ACOUSTIC AUDIT OF ENVIRONMENTAL NOISE IMPACT ASSESSMENT

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1. INTRODUCTION

Acoustic audit of environmental noise impact is an investigative procedure consisting of measurements or a combination of measurements and acoustic modelling of noise emissions due to operation of the audited sources (equipment/facilities), carried out, primarily, to compare the measured/modelled noise emissions with the design objectives.
However, the purpose of an acoustic audit may be multifold as outlined below:

a) to establish background sound level which is then used as a criterion of acceptability in the certification process for equipment/facilities that contain significant sources of noise emission;
b) to assess the magnitude of noise impact due to noise source(s) operation;
c) to verify if the level of noise emissions is not exceeding the applicable performance limit;
d) to evaluate effectiveness of noise abatement programs for existing noise sources, and
e) to determine if noise control measures applied to proposed, new noise source(s) are adequate to ensure design objectives.

In the course of environmental noise impact assessment the acoustic audit is typically required when equipment/facilities contain complex noise sources displaying a wide range of temporal and spectral variation in the noise emission pattern, when various empirical models are available for prediction of sound emission levels of a particular noise source and when the outcome of noise impact analysis indicates marginal compliance with the design objective (performance limit).

The term Aaudit@, in the context of environmental noise impact assessment, signifies a follow-up examination or verification process. For the purpose of equipment/facilities certification such verification should be carried out by an impartial, neutral investigator (a qualified acoustic consultant) having no prior association with the project being audited and, specifically, not involved in the original assessment of noise emissions and/or the design/implementation of the required noise control measures.

- calculation of sound level due to noise source(s) subject to the acoustic audit (excluding the contribution of the

Findings of the acoustic audit are documented in an acoustic audit report, which may be required as a condition of certification, and the audit performed in accordance with the methods and procedures accepted by a regulatory agency involved in the certification process.

2. METHODS

A number of factors may determine the selection of a suitable method for performance of the acoustic audit. The predominant factors are; operating conditions of noise source(s), the nature of acoustic environment at point(s) of reception, availability of measurement instrumentation and the range of measurement instrumentation capability. The following four methods are typically applied for the performance of the acoustic audit:
- direct measurements at point(s) of reception;
- source(s) sound pressure level measurements combined with acoustic modelling;
- sound intensity measurement combined with acoustic modelling, and
- long-term monitoring and data analysis of sound levels at point(s) of reception.

All four methods outlined below focus on verification of compliance with the applicable performance limit. A brief description of each method, including applicability, instrumentation and reporting requirements as well as limitations is provided:

2.1 Direct Measurements

This method can be applied when contribution of continuous, steady noise emissions from noise source(s) in a facility is dominant, and the effect of extraneous noise sources other than vehicular traffic is insignificant at the point(s) of reception.

Depending on characteristics of noise source(s) emissions, Class 1 or Class 2 integrating-averaging sound level meter with impulse and frequency analysis capability is required.
Application of this method requires:
- measurement of the overall noise emissions with noise source(s) in full operation at selected point(s) of reception [1]

established background sound level determined in accordance with) [2].

2.2 Source SPL Measurement and Acoustic Modelling

This method, combining SPL measurements at close distance to significant noise source(s) and acoustic modelling of propagation path from the intermediate measurement location (close to the source) to selected point(s) of reception, is typically applied when there is a significant contribution of extraneous sources to acoustic environment, source(s) operation is intermittent or cyclical and noise source(s) subject to acoustic audit are in continuous operation. Application of this method requires:

- measurement of individual source(s) noise emissions (SPL) at close distance following a standardized measurement procedure (such as one described in reference [3]). The measurement distance to each source must be selected outside the acoustic near field and must also ensure that noise emissions of the measured source are dominant over other noise sources in the vicinity.
- calculation of sound power level of the source(s) based on the results of SPL measurements.
- acoustic modelling of propagation path from the measurement location to selected point(s) of reception) for each noise source. [4]
- calculation of an aggregate contribution from all significant sources in a facility to the overall SPL at point(s) of reception.

2.3 Sound Intensity Measurement and Acoustic Modelling

In this method, sound power level of noise source(s) is determined through measurement of sound intensity of noise radiating surfaces for significant noise source(s).[5] The remaining steps required to determine if noise emissions of the audited noise source(s) conform with the applicable performance limit are identical to those outlined in 2.2 and in the Summary.

The main advantage in using this method is that it enables quantifying the PWL of sources in-situ in close proximity of other noise sources.

Due to complexities involved in sound intensity systems data acquisition and signal processing, application of this method is limited to experienced users fully trained in the technology and operation of the system, capable of interpreting measurements to provide meaningful results.

2.4 Long-term Monitoring and Data Analysis of Sound Levels at Point(s) of Reception

This diagnostic method may be applied when noise emissions due to audited noise source(s) are steady and continuous in a background of non-steady, intermittent extraneous sources including other industrial/commercial facilities and road/rail traffic. It requires a detailed analysis of acoustic data collected from a long-term monitoring survey, carried out simultaneously at close distance to a facility containing audited noise sources and at selected point(s) of reception. Class 1 or Class 2 sound level meter capable of continuous monitoring and data logging of the equivalent sound level $L_{eq}$and ninety percentile sound level L_{90} values is required. Implementation of this method is based on:

- analysis of the monitored values of the hourly equivalent sound level L_{eq} and the nineties percentile sound level L_{90} distribution..
- acoustic modelling of propagation path from the monitoring location(s) close to the facility to selected point(s) of reception [4].
- comparison of the calculated (through acoustic modelling) sound levels with the monitored L_{eq} and L_{90} data at points(s) of reception.
- establishment of a pattern (consistency) between the modelled and monitored L_{90} values. The results of comparison analysis must clearly demonstrate that the monitored levels are representative of contribution of noise emissions from the facility.

3. SUMMARY

Application of each method requires an assessment (monitoring or prediction) of the background sound levels in accordance with an accepted procedure [1][2], adjustment of the measured levels for special quality of sound, if applicable, and a comparison of the calculated resultant sound level due to the operation of the audited noise sources with the applicable performance limit.

Each of the above outlined methods may be suitable for a particular noise environment. In all cases it is important to demonstrate why a particular method was applied and to describe how it was implemented.

REFERENCES

[1] ISO 1996-2, "Acoustics - Description, assessment and measurement of environmental noise, Part 2 Determination of environmental noise levels."

[2] ORNAMENT, Ontario Road Noise Analysis Method for Environment and Transportation, Technical Document, Ontario Ministry of Environment, ISBN 0-7729-6376, 1989.

[3] ISO 3744:1994, "Acoustics - Determination of sound power levels of noise sources using sound pressure - Engineering method in an essentially free field over a reflecting plane."

[4] ISO 9613-2:1996, "Acoustics - Attenuation of sound during propagation outdoors - Part 2: General method of calculation."

[5] ISO 9614-2:1996, "Acoustics -Determination of sound power levels of noise sources using sound intensity - Part 2: Measurement by scanning."