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INFORMATIVE GUIDELINES FOR THE ASSESSMENT OF NOISE ANNOYANCE

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ABSTRACT
Most national and international community noise assessment procedures are based on the use of hand-held sound level meters. Relatively few national standards acknowledge the benefits or need to utilise statistical sound measurement systems. This paper examines some of the more significant limitations involved in the assessment of community noise. It presents recommendations for relevant changes to the standards, regulations and associated noise impact assessment methodology.

BACKGROUND
Australian[1], New Zealand[2], British[3] and ISO[4] community noise standards were based on the use of simple hand-held sound level meters which were the primary sound measurement tool in use at the time when those standards were originally created.

Thirty years ago when the first community noise standard[3] was published, the only statistical analyser being marketed was the Brüel & Kjaer model 4420, which provided relatively low precision. Whilst the fluctuations on a conventional SLM could be 'eyeballed', that only provided nominal peak or mean peak meter readings. Community noise standards consequently nominated L_{max}, mean peak levels (subsequently assumed to be equivalent to L_{10}) and L_{bg} or L_{min} (similarly assumed to be equivalent to L_{90} and L_{100}). The first community noise standards adopted the application of a 5dB(A) adjustment for sounds that exhibited significant tonality or impulsive characteristics. The standards did not acknowledge that there are relatively few sounds within our urban environment that are broadband, and that most sounds display significant tonality.

Twenty years ago Brüel & Kjaer[5] released its Type 4426 noise level analyser, and Genrad[6] released its model 1945 community noise analyser. Those instruments provided a simplified and convenient means of assessing the variability of community noise. When supplemented by noise exceedance charts of the type developed by Schultz[7] for daytime assessments, or Challis[8] for nocturnal assessments, comparative noise assessments could be deduced from a single set of data.

The people charged with the responsibility of assessing statistical data faced considerable difficulties in interpreting and understanding the issues raised, or in drawing appropriate conclusions. Whilst single period statistical assessment procedures were adopted by many consultants, statistical noise assessments were ignored by national and international standards. Those standards retained a measurement and assessment procedure predicated on an assumption that noise measurements would utilise hand-held SLMs.

The BS4142 community noise standard[3] was the first to be adopted in Australia and New Zealand. That standard, and the first Australian community noise standard[1] incorporated graphical corrections which were intended to address periodicity or duration of intermittent noise (see figures 1 and 2). Those graphs were discarded by Australian Standards Committee AK/5, when the British Standards Institute was unable to provide the provenance for figures 1 and 2. The subsequent Australian standard thus placed even greater emphasis on the adoption and use of data provided by hand-held SLMs.

MAJOR DEFICIENCIES IN CURRENT STANDARDS

Noise Sources Displaying Constant Output

The current measurement and assessment methodology incorporated in Australian[1], and New Zealand[2] community noise standards, and in representative State regulations[9], specify that the following measurements be recorded, and rating procedures utilised:

(a) The mean peak (L_{10}) noise level recorded with the noise source operational.
(b) The background (L_{90}) noise level recorded with the noise source inoperative.
(c) Determine the difference between the mean peak(L_{10}) and the background (L_{90}).
(d) Where the mean peak noise exhibits tonality or impulsive characteristics then a further 5dB(A) or greater adjustment (penalty), shall be applied to the L_{10} level.

The four step assessment procedure tacitly assume that all annoying sources of community noise exhibit sufficient fluctuations to facilitate such measurements. The standards and regulations ignore the possibility (or the reality) that many noise sources within our community exhibit constant sound output. Such sources are typified by power stations, large transformers, cooling towers, exhaust fans and air conditioning units whilst operating in a stable or steady mode.

Regrettably, when the standards or regulations L_{10} - L_{90} assessment procedures are applied in an arbitrary (or worse in a vexatious) manner, then one must expect results which are fatuous, and/or ridiculous. Notable examples which we have observed included:

(i) An assessment of community noise from a large New Zealand power station[10].
(ii) Two assessments of transformer noise impact from high voltage substations[11].
(iii) Evidence presented in a court case[12] involving an air conditioner which was inaudible at the adjacent residential property and just detectable at the fence line.

