Manufacturers' Sound Data – Application Experiences

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1 Introduction

In our practice we are regularly asked to validate environmental noise impacts at noise-sensitive receptors, due to proposed new noise-generating equipment. Following validation, we are frequently able to perform sound pressure level measurements of the installed equipment, as a commissioning activity. This paper provides an overview and discussion of the practical challenges at each step of the validation and commissioning processes: input manufacturer sound data; field measurements; and use of acoustic modelling software. Finally, manufacturer equipment sound power levels are compared to those calculated from commissioning measurements.

2 Sound Data from Manufacturers

The quality of noise emissions data available from manufacturers of outdoor equipment varies significantly between manufacturers and equipment models. While claims of "quiet" or "low noise" performance are commonly found in marketing materials, it is not always the case that noise emissions data are available to back up those claims.

Equipment manufacturers can obtain high quality environmental noise emissions data by following an industry standard such as ISO 3744[1] or AHRI 270[2]. The process of then incorporating the resulting octave band (or one-third octave band) sound power levels into environmental noise modelling software is straightforward.

Noise data are often provided as sound pressure levels measured at one or more defined positions around the equipment. Additional calculations are then needed to determine the sound power level. Typically, there are fewer measurement points than would be required per the above-noted standards.

In some cases, noise data are not available for the proposed equipment as a whole, but data are available for its individual noise-generating components, such as condenser fans, blowers, and compressors. The resulting sound power radiated to the outdoor environment will take several paths (including intake/exhaust openings, cabinet breakout noise, or the direct path for condenser fans). The total radiated sound power calculation becomes complex with significant uncertainties, and thus can only be considered an estimate.

Packaged HVAC equipment which may operate in several different modes (e.g. providing both heating and cooling) add further complications to the application of manufacturer sound level data, as the operating conditions represented by the data are not always clarified. A further challenge occurs when key information are missing, such as the type of data (sound power or sound pressure), whether the data are A-weighted, or the distance and spreading conditions of sound pressure level measurements. This is especially common when the data are provided by a third-party vendor rather than the manufacturer – vendors may not accurately replicate all relevant sound information into their documentation.

3 Field Measurements

Field measurements provide significant value in terms of verifying whether newly installed equipment produce the expected level of noise. Significant challenges are nonetheless encountered.

An ideal case would be to measure equipment noise in accordance with ISO 3744, which would produce one-third-octave band sound power levels complete with directivity information. In practice, these measurements are time-consuming, and could be significantly impacted by background noise. In fact, background noise is a primary limitation for field measurement of outdoor equipment. Typical sources of background include other equipment and transportation sources (surface and airborne).

We use multiple strategies to deal with the challenge of background noise. Often, other nearby equipment must be turned off, which can require significant coordination for manufacturing facilities with many outdoor noise sources and full-time production requirements. In some cases, background noise levels can be measured separately, allowing the source measurements to be adjusted accordingly. Finally, we typically take measurements at relatively short distances from noise sources, to maximize the signal-to-noise ratio for the source we are measuring. For packaged HVAC equipment, we typically treat the individual noise-generating components (condenser fans, condenser grills, compressors, air intake and exhaust openings) as separate noise sources: we measure sound levels near the various noise-generating components as needed to determine individual radiated sound power levels.

Where possible, additional verification measurements are taken at a greater distance from the equipment. Those measurements can then be compared to predictions from environmental noise modelling software.

A further challenge for measurement collection is ensuring that the equipment is operating at the representative condition (or conditions) as needed for the environmental compliance assessment. For units that provide both heating and cooling, it is often only practical to measure each mode in the appropriate season.

4 Environmental Noise Modelling

We use CadnaA noise modelling software by DataKustik GmbH, with the calculations completed as per its implement-

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tation of ISO 9613 [3].

Validation of a proposed new noise source starts with implementing the available sound level information from the manufacturer. Typically, a single point source with the reported radiated sound power data is added to the model. When the available sound level data include individual components (e.g. condenser fans), this might be modelled separately (one point source per fan), with the equipment cabinet also incorporated as a screening object.

