Chartered Building Consultancy

# Acoustic South East

## Substation Noise Assessment

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|---|---|
| **Client:** | **Roffey Homes** |
| **Site Address:** | **Union Place, Worthing** |
| **Reported By:** | **George Orton BEng(Hons) MIOA** |
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# 1 Summary and Conclusion

Acoustic Southeast has been instructed to assess the acoustic design of the Union Place, Worthing development.

This report details the noise assessment for the proposed electricity substation that will be installed as part of the development.

The substation transformer will be housed inside a purpose built brick/concrete enclosure at the south east corner of the site as shown below (although substation is at ground floor the 1st floor plan has been shown to show the dwelling areas close to the substation):

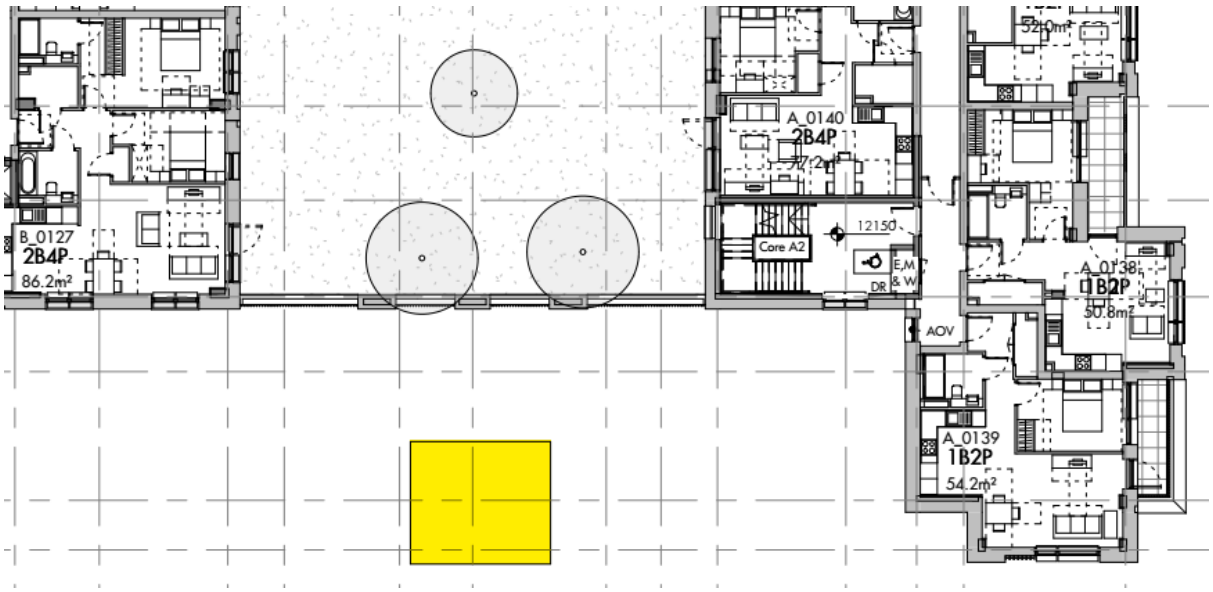


**Figure 1: Substation Location**

At the time this report was completed a draft planning condition had been issued however the condition did not refer to any specific guidance documents. As such the noise levels created by the substation have been assessed in terms of and following the guidelines of the documents listed below (often used for assessments of this nature):

- DEFRA NANR45: Proposed criteria for the assessment of low frequency noise disturbance" (as detailed in the original condition)
- World Health Organisation (WHO): Guidelines for Community Noise (1999)
- BS8233: Sound insulation and noise reduction for buildings (2014)
- BS4142 (2014+A1-2019) Method for rating industrial noise affecting mixed residential and industrial areas

The calculated sound breakout levels from the substation enclosure are very low. The assessment concludes that, other than following the current design proposals, no additional mitigation measures are required to ensure the above criteria are achieved.