In the court case which related to the air conditioner, the judge accepted the evidence of acoustical consultants representing the plaintiff. The plaintiff's barrister and his consultants advised the judge that he should strictly apply the regulations nominated procedure[9] ie. to determine the difference between the L_{10} measured with the equipment on, and the L_{90} with the equipment switched off.

To its credit, the NSW EPA subsequently acknowledged[13] that the original noise assessment procedure in its regulation was flawed when applied to a constant noise source with low noise emission. Notwithstanding, the EPA has not yet changed the regulation, nor has it modified its Environmental Noise Control Manual (ENCM).

Recommendation
Where the output level of a potentially intrusive noise source is constant, the noise assessment parameter shall be the L_{90} level (or L_{bg}) measured with the source operational and inoperative. Tonal corrections shall then be applied where appropriate.

Assessment of Fluctuating Noise
Following the development of statistical community analysers[5,6], countless community noise assessments provided unexpected information. The data revealed that in most urban, outer-urban and rural situations, the differences between the L_{max}, L_1, L_{10} and L_{90} parameters were generally well in excess of the 5dB(A) tone corrected criterion arbitrarily adopted by the national standards or imposed by many state regulations.

The earliest and most definitive study to categorise acceptability limits for measured community noise levels, was commissioned by the US Federal Housing Authority in 1970. They briefed Ted Schultz of Bolk Beranek and Neuman to assess *"Noise Abatement Requirements in HUD's Residential Developments"*. Schultz presented a system which sub-divided measured levels into categories which ranged from un-acceptable to normally acceptable. The application of Schultz's criteria proved to be both effective, and generally appropriate when applied to conventional inner urban areas. Schultz's study did not assess the more demanding nocturnal requirements, and those were addressed by studies undertaken during the period 1975 to 1981 by Challis *et al*, whose paper was presented in 1982[8]. Both Schultz and Challis criteria were predicated on the basis that a normally acceptable urban environment will display L_1 and L_{10} parameters that consistently exceed the arbitrary 5dB(A) margin previously proposed by regulators, and/or people who had no significant involvement in statistical noise assessments *'at the coalface'*. The most significant exception to that general rule, was NZS 6802[2], which acknowledges that the L_{max} is frequently 75dB(A) or equal to L_{bg} + 30.

During the period 1982 to 1997 Challis & Associates' staff recorded more than 3 x 10^5 hours of statistical A-weighted noise levels in each state of Australia and in New Zealand. The largest of those investigations involved simultaneous statistical analysers working continuously for almost one year at 10 locations in Sydney. The statistical data recorded during the 15 year period, included numerous rural situations subject to minimal, or negligible transportation noise impact. That data has been examined to identify the representative minimum values of statistical variance recorded during daytime evening and nocturnal periods. That data provides a compelling basis for quantifying a statistical set of parameters of acceptable A-weighted community noise levels. Those levels were presented to Standards Australia Committee AV/5 in 1996, and were documented in **"Informative Guidelines for Assessment of Noise in Residential Areas:"** presented in AV/5-0230-510 (a draft review of Part 2 of AS1055[14]).

A comparison of those criteria[14], with Schultz's ***clearly acceptable*** *daytime criteria*, or Challis' ***clearly acceptable*** *nocturnal criteria*, reveal that the proposed criteria are far more conservative, and in such circumstances constitute the lower bound of what may be considered, or deemed to be *'reasonable'*.

Recommendation
The next revision of Australian Standard AS1055 should adopt the **"Informative Guidelines for Assessment of Noise in Residential Areas:"**[11] presented in AV/5-0230-510, as a component of Appendix 'A' of Part 2 of that standard.

Noise From Schools and Colleges
Most community noise Standards and/or noise regulations ignore the noise emission issues associated with schools, colleges and child care centres. The absence of appropriate standards and regulations has not deterred various protagonists from seeking legal redress from present and/or future perceived adverse noise impact.

In the last decade, we have been privy to numerous reports dealing with forecast or measured noise emission from schools and colleges which were presented to councils and/or to various court jurisdictions in NSW. An examination of specific reports reveal that the criteria adopted by the majority of acoustical consultants when representing councils[15] or neighbours amd potential complainants[16], were invariably different from those adopted by consultants representing the schools or authorities[17]. The differential margin in the criteria adopted were typically 15dB(A) or more.

