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Association of Australasian Acoustical Consultants
Licensed Premises and Patron Noise Assessment Technical Guideline

Version 3

Association of Australian Acoustical Consultants

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1 Introduction

The potential impacts of noise from the operations of licensed premises needs to be carefully addressed by relevant regulatory authorities to balance the needs of our society for entertainment and socialising and the desire for reasonable levels of amenity in the surrounding community.

This Technical Guideline has been drafted based on the collective experience of AAAC member firms. The different States and Territories within Australia have quite different criteria in relation to noise from licensed premises, so this Guideline specifically excludes discussion around the appropriateness of criteria. It is possible AAAC member firms in each State, may produce an Appendix to this Guideline if they feel consensus is met within the State.

Noise from licensed premises can be broken down into the following main categories:

- Patrons and music within the premises (both internal and external).

  Whilst music noise can be appropriately controlled, patron noise depends on a number of factors.
- General operational noise such as cleaning, clearing of glass bottles, garbage collection, deliveries
- Patron and vehicle noise from "on-site" car parks
- Patrons in the public domain in close proximity to the premises as they leave (wait for taxis) and in surrounding streets walking to parked cars, public transport, or home
- Mechanical plant such as air-conditioning and kitchen exhaust fans during operating hours and refrigeration equipment (24 hours)

We consider that the assessment of "off-site" noise is best handled by planners, as it is clear that unruly, loud behaviour of patrons and noise from car-doors and engines late at night have the potential to cause disturbance. However, these are lawful activities which could similarly result from any visitors to private gatherings in a residential street, or patrons who have visited other licensed premises.

In addition, the assessment of general operational noise, noise from patrons and cars in car parks can be addressed in accordance with other relevant guidelines which apply to the operation of any business.

This Technical Guideline therefore provides information to cover two key areas:

- Patron sound level data which will be useful in predicting noise emissions from groups of people in various situations including, restaurants, small outdoor drinking/smoking areas, poker machine areas, beer gardens and nightclubs.
- Typical music sound level data within venues and measures to minimise and limit music noise breakout.
- It encourages operators of licensed premises to seek the advice of specialists and tries to address the "louder is always better" approach which seems to have prevailed for many years.

  Investment in high quality equipment, design of spaces, and construction materials can result in a better experience for venue patrons listening to music, a better experience for those in other parts of the venue and better amenity for residents living nearby.

2 Patron Sound Levels

This section provides a summary of existing research, suggested prediction methods and recommendations for further investigations. A Technical Appendix is also provided which includes more detailed discussion.

2.1 Overview

In many areas within licensed premises and eating establishments in which people are gathered to socialise, noise levels from conversations can often be elevated due to the noise-begets-noise phenomenon. These elevated levels are associated with the Lombard effect and are due to a combination of the number of people talking, the style of gathering and the local acoustic environment in which the people are gathered. In addition to the noise-begets-noise mechanism, loud levels can also be produced by exuberant people talking loudly to simply make a point.

Five main categories of use are considered.

- Predominantly internal areas; e.g. restaurants or bars
- Small semi enclosed or outdoor areas; e.g. smoking terraces/areas
- Outdoor gaming rooms
- Medium to large semi-enclosed or outdoor areas; e.g. beer gardens

The consumption of alcohol has the potential to increase level of crowd noise as people lose their inhibitions and become more boisterous. Rindel [Ref 1] summarises studies by others into the effects of noise on alcohol consumption and the effect of noise on taste and smell. Those studies show that alcohol consumption increases with noise level and noise appears to make food taste less intense.

Although laboratory data shows that sound levels from females are 2 to 3 dB lower than males with an equivalent vocal effort, field experience indicates that within a group environment at a licenced premises, females vocal levels are often similar to or exceed male levels. For this reason, the calculation procedure set out in this report may apply male vocal effort levels given in Appendix B as the basis for calculation.

In outdoor drinking areas in hotels, the use of security guards to manage any unruly behaviour and avoid noise disturbance is sometimes proposed. However, this can lead to difficulties in some situations with guards having to draw the line between appropriate and inappropriate behaviour. One example is where a large number of people are all behaving well, but speaking in raised voices, while another example is where a few people are simply raising their voices in animated conversation. Although both these situations represent appropriate behaviour, they have the potential to cause noise disturbance.