For the reasons above it is considered planning permission would not be refused on noise grounds.

# 2 Acoustic Criteria

## 2.1 Planning Condition

The draft planning condition, which relates to the substation, has been detailed below:

"Prior to above ground works, an acoustic assessment of the external electricity sub-station shall be undertaken and submitted to the Local Planning Authority for approval in writing. The assessment should ensure that the detailed design and specification of the substation is suitable to avoid risks of noise and vibration to future occupiers of the development and neighbouring premises. The development shall implement any necessary mitigation measures and retain them thereafter for the lifetime of the development.

## 2.2 DEFRA NANR45

DEFRA have created the *"Proposed criteria for the assessment of low frequency noise disturbance"* which is known as NANR45. The proposed criteria curve has been copied below:

If the noise occurs only during the day then 5dB relaxation may be applied to all third octave bands.

If the noise is steady then a 5dB relaxation may be applied to all third octave bands. A noise is considered steady if either of the conditions a. or b. below is met:

a. $L_{10}$-$L_{90}$ < 5dB
b. the rate of change of sound pressure level (Fast time weighting) is less than 10dB per second*

where the parameters are evaluated in the third octave band which exceeds the reference curve values (Table 9) by the greatest margin.

**Table 9 Proposed reference curve**

| Hz | 10 | 12.5 | 16 | 20 | 25 | 31.5 | 40 | 50 | 63 | 80 | 100 | 125 | 160 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| dB, Leq | 92 | 87 | 83 | 74 | 64 | 56 | 49 | 43 | 42 | 40 | 38 | 36 | 34 |

**Figure 2: NANR46 Reference Curve**

It should be noted that the document states the following:

*The procedure is intended to assist in the evaluation of existing problems. It is not intended as a means of predicting when disturbance might occur, for example in a planning situation, and would not be reliable to use as such. This is because disturbance by LFN depends on a number of factors, such as the character of the sound, whose effects are neither well understood, nor readily predictable. Levels of sound above criteria based on the average threshold of hearing are frequently found to be acceptable and levels falling marginally below can occasionally cause disturbance, so no generic approach to prediction of disturbance appears to be possible.*

However despite the above note it is considered that the NANR45 criteria would be more suitable, for the low frequency noise assessment relating to the substations, than broadband criteria such as those detailed below.

## 2.3 Supplementary Environmental Noise Planning Criteria

Substation conditions often refer to the DEFRA NANR45 Guidance, For completeness this assessment also refers to criteria in the following guidance documents and standards:

- World Health Organisation (WHO): Guidelines for Community Noise (1999)
- BS8233: Sound insulation and noise reduction for buildings (2014)
- BS4142: 2014+A12019: Method for rating and assessing industrial and commercial sound

The criteria have been summarised below:

### 2.3.1 Internal Ambient Noise

The BS8233 2014 and WHO noise criteria will be used to specify the noise mitigation measures for all habitable rooms. The maximum internal noise level for each area is as follows:

- Bedrooms 35/30dBA Day/Night
- Lounges 35dBA Day
- Kitchen/Diners 35dBA Day

### 2.3.2 External Noise Criteria

With regard to outdoor amenity areas WHO states the following:

*To protect the majority of people from being seriously annoyed during the daytime, the outdoor sound level from steady, continuous noise should not exceed 55dB(A) on balconies, terraces and in outdoor living areas.*

### 2.3.3 BS4142 Assessment Details

The standard states that:

*The lower the rating level is relative to the measured background sound level, the less likely it is that the specific sound source will have an adverse impact or a significant adverse impact. Where the rating level does not exceed the background noise level, this is an indication of the specific sound source having a low impact.*

## 3 Substation Details

The substation will be housed inside a standalone brick/concrete enclosure that will be built close to the site boundary at the south east corner of the site. The substation building is close to the existing Chatsworth House commercial building which is outside of the site boundary. The closest residential receptors will be the development itself (apartments on floor levels 1st and above)

The standalone substation has one louvred door/wall panel that faces north and an additional smaller west facing louvre panel (as seen below).