Following field measurements of the equipment, it will typically be modelled in more detail, including the equipment cabinet, point sources for components such as condenser fans and compressors, and large air openings modelled as area sources. If equipment casing breakout noise is significant, this too is modelled as multiple area sources.

Where field measurements at a distance from the equipment are available, a verification process can be used to confirm that noise emissions in the model match those measurement points. This means adding a receptor object in the model at the location of each measurement position. Often, the acoustic model configuration must also be set differently to ensure an accurate comparison. For instance, the Ontario Ministry of the Environment, Conservation and Parks environmental noise guideline [4] requires a +5 dB penalty for noise characteristics that are expected to increase disturbance, such as tonal noise – this penalty needs to be removed for the model verification process. It must also be checked that the calculation configuration doesn't exclude significant reflections that would have been present during measurements.

5 Sound Power Comparisons

Our environmental noise validation and commissioning processes provide an opportunity to compare manufacturer-reported sound data with measurement data of the equipment once installed. For 22 individual pieces of equipment, Figure 1 compares the sound power level determined by measurement, relative to the sound power level provided by the manufacturer (or calculated from manufacturer-provided sound pressure levels). A positive value in Figure 1 indicates that the sound power determined by measurement was higher than expected given the manufacturer sound data. This data set is limited to equipment with relatively high-quality manufacturer data, with no additional calculations needed for duct losses or breakout noise.

Comparing overall dBA ratings, most equipment are within +/- 4 dB of the manufacturer-reported level. Outliers as far as – 6 dB and +12 dB are found. Even greater variability is found in individual octave band data per Figure 1.

There are many possible explanations for significant differences in the measured vs expected sound power ratings. The specific equipment configuration and operating conditions could differ from those represented by the manufacturer data (e.g. differences in air flow conditions can have a considerable impact on noise emissions). Some of the field measurements were performed many years after the equipment was installed, inviting the possibility that sound levels had changed as a result of equipment wear and tear. There are also

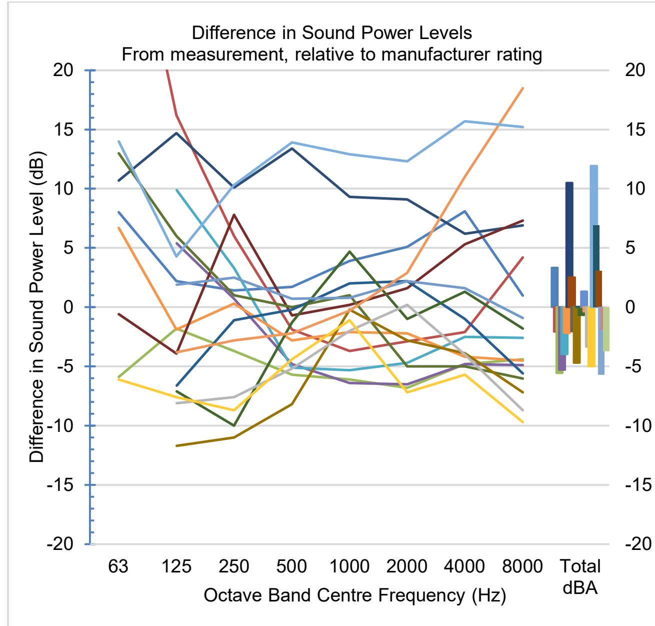

Figure 1: Sound power levels calculated from measurements, relative to sound power levels obtained from manufacturer data.

several possibilities for measurement error, given the above-noted challenges with measurement collection.

6 Future Work

Further study into the specific factors affecting the correlation between reported and measured sound power levels could be done by performing a statistical analysis with more input data. This could include tracking the "repeatability" of reported sound power ratings based on the equipment type, model, or manufacturer. Finally, a detailed analysis of the outliers may provide a better understanding of the causes for those discrepancies.

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References

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[2] AHRI 270-2015: Standard for Sound Performance Rating of Outdoor Unitary Equipment

[3] ISO 9613-2:1996 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation

[4] Ontario MECP Publication NPC-300 Environmental Noise Guideline – Stationary and Transportation Sources – Approval and Planning