To date, prediction of patron noise levels has often been made by simply assuming that patrons speak with a raise voice and adjusting the level for the number of talkers N on the basis of $10\log N$. However, this method can be inaccurate with groups of people as it does not account for the Lombard effect in human responses to noise. The Lombard effect is the involuntary tendency of talkers to increase their vocal effort when speaking in a noisy environment to enhance the audibility of their voice.

Accurate prediction of the noise levels produced by patrons enables the following:

- accurate prediction of noise breakout from semi-enclosed dining/drinking/smoking areas
- the acoustic comfort of patrons with respect to ease of conversation or elevated sound levels
- the degree of speech intelligibility perceived by listeners

2.2 Computational Approach

Introduction

There is no perfect approach to predict noise from licensed premises. An acoustical consultant should consider each situation and advise the most appropriate approach.

One method to predict patron noise levels uses the human psychoacoustic effect known as the Lombard effect, in which people automatically speak louder in situations with an elevated ambient noise level. Of particular importance in the calculation of talker levels is the Lombard ratio . The Lombard ratio is the ratio of the decibel increase of a talker's speech level relative to the increase in the level of ambient noise in which the talker is immersed. An important feature associated with the use of the Lombard ratio is that it is based on talkers attempting to maintain verbal communication in the presence of noise.

The method proposed by J.H. Rindel [Refs 1,2,3] provides a method to predict noise from talkers in semi-enclosed and enclosed spaces. The size of the speaking group and reverberation time of the space are determined and combined with the Lombard ratio to predict the level of noise in the space. The major uncertainty in Rindel's method is the size of the speaking group and correct value of the Lombard Ratio to use.

Rindel recommends a Lombard ratio of 0.5, which equates to 0.5 dB per 1 dB increase in the ambient level and produces a 6 dB increase in sound level for every doubling of the number of people talking simultaneously. This result contrasts with the usually accepted rule of 3 dB increase per doubling of talkers. A large study of talkers conducted in 1977 by Bolt Beranek and Newman concluded people increase their speech at the rate of 0.6 dB per 1 dB increase in the ambient level. Haynes et al present a list of ratios used by various researchers showing ratios ranging from 0.2 to 1.

In addition to the 6 dB increase in level per doubling of talkers, there is also a 6 dB decrease in level per doubling of the total sound absorption area. This contrasts with the usual 3 dB decrease per doubling of absorption area with constant sound sources.

Rindel states that the method is validated only for more than 50 people, however comparison of measured and predicted levels for groups of 8+ people by a AAAC Member in a number of semi-enclosed and closed environments has shown good similarity between measurement and predictions. The method is not recommended for sporting crowds with cheering noise, as cheering involves other human factors besides the Lombard effect.

The primary equations underpinning this method are given in Appendix A. Pertinent aspects of the method are:

- Although Rindel's equations are based on A weighted levels, the method can be adapted to yield octave and third octave band spectral levels in the patron area.
- The spectrum associated with the vocal effort used by patrons should be selected according to the computed talker level; i.e. normal, raised, and loud voice.

In applying the method, it is critical that items such as the proposed use of the space, reverberation times, reflective surfaces, layout of tables and expected density of patrons are understood, along with speaking group size and the Lombard ratio. The presence of background music in a venue and the fact that its level can be readily adjusted significantly complicates the noise-begets noise mechanism and needs to be dealt with on a case-by-case basis. Given that complexity, it is not covered in this document.

Leembruggen [4] presents an overview of the methods proposed below and comparison of measured and predicted levels for two situations.

Computational Methods

There are two methods that can be used to predict the level of patron noise in venues with Rindel's method for the Lombard Effect:

i. statistical

ii. simulation

iii. hybrid

Statistical Method

Rindel's equation for the patron noise levels computes the statistical broadband A-weighted reverberant sound field using the total absorption area (SA) in the patron area. The contribution of the talkers' direct field and early-arriving reflections to the total sound field in which talkers are immersed is not considered.

Equations 2 and 6 in Appendix A are the operative equations for this statistical approach and are based on a Lombard Ratio of 0.5.