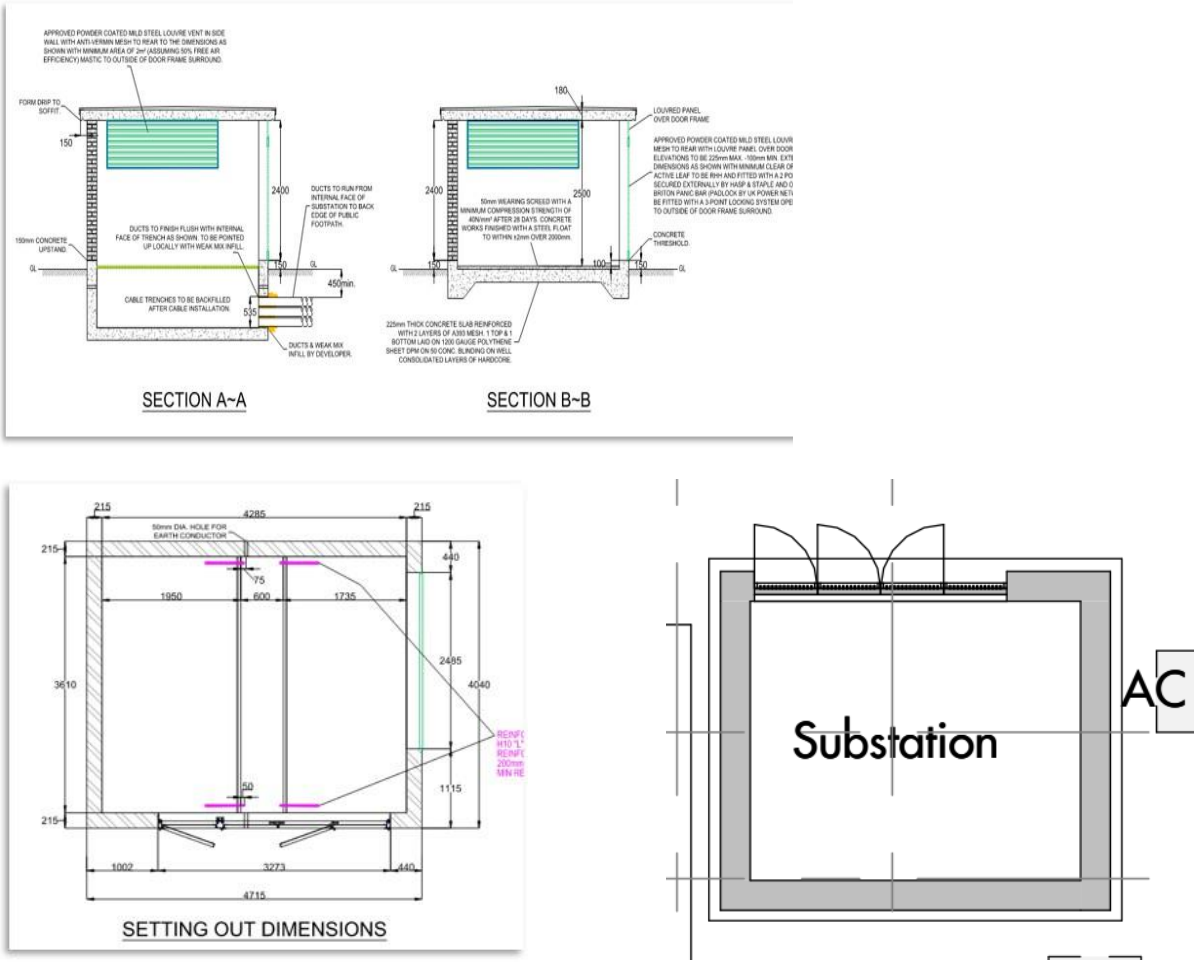


**Figure 3: Substation Details**

### 3.1 Substation Transformer Details

It is understood that a 1000kVA transformer will be installed which has a sound power level of 59dBA (see datasheet in appendix)

