Applied Acoustics 93 (2015) 88–96

Contents lists available at ScienceDirect

Applied Acoustics

journal homepage: www.elsevier.com/locate/apacoust

Technical Note

Application of noise guidance to the assessment of industrial noise with character on residential dwellings in the UK

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ARTICLE INFO

Article history:
Received 7 April 2014
Received in revised form 16 January 2015
Accepted 22 January 2015
Available online 14 February 2015

Keywords:
Industrial noise annoyance
British Standards
World Health Organization
Anonymous noise

ABSTRACT

British Standards are used to assist the assessment of noise impact from new or existing sources and assist judgements of acoustic acceptability. Standards may include provision for the assessment of noise with character whilst others are limited to anonymous noise. Noise guidance designed for the assessment of anonymous/characterless noise appears increasingly used to justify acceptable noise impact from industrial noise with character (identifiable site noise). The result is an inappropriate comparison with guideline values that ignore noise character and context in the assessment of noise acceptability at dwellings. This technical note conducts a critical review of noise guidance and considers four sources of industrial noise with character. Preliminary comparisons of analysed noise data with the World Health Organization Guidelines for Community Noise (WHO 1999), World Health Organization Night Noise Guidelines for Europe (WHO 2009), BS8233 2014 Guidance on sound insulation and noise reduction for buildings (BS8233) and BS4142 2014 Methods for rating and assessing industrial and commercial sound (BS4142) demonstrate guidance designed for anonymous noise significantly understates the impact of industrial noise with character on dwellings when compared to noise guidance for rating and assessing industrial sound accompanied with context based observations of noise impact.

1. Introduction and background

Noise can be steady, benign and anonymous (distant road traffic) or unpredictable, intermittent and contain specific inherent characteristics that attract attention or impart a message that is perceived to be unwanted depending on the circumstances (state of affairs or context) in which noise is received.

In the UK, British Standards are used in the design of new buildings to reduce internal and external intrusive noise, assess noise impact on amenity for planning and assist the determination of nuisance (statutory and common law) or pollution. The standards assist assessment of acoustic acceptability on new or existing dwellings.

BS8233 [1] is a design standard that considers noise control in and around buildings and suggests guidelines for different building types and room uses. Clear caveats exist within the guidance on use and application.

Noise guidance designed for assessing anonymous noise is increasingly applied to the assessment of industrial and other noise sources with character[1] from existing sources on dwellings, proposed sources affecting existing dwellings and existing sources adjacent proposed dwellings. The comparison understates impact by ignoring inherent acoustic features/character, context and receiving soundscape.

Industrial noise is emitted in different localities around the UK. An important consideration when town planning for new industrial development is noise impact on noise sensitive receptors. Where dwellings are proposed adjacent existing industrial uses care is required to locate, separate, orientate and design (passive engineering measures[2]) residential development to adequately mitigate environmental noise impact.

Using preliminary data this technical note compares four sources of industrial noise against anonymous noise guidelines in

[1] Sources of noise emanating from industrial premises that contain noticeable and identifiable characteristics e.g. impulsivity, tonality, unpredictability, temporal variation or other distinguishable characteristics that identify site specific noise. These sources cannot be considered 'anonymous' noise. The principle is applicable to other sources of site specific noise.

[2] Passive engineering measures refer to physical design to mitigate noise breakout or break-in (immission) at dwellings. Active measures rely on human action/inaction e.g. closing doors to prevent breakout, not sounding horns etc.

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http://dx.doi.org/10.1016/j.apacoust.2015.01.018
0003-682X/

BS8233 and WHO [2,3]. Three scenarios consider industrial noise affecting existing dwellings. One scenario considers proposed residential development adjacent existing industry. In all scenarios the industrial noise contains character. Annoyance responses inside and outside dwellings during the daytime and sleep disturbance within dwellings during night time are considered[3]. A comparative noise assessment using BS8233, WHO 1999 & 2009 and BS4142 [4] with context relevant observations is presented.

The UK Planning system allows applicants and regulators to minimise noise impact on new or existing dwellings. Finegold [5] advises it is logical to avoid placing noise sensitive areas near to noise producing land uses. It is important to prevent unreasonable noise immission from new development and the correct application of noise guidance is critical.

2. Psycho-acoustics, annoyance and industrial noise

'Noise' introduces a subjective element to an individual's decision of whether sound has value. Thorne and Shepherd [6] describe reaction modifiers to noise for individuals to include attitude to the source, attitude to the information content of the noise, perceived control over the noise, sensitivity to noise (in general and specific measures) and sensitivity to specific character of the noise (e.g. changes in pitch or modulation).