One of the more interesting cases involved a state primary school in NSW, and a complainant subjected to noise impact resulting from the use of outdoor play equipment constructed relatively close to the residential common boundary. The case was heard by the NSW Supreme Court, and the measurements revealed that the mean peak noise level (defined as L_{10}), exceeded the prevailing background by more than 35dB(A).

The court held that differential levels of that magnitude were unreasonable, and particularly for an after-hours child care centre which utilised the school's facilities after normal school hours.

Recommendation

That the Australian Standard AS1055 should address the subject of noise from schools, colleges and similar child oriented institutions. The standard has two possible options available:

(a) It should either exclude the assessment of noise emitted by children at play in such centres, or

(b) It should adopt appropriate criteria for short term L_1 and L_{10} exceedances. We recommend that those criteria be specified as being 30dB(A) and 25dB(A) respectively relative to the prevailing background sound levels, measured in the absence of those activities. No tonal corrections should be applied to those exceedances. The generation of such levels should be limited to the normal school hours, ie. 8.00am to 3.30pm or 4.00pm.

Tonal Noise Emission from Places of Entertainment

When assessing noise emission from places of entertainment, the adoption of an L_{10}-L_{bg} differential criterion which is advocated by the Australian Standard AS1055, and similarly by most regulatory requirements[18], normally creates no significant problems provided the A-weighted (tonal) noise level exceeds the background noise. Where however, the regulatory authority imposes nocturnal noise emission goals and guidelines which specify either inaudibility, or a requirement that the measured tonal noise emission component of such premises should not exceed the background, there are invariably difficulties involved in confirming compliance.

An examination of a number of recent reports presented to the NSW Liquor Administration Board (LAB), reveal frequent conflict between various consultants' reports[19,20], and specifically when assessing tonal noise impact using A-weighted levels[21].

The most significant problem facing the regulatory authorities and consultants, is the absence of an approved or recommended measurement methodology. The measurement procedures adopted by acoustical consultants are frequently predicated by their client's requirements or legal position, rather than by the application of best possible proven practice. Where the measurements and data are presented on behalf of the management of the licensed premises, then with few exceptions, where the data is dominated by low frequency components, A-weighted measurements seldom provide an appropriate basis through which a discrimination of the magnitude of the intrusion may be assessed.

Recommendations
Where the intrusive sound is dominated by the low frequency beat components from disco or similar generic music, then the data to be recorded should either focus on, or include:

(i) The 125Hz octave band filtered signals recorded by means of a level recorder.

ii) The use of a digital statistical sound logging analyser, whose A-weighted input circuitry is replaced by a 125Hz octave band filter, or filter circuitry with wider bandwidth, as appropriate.

(iii) Recording of unweighted data by means of a digital or calibrated tape recorder providing adequate dynamic range. That data may then subsequently be analysed by means of real time analyser and computer to provide definitive data on the magnitude of the intrusion.

(iv) The measurement and/or recording system's microphones and preamplifiers should conform to Type II precision requirements as specified by AS1259.

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NOISE ASSESSMENT INTERMITTENCY CORRECTIONS
INCORPORATED IN B.S. 4142:1967