Additional 1/3 historic sound test data from UKPN has been used to calculate the noise level in the substation enclosure:

Measurements were taken at the following locations:

- Brunswick Plain: 500 kVA
- Fellowes Plain (Gold): 1000 kVA

At both locations constant background noise from road traffic was audible. Subjectively, noise from the transformers consisted entirely of tonal hum, which was sufficiently above the background noise level to be measurable.

Measurements were taken in terms of $L_{eq,\ 30\ seconds}$ using a moving microphone, in one -third octaves, around the enclosure. The results were logarithmically averaged and are tabulated below:

| | Leq, T (dB) in one-third octave bands (Hz) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Substation | 50 | 63 | 80 | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 |
| Brunswick Plain | 52.8 | 47.3 | 38.0 | 43.9 | 35.9 | 31.9 | 41.5 | 31.9 | 39.1 | 33.0 | 33.6 |
| Fellowes Plain | 54.1 | 50.2 | 44.8 | 46.0 | 39.1 | 35.6 | 39.5 | 33.3 | 35.1 | 30.9 | 30.4 |

**Figure 4: Additional UKPN 1/3 Octave Details**

The above profile is similar to as measured by ASE close to a GRP enclosure substation vent hole (see appendix for details. It should be noted that the higher frequencies for the ASE results were affected by other environmental sources).

### 3.2 Sound Level inside Substation

The sound test data from UKPN has been used to calculate the noise level in the substation enclosure. The UKPS datasheet for the 1000Kva substations all state that the sound power will be 59dBA (as is the sound power level of the proposed transformer).

Initially the 1/3 octave band sound power levels were calculated by increasing the measured (UKPN Fellowes Plain) 1/3 octave band data until the overall sound power was 59dBA.

The reverberant and direct sound levels inside the enclosure was then calculated based on the 1/3 octave sound power levels. The reverberation time in the room was assumed to be 1s (this is likely to be worst case as recent RT measurements in an empty plant room, with acoustic louvres, were significantly lower at the low frequencies). The calculated sound pressure in the room can be seen in the appendix of the report.

### 3.3 Vibration Isolation

It is understood that UKPS will be providing suitable vibration isolation mitigation for both substations.

# 4 Substation Noise Model

## 4.1 External Noise Model

In order to see how noise varies at different positions around the proposed development it is possible to produce a noise contour map. A computer noise model has been completed using the computer package IMMI. IMMI faithfully implements the propagation method of ISO-9613:1996; Acoustics – Attenuation of sound during propagation outdoors. The development and surrounding buildings were added to the model along with various reception points (RPs). The RPs predict the noise level (incident noise level) at a discrete position within the noise model

Area sound sources have been added to the noise model for the walls, roof and louvred door/wall vent panels:

- Louvre wall/door panel – 0dB sound insulation
- Louvre wall panel – 0dB sound insulation
- Roof 180mm Concrete (see appendix for predicted sound reduction)
- Wall 215mm masonry (see appendix for predicted sound reduction)

For the area sources the internal 1/3 octave band levels, as predicted for a 59dBA sound power transformer, were added to the model. The model predictions can be seen below:

| | | | |
|---|---|---|---|
| IPkt289 | SS 127 Bedroom | | 8.994 |
| IPkt290 | SS 127 Lounge | | 11.926 |
| IPkt291 | SS 126 Lounge | | 6.347 |
| IPkt292 | SS 140 Lounge | | 8.818 |
| IPkt293 | SS 140 Bedroom | | 6.701 |
| IPkt294 | SS 231 Lounge | | 10.973 |
| IPkt295 | SS 230 Lounge | | 6.062 |
| IPkt296 | SS 231 Bedroom | | 8.480 |
| IPkt297 | SS 244 Bedroom | | 8.818 |
| IPkt298 | SS Chatsworth at 5m | | 12.986 |