Numerous calculations of patron-noise situations have shown that the direct field is approximately 2 to 3 dB below the level of the reverberant field, and therefore exclusion of the direct field has a smaller effect on the total sound level than the reverberant field.

The statistical approach breaks down when there are a small number of talkers distributed over a large area, due to overestimation of the reverberant sound energy in the space.

A discussion is given in Appendix A of the various equations that form the basis of the method.

Simulation Method

The second method is to use a virtual acoustic model with simulation software to compute the total sound field in the area in which patrons are immersed. Rindel [Ref 5] also describes this method. This method first computes the gain in sound level *K* between a nominal talker level and the average total sound field with a given number of talkers in the proposed environment. Then, using this relationship and Equations 7 and 8 in Appendix A, the level in the patron area and the talker levels are adjusted to account for the Lombard Effect. The method can be extended to use octave or one-third octave bands as per Equation 10.

This method has the advantage of computing the total sound field over the patron area incorporating the direct, reflected, and reverberant fields including the directivity of talkers. However care must be taken to exclude positions close to a talker in the calculation of the patron area sound field. The exclusion zone around each talker will depend on the layout of the patrons.

This method also avoids overestimating the reverberant field with a small number of talkers.

Hybrid Method

The hybrid method estimates the room-gain parameter *K* by combining the calculating the statistical reverberant level with an estimate of the average direct field permeating the patron area. Although this method is not as accurate as the simulation method, it does include a number of factors that the statistical method ignores. The method calculates levels in octave-wide frequency bands, with the spectrum of a raised voice being initially used.

Features of the method to compute the reverberant component of the noise level are:

- The octave-band room constants are used, (based reverberation time described by the Eyring equation).
- The directivity indices of a human talker are used to compute the sound power levels entering the room.

Features of the method to compute the direct component of the noise level are:

- Talkers are assumed to face in every direction, which enables an average directional loss of the direct field to be computed at each frequency from the radiation patterns of the human talker in each octave band.
- Talkers are assumed to be evenly distributed over the venue floor plan, with 500 mm between any talker and the room boundary.
- At least ten calculation points are randomly located in the in the patron area, with a minimum distance of 1.2 m between a talker and calculation point.
- The direct-field level of every talker at each calculation point is computed and the energy sum of all talkers computed. The energy average of all calculation points is computed to yield the estimate of the direct field.

2.3 Example Venue Patron Levels Computed Using Statistical Method

To assist users of this guide, Table 1 presents predicted L_{Aeq} levels within the patron area for seventeen situations, ranging from small semi-enclosed areas to large bars and restaurants, with a variety of patrons. Also given are the sound power level (L_{wA}) produced by an individual talker acting under the Lombard effect, and various room acoustic details.

For the examples in Table 1, the predicted levels were computed with the following parameters, all of which could change to suit a particular venue:

- The speaking group size of 3, meaning that one in three people is talking simultaneously.
- The spectrum of the speech was adjusted according to the vocal effort required in accordance with the Lombard ratio of 0.5.
- The reverberation times are for an unoccupied space with the assumed normalised reverberation times in octave bands shown in Table 2.
- The spaces are modelled using the Eyring method and therefore may be conservative.
- The unoccupied reverberation times were adjusted according to the absorption of patrons who are assumed to occupy 70% of the floor area. Adjustments must be made using the area of patrons, and not on a per-person basis.
- Talkers are assumed to be evenly distributed over the floor.
- The direct field of the talkers in the patron area was calculated as a spatially-averaged level using numerous talker and listener locations selected at random. Talkers were assumed to face in different directions and with losses due to directivity. The direct and reverberant fields were then summed. (Although the level of the direct field varies with selected positions, it is sufficiently small to not significantly affect the overall level.)
- The calculations were made in octave bands using the talker data given in Appendix B.

Table 1 – Estimated noise levels produced by talking patrons

Readers can also calculate the levels using fundamental acoustic principles, based on a given number of talkers, selected Lombard ratio, reverberation times, size of space, distance attenuation and acoustic shielding etc. It is recommended that the calculations be made on an octave-band basis, as this produces results that match measurements over a wide range of situations.

