz.

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Frequency event on 09/08/2019