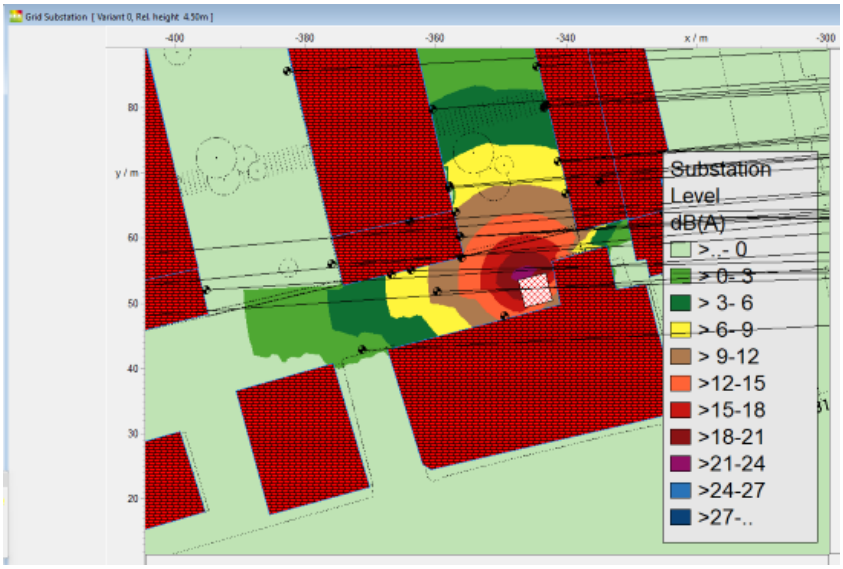


**Figure 5: Substation Noise Model**

*The predictions above are for broadband sound levels in dBA. The model also predicts the 1/3 octave levels as detailed in the next section.*

# 5 Noise Assessments

## 5.1 NANR45

The (worst case) predicted results can be seen below along with the NANR45 criteria:

| Note: | 40 Hz | 50 Hz | 63 Hz | 80 Hz | 100 Hz | 125 Hz | 160 Hz |
|---|---|---|---|---|---|---|---|
| Chatsworth | 26 | 32 | 28 | 22 | 24 | 16 | 12 |
| 127 Lounge | 24 | 30 | 26 | 20 | 22 | 15 | 11 |
| 231 Lounge | 23 | 29 | 25 | 19 | 21 | 14 | 10 |
| NANR45 | 49 | 43 | 42 | 40 | 38 | 36 | 34 |