Table 1 – Estimated noise levels produced by talking patrons

Scenario	Volume m^3	RT (sec) without patrons*	No of Patrons	Assumed Floor Area m^2	Assumed Room Height m	Room Constant with patrons*^	Talker $L_{WA\#}$	L_{Aeq} in patron area
A	50	0.3	10	16.7	3.0	47	78	74
B	50	0.6	10	16.7	3.0	25	81	79
C	100	0.5	10	33.3	3.0	62	77	71
D	100	0.8	15	33.3	3.0	43	81	78
E	100	0.5	20	33.3	3.0	62	80	78
F	100	0.8	20	33.3	3.0	43	82	80
G	150	0.7	30	45.5	3.3	70	81	80
H	150	1.0	30	45.5	3.3	54	82	82
I	150	0.7	50	42.9	3.5	68	84	84
J	150	1.0	50	42.9	3.5	52	85	86
K	250	0.8	50	71.4	3.5	107	82	80
L	250	1.3	50	62.5	4.0	70	84	84

Scenario	Volume m^3	RT (sec) without patrons*	No of Patrons	Assumed Floor Area m^2	Assumed Room Height m	Room Constant with patrons*^	Talker $L_{WA\#}$	L_{Aeq} in patron area
M	250	0.8	100	62.5	4.0	100	85	87
N	250	1.3	100	62.5	4.0	70	87	90
O	300	0.8	100	75.0	4.0	122	84	85
P	300	1.3	100	75.0	4.0	86	86	88
Q	400	1.8	200	100.0	4.0	96	88	93

* averaged over range from 250 Hz to 2 kHz;

^ includes an estimate of the sound absorption produced by patrons;

the sound power level of one third of the total patrons in the space who are speaking.

Table 2 Normalised reverberation times used for calculations in Table 1

Frequency Hz	125	250	500	1000	2000	4000	8000
Relative RT	1	1.1	1.1	1	0.9	0.8	0.6

2.4 Open Air Gaming Areas

Open-air gaming area have become ubiquitous in licensed premises since the introduction of the Smoke-free Environment Regulation 2007 and have subsequently resulted in many noise assessments for such areas.

Noise emissions are commonly predicted by determining internal reverberant noise levels based on published speech levels and subsequent breakout to receivers. The challenge lies in choosing a representative vocal effort and quantity of speaking patrons. Gaming lounges can often be very quiet where gamblers are individually immersed or conversely, small groups can be gregariously huddled around machines. In these situations, the Lombard effect is likely to not occur and therefore Rindel method should probably not be used.

Noise emissions from the machines themselves can be manually adjusted by staff and thus it is conservatively assumed that patron noise takes precedence.

2.5 Semi-Enclosed (e.g. Smoking Areas)

Semi enclosed areas for drinking, smoking, or dining can range from small to large. There is considerable diversity in the way that people engage with dedicated smoking areas. Some venues have low-capacity areas with patrons engaging in minimal, casual conversation, while others are places for people to sit, drink and converse, many without smoking. While some areas are overseen by a security guard, many are not. In many smoking areas, the area is partly enclosed, often by a rear wall, floor and ceiling, and this enclosure renders the acoustic environment partially reverberant. Reflections therefore can play an important role in determining the overall sound pressure levels in the area.

Rindel's method is able to model Scenarios A to E in Table 1 can be representative of small semi-enclosed areas, particularly as animated conversations can occur in these areas when a number of people are gathered.

2.6 Outdoor Areas (e.g. Beer Gardens)

The prediction of source noise levels of medium to large outdoor areas (e.g. 20-200 patrons) remains the least conclusive area of research. Crowd noise levels do not always appear to be directly related to crowd size, and the presence of alcohol or a celebratory atmosphere are likely to be important factors.

Research in this area has been undertaken by acoustic professionals including AAAC Members listed in the bibliography.

The research has shown that noise levels are not directly related to crowd sizes, particularly for larger numbers. The area occupied by the crowd and distance from the venue will require different adjustments in each situation. An acoustical consultant will need to assess each situation carefully in order to determine noise egress.

3 Live Music / Nightclub Internal

These venues are dominated by music rather than patron noise and would often use an appropriate noise limiter to manage noise levels. Where the venue is in a building separated from the nearest noise-sensitive receiver, low frequency noise and breakout through windows and the roof need to be considered. In addition, where the venue is in the same building as noise-sensitive receivers, structure-borne noise needs to be considered. These are both complex acoustical issues which will require the input of an acoustical consultant.

