Annex 2: GSR036 Impact Assessment

Introduction:

GSR036 proposes a modification to the National Electricity Transmission System Security and Quality of Supply Standard (SQSS) to review and increase the upper voltage limit for the 275 kV network from +9% back to +10% as applied prior to 2017. This change provides additional operational flexibility and supports the delivery of the UK's clean energy and Net Zero targets.

The current voltage limit is increasingly constraining the pace and development required to meet 2030 and 2050 decarbonisation objectives. Increasing the upper limit to +10% would improve outage planning flexibility, reduce costs, and maintain system resilience.

The change is expected to have a medium impact on industry parties including Transmission Owners (TOs) and Offshore Transmission Owners (OFTOs), NESO, Network Operators, Non-Embedded Customers, Interconnectors, and Generators. Benefits include reducing outage rejections by NESO due to voltage violations and accelerated grid connections without compromising asset integrity. This ultimately enables a greater volume of network outages to be accommodated. In practice, the additional flexibility is expected to enable a limited number of otherwise constrained outages to be accommodated within the outage plan, on a case-by-case basis, subject to operational conditions.

Aims and objectives of this impact assessment:

This document provides an impact assessment of the proposed modification to the SQSS to restore the upper steady-state voltage limit on the 200 kV – 300 kV network from +9% to +10%. The assessment considers how this change is expected to increase operational flexibility and enable a limited number of otherwise constrained outages to be accommodated within the outage plan, on a case-by-case basis, while supporting more efficient network delivery and associated cost savings. For the 275 kV network, this represents an increase in the post-fault voltage limit from 300 kV to 302.5 kV.

Impact on system resilience:

The proposed changes to the 200 kV–300 kV voltage limits in the SQSS are anticipated to have no material impact on overall system resilience.

This conclusion is supported primarily by several case studies, which demonstrate that under stressed but credible system conditions, observed post-fault voltages are modest (typically around 300-302 kV) and are already managed securely through established operational practices, without loss of demand security or asset integrity.

In Case Study 1 (West London) and Case Study 2 (North-West England and Wales), operators intentionally tolerated brief simulated post-fault overvoltage in order to preserve network redundancy and avoid exposing demand to single-circuit risk. The proposed +10% limit would not change these resilience-preserving operational decisions but would instead render them compliant with the SQSS without altering fault standards or asset limits.

Case Study 3 (North-East England) similarly demonstrates that medium probability events remain secure under the proposed limits, reducing the need for unnecessary operational interventions while leaving all existing security barriers unchanged.

275 kV steady-state and post-fault voltage limit increase:

Following discussions held in a joint workshop between NESO and all TOs, there is agreement that restoring the pre-2017 SQSS limits for the 275 kV network by increasing the steady-state and post-fault upper voltage limit from 1.09 per-unit (pu) (300 kV) to 1.10pu (302.5 kV) is acceptable.

This position is consistent with the Grid Code, including Connection Conditions CC.6.1.4 and with relevant electrical standards. The current +9% limit represents a deviation from limits introduced in 2017 to align with IEC considerations; however, TOs have confirmed that, in practice they continue to design and operate their 275 kV networks in accordance with the 1.10pu (302.5 kV) limit.

As a result, the relevant Electrical Specifications for connections to each Transmission Owner's network continue to specify equipment capability at 1.10pu (302.5 kV), and connected assets are already designed to withstand voltages at this level. The TOs also confirmed that reinstating the pre-2017 voltage limits would have negligible effect on the generation side, as the change represents a reversion to historically applied design and operating conditions rather than the introduction of new requirements.

Further upper voltage limits increase at 275 kV:

While GSR036 updates the SQSS steady-state and post-fault voltage limits, responsibility for risk assessment remains unchanged. Asset Owners remain responsible for assessing their assets and system risks in all circumstances, including where operation exceeds the SQSS limits and is considered under a separate risk-based approval process. Any proposal to raise the upper voltage limit above 1.10pu would therefore require detailed, asset-specific risk assessments and a formal review in line with the Grid Code process, to ensure that all equipment would continue to operate within safe and proven design limits.

Post-Fault Voltage Limits for the 200 kV–300 kV Network

Nominal Voltage	PU Value (1pu relates to the Nominal Voltage)	Minimum (percentage of Nominal Voltage)	Maximum (percentage of Nominal Voltage)
200 kV up to and including 300 kV	0.90pu- 1.10pu	-10%	+10%

Case studies:

The case studies below demonstrate how the proposed voltage upper limit increase could positively impact the operation of the electricity transmission system if implemented.

Importantly, no real events have been identified that exceed the 9% limit on the 275 kV network. All examples presented here are based on calculated voltage limits derived using the Power Network Analyser (PNA) tool. These scenarios involve network faults that would create an 'insecure' system, which fall outside the SQSS limits in an offline environment.

One possible explanation for the absence of real events exceeding the 9% limit on the 275 kV network is the stricter 5% limit applied to the 400 kV network. As a result, voltage breaches are typically detected on the 400 kV network first, prompting operational interventions before the 275 kV network voltage limits are reached. Consequently, operational responses are implemented at that level, which mitigates voltage escalation across the wider system.