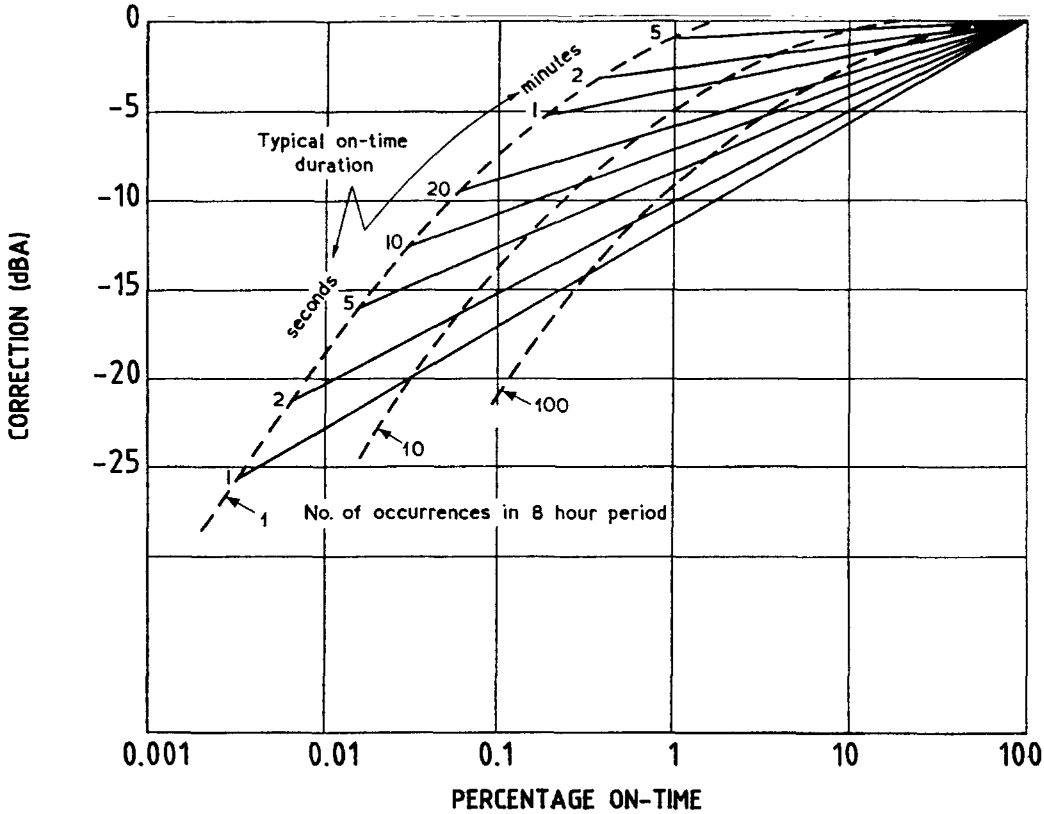


FIG.1- INTERMITTENCY DURATION CORRECTION FOR NIGHT-TIME

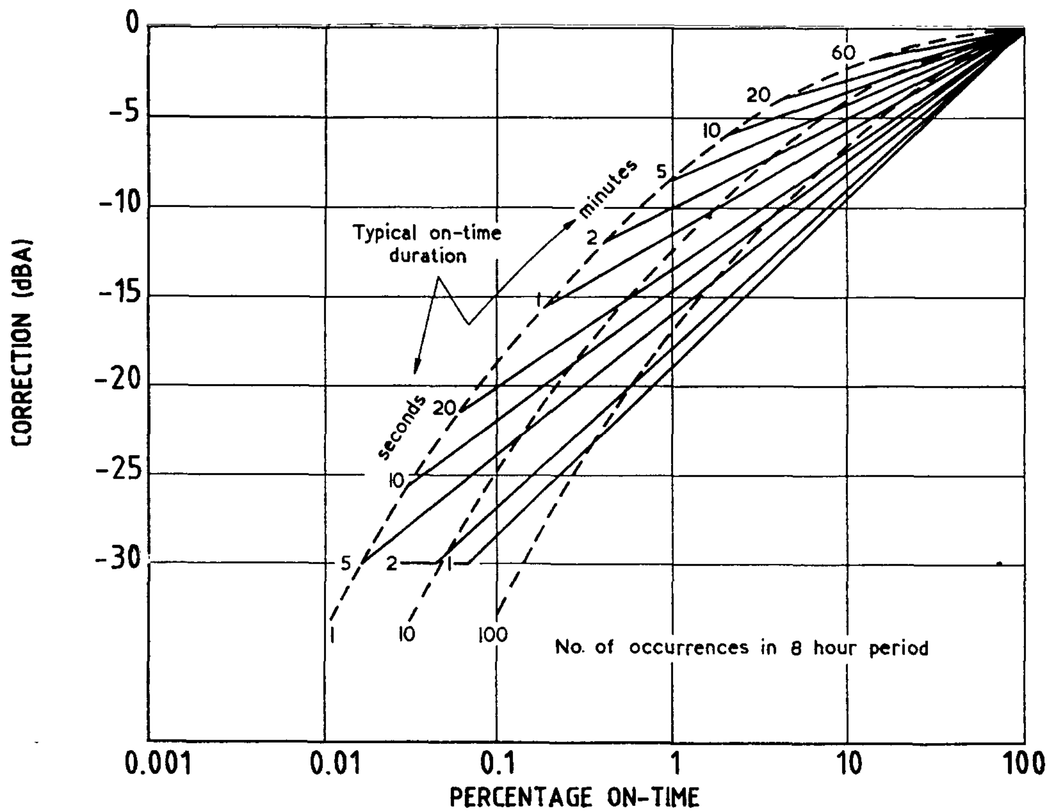
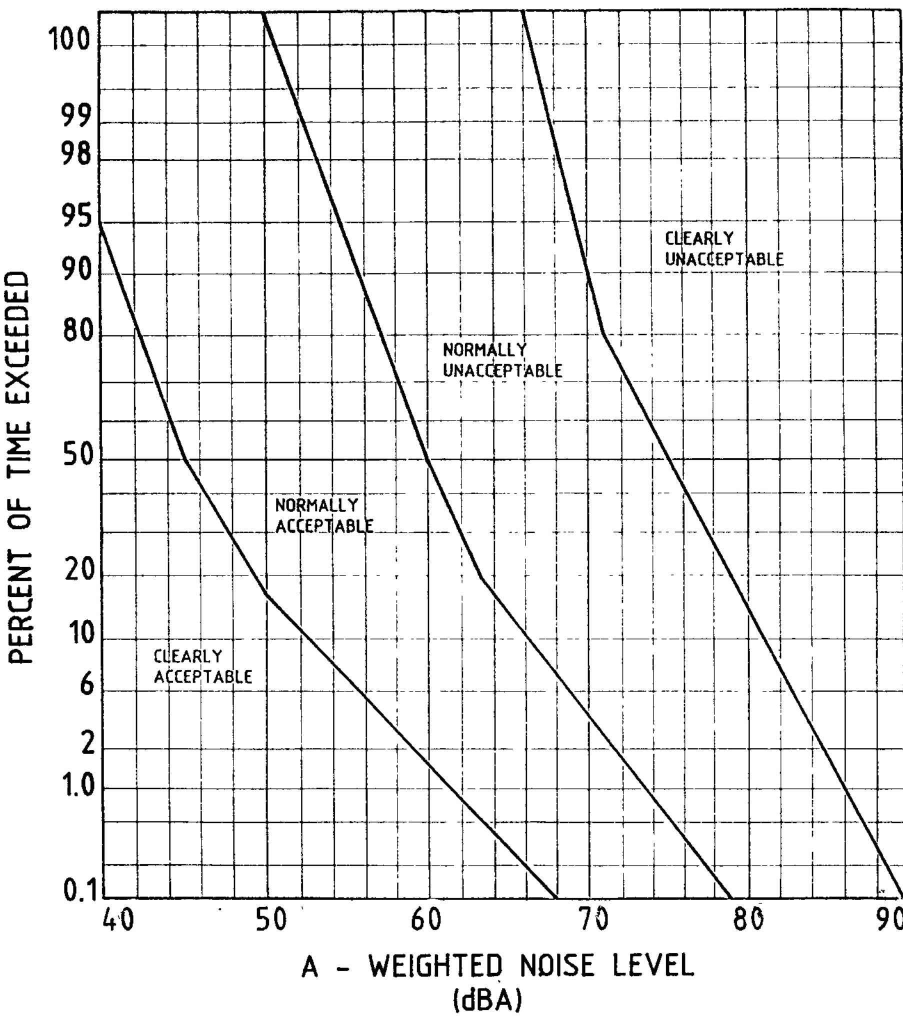


FIG.2- INTERMITTENCY DURATION CORRECTION FOR OTHER THAN NIGHT-TIME

DAY TIME

SUGGESTED CRITERIA FOR ACCEPTABILITY



NIGHT TIME

SUGGESTED CRITERIA FOR ACCEPTABILITY