Electricity Transmission

Operational Noise from Substations: Considerations for Decision Makers

Background

National Grid Electricity Transmission (NGET) owns, builds, and maintains the high-voltage electricity network in England and Wales, operating it as a core part of Great Britain's energy infrastructure. We transport large amounts of electricity from power stations and renewable sources via pylons, overhead lines, and underground cables to regional distribution networks.

As a socially and environmentally responsible business, National Grid is committed to the protection and enhancement of the environment and communities in which we operate. National Grid Electricity Transmission (NGET) ensure compliance with all relevant internal, National and Local Planning Policies to uphold this commitment. However, it is beyond our control to guarantee that noise from our infrastructure is adequately considered when new developments are proposed. When operational noise from our Substations is not appropriately assessed, there is a risk that future occupants and communities may experience adverse noise impacts.

This poster aims to underscore the importance of accurately assessing noise from electricity transmission systems, outlining best practices, and serving as a resource for decision-makers and industry professionals when considering plant for future developments close to our assets.

Understanding Substations Function

Transmission substations are key points in the electricity network where power is converted and routed. Substations step voltages up or down to suit transmission needs, compensate for system changes, and allow circuits to connect or disconnect.

Electricity enters the transmission network near generation sites (like power stations or wind farms) and leaves at grid supply points (GSPs) for distribution to homes and businesses. Because generator output varies in voltage, substations adjust and control voltage for efficient high-voltage transmission (typically 275kV or 400kV) across overhead lines before the voltage is stepped down again for safe delivery to local distribution networks.

What Generates Substation Noise

The most common noise sources located on NGET substations are reactive components, such as Super Grid Transformers (SGTs) and Shunt or Series Reactors (SHRs). These assets operate continuously and produce a distinctive low-frequency tonal hum, at twice the UK supply frequency, with higher order harmonics, due to a phenomenon called magnetostriction.

Protection and switchgear equipment, such as circuit breakers, disconnectors, and switches, can also generate noise. These sounds are short and impulsive events that occur very rarely, typically during fault isolation or maintenance operations and are therefore generally not cause for concern.

Characteristics of Substation Noise

Low Frequency:

- Within acoustics, low-frequency range is generally considered 20 Hz to 200 Hz. Reactive assets within substation are typically dominant at 100 Hz.
- Low-frequency sound travels much farther than higher-frequency sound as it loses less energy over distance.
- Low-frequency sound has long wavelengths ($\lambda = v / f$), which allows for low-frequency sound to bend easily around obstacles (diffraction), making barriers and other obstacles largely ineffective at blocking the transmission path from source to receiver. Long wavelengths also penetrate materials with less energy loss compared to shorter wavelengths. These characteristics make controlling low-frequency noise particularly challenging.

Tonal:

- Often described as a low frequency hum, substation noise is highly tonal, meaning it stands out and can be perceived as more intrusive than broadband sounds. Windows offer higher levels of attenuation at higher frequencies than lower frequencies, which can result in the low frequency noise appearing more noticeable
- Low frequency tonal noise is often perceived more so at night-time as background noise reduces at night, whilst low frequency noise may not have changed in volume, it may be more noticeable.

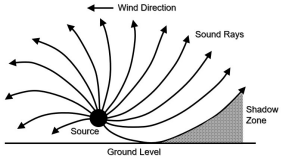
NOTE: Substations show peaks at 100 Hz and higher order harmonics.

Continuous:

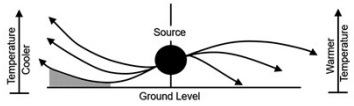
- Substations operate continuously 24/7. There may be times where individual assets are 'switched out' due to fault or for maintenance purposes.

Environmental Factors

Wind direction and noise propagation:
Wind direction can affect sound levels at receiver locations depending on the wind direction. Downwind has the potential to make sound louder and travel further, while upwind can create "shadow zones" where is it quieter as sound refracts upwards away from the ground.



Temperature inversions:
Temperature inversions can also cause sound waves to refract upward or downward, changing how audible they are at different distances from the source.



Receptor Sensitivity

Noise is not perceived equally; some people simply heave better hearing than others and our tolerance to noise also differs from person to person.

As noise perception varies between individuals, BS 4142 assessments are essential to objectively determine the significance of a sound source.

The standard provides a consistent framework for comparing measured sound levels against existing background conditions, ensuring that conclusions are evidence based rather than reliance on subjective or anecdotal responses.

British Standard 4142:2014+A1:2019

BS 4142 assesses industrial/commercial noise impacts on residential receptors. It compares the noise rating level with background sound levels:

- Rating ≤ background: low likelihood of adverse effects (context dependent).
- Rating > background: increased likelihood of adverse effects.

Limitations:

- A-weighting can underestimate low-frequency noise.
- Tonal corrections rely on judgement.
- Background levels may be unrepresentative.
- Compliance does not guarantee acceptability.

Addressing Limitations:

- Confirm low-frequency analysis is included. - Review octave/1⁄3-octave data to determine how prominent low frequency noise is at the receptor location.
- Check for tonality
- Ensure tonal corrections are justified and conservative.
- Check background measurements aren't influenced by substation noise
- Ensure measures appropriately address low-frequency noise.

BS4142 is a valuable assessment tool, but when applied to substations it should be supported by additional low-frequency analysis, caution interpretation, and robust mitigation to ensure residential amenity is adequately protected.

Agent of Change Principle

As referenced in the National Planning Policy Framework (NPPF), the Agent of Change Principal places responsibility on the new development to manage noise impact, rather than restricting lawful businesses.

Appropriate noise assessment and design mitigation at the planning stage protects both residents and established commercial operations. It is therefore crucial that developers and other stakeholders work together to ensure risk is minimised to an acceptable level when proposing new development.

Considerations for Decision Makers

Good acoustic design; layout, glazing, appropriate ventilation strategy and screening can reduce noise impact without placing constraints on existing businesses.

Early, evidence-based noise assessment helps prevent future disputes between residents and National Grid by identifying and addressing potential impacts before development occurs.

Like all environments, noise environments change over time as areas develop. Robust assessment ensures that new development responds to existing conditions rather than retrospectively redefining them at cost.

Appropriate noise assessment helps protect residential wellbeing by identifying when mitigation is required, particularly during evenings and night-time periods.

Sense check questions to ask when reviewing a Noise Assessment:

- Does the assessment acknowledge the complexities of low frequency noise and is the appropriately addressed?
- Does the assessment methodology allow for the assessment to reflect the operating hours of the substation against worst case background noise levels i.e. night-time?
- Does the assessment reflect real-world conditions? Were background noise measurements taken at appropriate times for suitable durations under reasonably varying weather conditions?
- Have appropriate BS4142 corrections been applied and justified addressing noise character?
- If required, is any proposed mitigation deliverable and technically achievable?
- Are the conclusions proportionate and clear? Do the conclusions align with the data presented and is the level of impact clearly explained, not just stated?
- Planning decisions should avoid foreseeable disputes – what is the risk of future conflict?

Appropriate noise assessments enables balanced development – supporting housing delivery while protecting existing commercial activity.

References & Further Guidance

References & Further Guidance:

- BSI (2019). BS 4142:2014+A1:2019: Methods for rating and assessing industrial and commercial sound
- Department for Levelling Up, Housing and Communities (2025), National Planning Policy Framework – (NPPF)
- Low Frequency Noise (LFN) Annoyance – IOA Briefing Note

For further enquiries please contact:
.Box.NE.OperationalNoiseEnqui@nationalgrid.com

nationalgrid