CASE STUDY 1:

Scenario/Constraint Overview

In this scenario an outage affecting a circuit in West London, combined with an outage on a circuit connecting the area to South Wales, led to high voltages at two West London substations. The simulated volts reached 300-301 kV, compared to the existing limit of 300 kV (+9%). An interconnector was out of service in the simulation, meaning its STATCOM was not available for voltage support. In addition, a voltage control circuit (VCC) in the area was required to remain in service. VCCs can normally be switched out as a means of managing voltage levels.

The simulated network represented a lightly loaded system, typical of overnight conditions. A range of operational actions was tested in the study, including tap staggering, adding additional generation, and network reconfiguration. The only option that successfully reduced the post-fault voltage within the existing limits would have introduced additional demand risk (single circuit risk). As such, this action would not be considered viable in real time operational timescales.

Worst Trip and Overload

The most severe contingency identified in this study was the loss of a mesh corner at a West London substation. Under this event, post-fault voltage levels were observed in the range of 300–301 kV, corresponding to approximately +9% to +10% above the nominal 275 kV voltage.

Observations and Conclusions

Under the increased post-fault voltage limits as proposed in GSR036, voltages would be considered acceptable up to 302.5 kV (+10% of nominal). Based on this, the post-fault voltages recorded in the simulation fall within the proposed secure operating range. Consequently, with a +10% upper limit applied, this outage scenario would not present a security or compliance issue. The outage combination assessed in this study could therefore proceed under the revised limits without requiring additional operational intervention. Additionally, reinstating the Voltage Control Circuit (VCC) would secure the demand supply.

CASE STUDY 2:

Scenario/Constraint Overview

This case study analyses a simulation of high post-fault voltages in the Northwest following a network fault that caused the loss of a single circuit and associated synchronous compensation. To maintain post-fault security, a voltage control circuit was returned to service. Regional generation was unavailable due to planned outages.
A subsequent simulated fault (a further double circuit event) showed the network to be insecure, with voltage limits exceeded at two substations: 302 kV at the most affected site and 301 kV at the secondary location. System loading was low, consistent with overnight demand.

Worst Trip and Overload

This scenario represents a combination of:

1. a planned shutdown of a nearby synchronous generator,

2. a persistent fault outage experienced on the system, and

3. an additional double circuit contingency simulated on the network to re-secure the system.

This sequence represents a low probability in a multiple-contingency scenario. Post-fault voltages ranged from +9% to +10% at both impacted substations.

Observations and Conclusions

Under the proposed post-fault upper voltage limit of +10%, all voltages in this scenario would remain secured. Moreover, the revised standard would help simplify the need of growing reporting arrangements. The proposed increase in the upper voltage limit highlights how the incremented limit would enhance the security of supply. By removing the need for a Voltage Excursion Report (VER) with the new limit, reinstating the Voltage Control Circuit (VCC) for demand security, and adjusting the voltage limit, the system's overall security would be significantly optimised. This proactive approach ensures security of supply and reliability of the power network, capable of effectively responding to both planned and unplanned operational scenarios. The overall security could be strengthened by avoiding the need to take voltage control circuits affecting demand sites.

CASE STUDY 3:

Scenario/Constraint Overview

This scenario evaluates simulated high post-fault voltages arising overnight in the Northeast of England. The assessment assumes that key generators were unavailable and essential reactive compensation equipment was out of service. Under these conditions, the simulation indicated that the system would be insecure following a single circuit contingency, with the worst-case post-fault voltage reaching approximately 301 kV at the most affected substation.

Worst Trip and Overload

This scenario considers:

1. unavailability of strategically significant generation,
2. unavailability of reactive equipment, and
3. a subsequent single circuit fault simulation.

This combination represents a medium probability scenario. The highest observed voltage was between +9% and +10% of the nominal level.

Observations and Conclusions:

With the proposed +10% post-fault voltage limit, the system would remain within secure operating thresholds. The change proposed would enable the requested outage of reactive equipment (such as reactors or Static VAr Compensators (SVC)) without compromising system limits or requiring additional reactive support services.

By allowing such outages to be scheduled while maintaining adequate voltage margins, the system could avoid unnecessary operational costs and preserve stability during unforeseen events. This supports the case for security of the transmission system and enhanced operational flexibility under the revised limits.

Conclusion:

The Transmission Owners' publication (2017) demonstrated that transmission assets were designed to withstand upper voltage levels of 1.10pu (302.5 kV), in line with the Grid Code (CC.6.1.4) and the relevant electrical specifications for equipment connected to each TO's network.

These standards continue to reference 1.10pu as the required equipment capability.

Across the case studies presented, it is evident that increasing the post-fault voltage limit to +10% can deliver systemwide benefits, including:

- enabling a broader range of outages to proceed without compromising SQSS security criteria.
- reducing the likelihood of unnecessary operational interventions or Voltage Event Reports (VERs).
- avoiding the need for additional generation dispatch or reactive support, thereby reducing operational costs; and
- improving the security of supply by retaining a greater voltage margin during abnormal system conditions.

Overall, adopting the increased voltage limit enhances the efficiency of system operations, ensures asset security, and improves the ability to manage the network under both planned and unplanned conditions. By maintaining a greater voltage margin, these changes provide the flexibility needed to take timely mitigating actions, thereby enhancing demand security. This proactive approach not only supports the stability and reliability of the power system but also ensures that the network can effectively respond to varying operational scenarios and potential disruptions. Analysis of outage management data identified five examples in 2024/2025 that may have been affected by the proposed changes. Ultimately, this contributes to a secure, resilient and efficiently operated electricity transmission system.