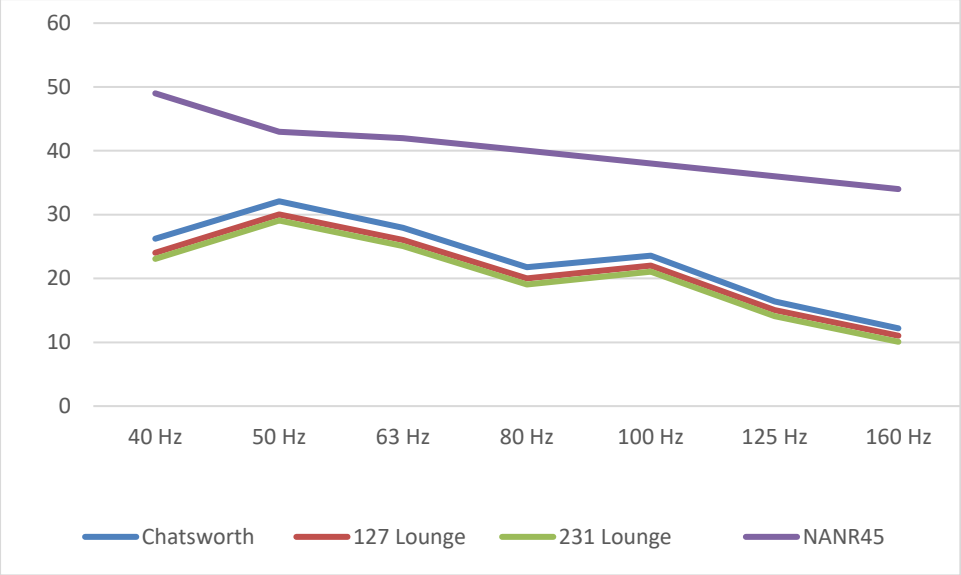


**Figure 6: NANR45 Assessment.**

The external noise levels are well below the NANR45 criteria. Inside the levels will be lower still even if a window is wide open (at the dominant lower frequencies indoor levels should be around 10dB lower than the external levels with a window open).

Based on the above it is unlikely for the substation noise to be audible inside the closest receptors.

## 5.2 WHO/BS8233 Noise Assessments

Based on BS8233/WHO criteria the maximum external noise level for each area is as follows:

- Outside[1] room that has window open
  - Bedrooms ≤45/40dBA Day/Night
  - Lounges ≤44dBA Day
- Outdoor Areas ≤50dBA

The worst case predicted level of 13dBA is significantly below the levels stated above.

[1] *Based on the assumption that indoor noise levels are 10dB below the external noise levels if a window is open. I.E. the external criteria above are 10dB higher than the internal criteria detailed in the guidance documents.*

## 5.3 BS4142

### 5.3.1 Specific Sound Level

The model predicted that the worst case specific noise level will be 13dBA.

### 5.3.2 Background Sound Level

The initial planning survey data was reviewed to determine that the lowest (day/night) background sound level was $L_{A90,T}$ = 39dBA.

### 5.3.3 Rating Level

The sounds created by the transformer will be tonal. However given the low sound levels the tonal sounds may be hard to perceive. A 6dB correction will be applied to err on the side of caution.

### 5.3.4 Assessment

The rating level of 19dB (13+6) is 20dB below the representative background sound level. The Standard provides guidance that:

*Where the rating level does not exceed the background noise level, this is an indication of the specific sound source having a low impact.*

The level below background is fairly significant so any uncertainties would not change the “low impact” outcome of the assessment.