Although these spaces are normally considered to be fully enclosed, noise escaping through external doors that are temporarily opened to allow entry and egress of patrons could be problematic. In these situations, the use of a sound lock should be considered.

Breakout noise from amplified music is a common concern for Councils and a trigger for neighbourhood noise complaints. The primary concern is often low-frequency noise emissions at. frequencies typically handled by the subwoofers due to reasons such as:

- ease of transmission through the building structure
- genres of music in nightclubs with high emphasis on bass frequencies,
- a preference for patrons to "feel" the music
- the affordability of powerful sound systems.

Table 1 provides a summary of typical internal reverberant noise levels from amplified music.

Table 1 Typical Internal Reverberant Noise Levels from Amplified Music

Type	Internal Level (LAeq)	Comment
Background Music	67-74 dBA	Allows for conversation at normal vocal effort at 600 mm separation.
	70-77 dBA	Allows for conversation at raised vocal effort at 600 mm separation.
Foreground music	85-90 dBA	Minimum level patrons expect for amplified music to be when the music is to be the dominating soundscape (i.e. levels below this would be considered not loud enough.) Typical night club level at the start of the night.
	90-96 dBA 101 to 106 dBZ 100 to 105 dBC	Typical level within a nightclub as patron numbers increase. Loud vocal effort required in close proximity to listener's ear. Potential nightclub level early in the night when patrons and operators may be suffering from a temporary threshold shift (TTS)[1] in hearing (e.g. after approximately 1 hour of amplified music exposure.)

Type	Internal Level (LAeq)	Comment
	97-105 dBA 107 to 115 dBZ 106 to 120 dBC	Typical level that may be considered "very" or "extremely" loud. Loud to shouting vocal effort required in close proximity to listener's ear. Potential nightclub level towards peak of the night and/or when patrons and operators may be suffering from an even greater temporary threshold shift (TTS)[1] in hearing. The LZeq sound level in the 63 Hz octave band can be as high as 120 dB. Note that the level of programme content in the 31.5 Hz band is increasing and may need to be considered.

Note 1: The temporary reduction in hearing sensitivity due to exposure to very loud sounds.

3.1 Recommended Approach to Noise Limiters

It is a common belief that the use of an RMS compressor limiter is all that is needed to control internal sound pressure levels of amplified music in order to limit noise levels at nearby receivers. In their conventional implementation, these devices significantly change the short-term dynamics of the music, reducing its crest factor and often sucking the life out of the music. Bass sounds are often the trigger for the compression process, which can lead to pumping effects or loss of clarity. The ultimate result of this type of sound-level limiting is discontent by venue operators, due to the poor sound quality.

A better approach is to use an automatic long-term RMS leveller, utilising relatively long attack and release time constants. This type of device sets the long-term RMS level of the music to a defined signal level, allowing the peaks to pass mostly unaffected. The target level is adjusted to suit the criteria for a L_{eq} or L_{10} level at noise receivers. Although the L_{eq} level inside the venue may be slightly softer with this approach, this is more than compensated for by the improved sound quality due to the increased dynamics in the music.

The time constants required for this type of level control are not usually found in compressor/limiter devices, and therefore a dedicated long term AGC (automatic gain control) device (implemented in a digital signal processor) is the optimum method of control. The target level can usually also be adjusted according to time of night to meet noise criteria in the post-midnight period.

4 Appendix A: Rindel Method

Statistical Method

a) Rindel's equation for the level of ambient noise due to people speaking is:

$$L_{NA} = 93 + 20\log(N_s/A) \quad \text{(eq 1)}$$

where L_{NA} is the A-weighted L_{Aeq} noise level in the patron area, A is average absorption area (*S.alpha)* in the space and N_s is the number of people speaking.