Thorne and Shepherd suggest noise is sound perceptible to an individual which has identifiable characteristics that modify an individual's response from pleasurable or neutral to adverse. Intrusive noise is sound whose character is adversely perceived compared to the character of the receiving environment in the absence of that sound. Reaction to sound varies based on sensitivity but also the receiving context. The sound may then be considered 'noise'. This perception of the sound and individual reaction modifiers by the receiver are known as the psycho-acoustical factors.

Finegold [5] identifies many reasons for noise annoyance in different situations including interference with speech communication, other desired activities and sleep disturbance which can be very annoying and may lead to long-term health effects. Noise can be perceived as inappropriate in a particular setting without any objectively measurable effect. The context in which sound becomes noise can be more important than the absolute sound level itself.

Industrial noise has been recognised as a source of common law nuisance by the UK Courts since the 1800s. Methodologies recognisable within guidance applicable to the assessment of industrial noise emerged in the 1960s, most notably the Kosten and Van Os [7] Community Reaction Criteria for External Noises and the Committee on the Problem of Noise [8] simplified procedure for assessing reaction to industrial noise in mixed residential areas.

Both studies recognised annoyance from industrial noise is subjective and affected by many factors additional to the absolute decibel level. Kosten and Van Os [7] applied decibel penalties where noise was received in dwellings and considered the receiving room (context), pure tone perceptibility (character and sensitivity to specific character), impulsivity and/or intermittency (character, frequency and duration), occurrence during work hours only, percentage of time present (duration), any economic tie (benefit of noise to receiver and control over noise) and the character of the receiving locality. The simplified procedure for assessing reaction to industrial noise in mixed residential and industrial areas [8] considered specific characteristics, time of occurrence, duration (min) of noise during one hour or half day and type of district. This was the predecessor to BS4142 1967 [9].

[3] Where night time measurement data is available from the selected sources of industrial noise.

Research projects into the assessment of industrial noise were undertaken by Berry and others [10–14]. Berry and Porter [10] highlighted compressor noise as more annoying than road traffic noise when played at the same LAeq,T level. Additional research by Berry et al. [12] evaluated acoustic features present in industrial noise. The study reconsidered the approach to the assessment of industrial noise by considering not only the absolute level of industrial noise but the acoustic features present (including tonality and impulsivity). The emphasis was to not only objectively measure levels of noise but to objectively measure the acoustic features present [14]. The study showed annoyance scores were relatively independent of the traffic noise levels within the combination of noises to which subjects were exposed. Berry and Porter [14] suggested that features contained within the traffic noise component were much less dominant in determining an adverse response than features containing tonal and impulsive components. The research demonstrated the difference and affect of noise characteristics when considering comparable equivalent LAeq,T levels of noise i.e. road traffic noise compared with a source of impulsive industrial noise.

A literature review for DEFRA by Berry and Porter [15] of available evidence into industrial noise annoyance concluded that in general, there was no strong evidence that industrial noise produces a higher annoyance response than transportation noise but there had been extensive studies of transportation noise and annoyance but far fewer studies into the annoyance caused by industrial noise. This conclusion was based on a number of international sources but primarily research by Henk Miedema who was considered the first to produce dose response relationships for combinations of transportation and industrial noise. As Berry and Porter [15] suggested, dose response relationships for transportation and industrial noise sources do apply but this was only relevant to industrial noise without impulsive, tonal or low frequency content. For industrial noises with these features, Miedema suggested corrections could be applied for the annoying character of these aspects [16–18]. The literature review by Morel et al. [18] suggests that locally, industrial noise sources can cause great annoyance but their occurrence is less widespread than transportation noise and their heterogeneity of spectral features may explain the lack of studies. By comparison, steady flows of road traffic noise may be considered homogeneous compared to industrial noise which covers a wide variety and combination of noise sources that may include impulsive, cyclic, tonal, unpredictable, intermittent and contain combined effects (noise and vibration, noise and odour, etc.).

The study by Morel et al. [18] builds on historical work by Miedema and Berry and Porter prior to 2004. The Morel et al. [14] study identifies the specific and total annoyance when comparing different sources of industrial noise and the ability of specific acoustic characteristics to inhibit the annoyance of broad band industrial noise. The study found that the focus of annoyance shifts to the low frequency and 100 Hz component noise inhibiting the annoyance from broad band industrial noise i.e. the psychological focus shifts to the most annoying characteristics of the noise.

The Morel et al. study [18] is supported by work by Fritz van den Berg [19] in relation to health effects from wind turbines. When comparing dose relationship curves for wind turbine noise, annoyance follows a similarly shaped curve to road, rail, aircraft, industrial and shunting yards. In comparison to the above, Van den Berg [19] shows wind turbines appear to be a relatively annoying noise source as shown in Fig. 1 below:

Fig. 1 shows wind turbine noise is more annoying than other environmental noise sources at lower dB(A) levels with the exception of shunting yards for various Lden dB(A) values. In the study by Miedema and Vos [17] the dose relationship curve for shunting yards and higher levels of annoyance appear to be due to the