# 6 Appendix

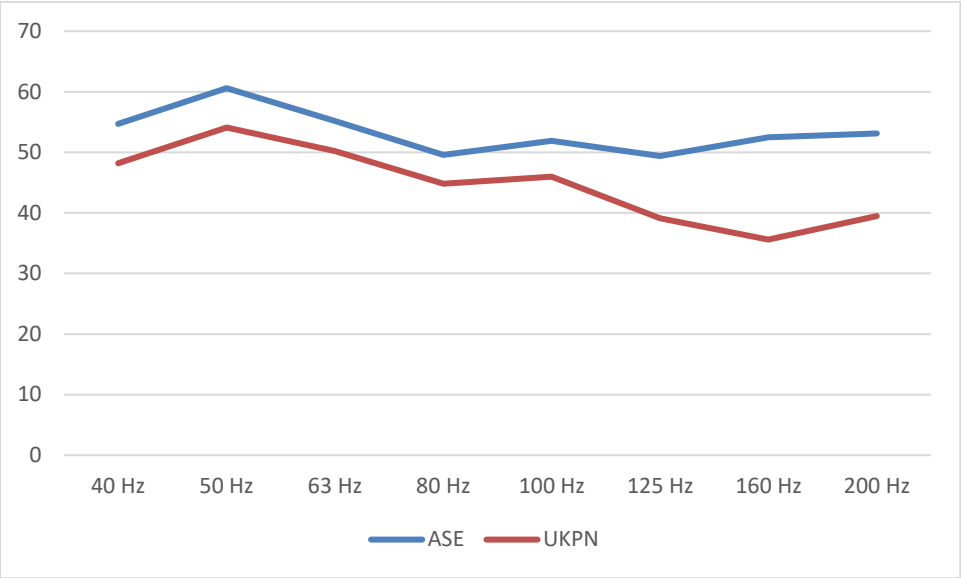


**Figure 7: Historic Measured 1/3 Octave Band Data**

| Note | Frequency - Hz | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 40 | 50 | 63 | 80 | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 |
| Lw | 50 | 56 | 52 | 47 | 48 | 41 | 38 | 42 | 35 | 37 | 33 | 32 |
| RT | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Vol | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 | 39 |
| SPL rev | 48 | 54 | 50 | 45 | 46 | 39 | 36 | 40 | 33 | 35 | 31 | 30 |
| SPL 1m | 39 | 45 | 41 | 36 | 37 | 30 | 27 | 31 | 24 | 26 | 22 | 21 |
| Total | 49 | 55 | 51 | 45 | 47 | 40 | 36 | 40 | 34 | 36 | 31 | 31 |

**Figure 8: Enclosure SPL Prediction**

| Note | Frequency - Hz | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 40 | 50 | 63 | 80 | 100 | 125 | 160 | 200 | 250 | 315 | 400 | 500 |
| Roof 180mm RC | 42.7 | 42.7 | 43.6 | 44.4 | 45 | 44.8 | 42.7 | 42.8 | 45.3 | 47.9 | 50.5 | 53 |
| Wall 215mm Brick | 40 | 40.5 | 41.2 | 41.5 | 40.9 | 37.8 | 38.6 | 41.1 | 43.7 | 46.2 | 48.7 | 51.3 |

**Figure 9: Element Sound Reduction Predictions (INSUL)**

WILSON POWER SOLUTIONS

| TRANSFORMER DATA SHEET | | |
|---|---|---|
| Project Name: | -- | |
| Quote Number: | -- | |
| Manufacturer: | Wilson Power Solutions Ltd | |
| Applicable Standard: | IEC 60076 | |
| General Arrangement Dwg #: | --- | |
| Transformer Rating: | kVA | 1000 |
| Rated High Voltage @ No Load: | Volts | 11000 |
| Rated Low Voltage @ No Load: | Volts | 433 |
| Minimum Insulation class HV LI: | kV | 75 |
| Minimum Insulation class HV AC: | kV | 28 |
| Minimum Insulation class LV LI: | kV | -- |
| Minimum Insulation class LV AC: | kV | 3 |
| Insulating Fluid: | | Mineral Oil |
| Fans: | | No |
| Pumps: | | No |
| Type of Cooling: | | ONAN |
| Number of Phases: | | 3 |
| Frequency: | Hz | 50 |
| Vector Group: | | Dyn11 |
| Impedance Voltage (Z): | % | 4.75 |
| Core Material: | | CRGO steel |
| No Load Losses: | W | 693 |
| Load Losses @ 75°C: | W | 7600 |
| Losses as per EU Regulation No. 548/2014 | | Meets Tier-2 Requirement |
| Resistance | % | 0.76 |
| Reactance | % | 4.69 |
| Regulation type: | | DETC |
| Tapping on HV: | % | +5.0, +2.5, 0.0, -2.5, -5 |
| Design Ambient Temperature: | °C | 40 |
| Temp Rise of Top Oil: | °C | 60 |
| Temp Rise of Winding: | °C | 65 |
| Altitude: | m | <1000 |
| Pollution class: | | C4 |
| Sound Power Level: | dB(A) | 59 |
| HV Conductor Material: | | Aluminium |
| LV Conductor Material: | | Aluminium |
| Paint Finish Colour: | | RAL 7033: Cement Grey |
| Transformer Type: | | Unit Type,Free Breathing, bolted cover, Tank attached Radiators |
| HV termination type: | | Plug-in Monoblock bushing |
| LV termination type: | | Epoxy Monoblock bushing with 1 take off per phase & Neutral |

**Figure 10: Transformer Details**