Replacing A with the Room Constant (R) provides a better match to measured levels in smaller or less reverberant areas. R is computed from the average reverberation time in the 250 Hz to 2 kHz range, based on the Eyring equation.

b) The level of individual talkers at 1 m is computed as:

$$L_{SA\,1m} = 55 + C(L_{NA} - 45) \quad \text{(eq 2)}$$

where C is the Lombard ratio of 0.5 and $L_{SA\,1m}$ is the A--weighted talker level at 1m

c) For reference, Equation 1 is derived from Equations 2 to 5 with C=0.5

$$L_{NA} = L_{SA\,1m} + 8 + 10\log(N_s/A) + 6 \quad \text{(eq 3)}$$

$$L_{NA} = 55 + C(L_{NAeq} - 45) + 8 + 10\log(N_s/A) + 6 \quad \text{(eq 4)}$$

$$L_{NA} = 1/(1 - C)\{69 - 45C + 10\log(N_s/A)\} \quad \text{(eq 5)}$$

The 8 dB term relates to the conversion of power to direct-field pressure of an omnidirectional talker in half space and the 6 dB is part of the conversion of sound power to reverberant pressure.

d) Incorporating the concept of a Group Size *G*, equation 1 becomes:

$$L_{NA} = 93 + 20\log(N/GA) \quad \text{(eq 6)}$$

where $G = N/Ns$ and N is the total number of patrons.

e) As statutory noise criteria sometimes require the use of the L_{10} level, 3 dB is usually added to the L_{eq} levels to produce the L_{10} speech levels.

f) The calculations can also be done on an octave-band basis, which is the method used to derive the values in Table 1.

Simulation and Hybrid Methods

a) The relationship between talker level and overall noise level that Equation 3 describes can be formulated for the simulation and hybrid methods as shown in Equation 7.

$$L_{NAm} = L_{SAm\,1m} + K \quad \text{(eq 7)}$$

where K is the A-weighted difference between the nominal talker level at 1m $L_{SAm\,1m}$ used in the model and the modelled total sound field L_{NAm} in which the group of talkers is immersed, computed in the model with a specified number of talkers.

b) As the term K is derived from the acoustic model, it includes the contribution of talker directivity, direct and reverberant sound fields, and early-arriving reflections. As there is no Lombard effect in Equation 7, K can be adjusted post-calculation to account for a slightly different number of talkers than was used in the model.

c) Re-arranging Equations 5 and 7 yields Equation 8, which is used to calculate the actual total A-weighted level in the patron area with the Lombard Effect for a given Lombard ratio.

$$L_{NA} = (55 - 45C + K')/(1 - C) \qquad \text{(eq 8)}$$

where K' is the adjusted value of K to account for a different number of talkers and C is the Lombard ratio.

d) The actual talker level is then calculated using Equation 8.

$$L_{SA\,1m} = L_{NA} - K' \qquad \text{(eq 9)}$$

e) if K' is computed in octave or third octave bands in the model, Equation 10 can be used adjust the room noise level L_{NA} using the speech spectrum associated with the computed talker level at 1m.

$$L_{NA}(f_j) = L_{S\,1m}(f_j) + K'(f_j) \qquad \text{(eq 10)}$$

where f_j is the jth octave or one-third octave band.

5 Appendix B: Talker Data

This Appendix includes raw data often used by acoustical consultants. Once the operation of the Licensed Premises is understood it can be used to assess noise in almost every situation.

A summary of speech levels often quoted is shown in Table B1.

Table B1 Mean vocal effort levels in dBA in anechoic conditions, measured at 1 m.

Vocal Effort	Male, dBA @ 1m	Female, dBA @ 1m	Source
Casual	53	50	C.M. Harris
Normal	58	56	Cushing et al
Raised	67	64	
Loud	76	71	
Shout	89	82	

Table B2 gives the long-term octave-band L_{Zeq} levels at 1 m from a talker on axis of the mouth.

Table B2 Octave band spectra for Male talker (Cushing et al)

Frequency	125	250	500	1000	2000	4000	8000	Overall dBA	Overall dBZ
normal	46.5	56.4	57.5	52.3	48.3	44.3	38.8	58	61.2
raised	55.8	62.5	65.4	61.7	57.1	52.1	45.9	66.4	69.0
loud	58.5	66.9	73.2	72.3	66.9	61.5	52.9	75.5	77.0

Table B3 gives the L_1 and L_{10} exceedance levels in each octave band for normal speech in which the long-term L_{Zeq} level has been normalised to 0 dB. To use these exceedance levels, simply add the levels in Table 3 to the overall L_{Zeq} of the speech.

Table B3 L_1 and L_{10} exceedance levels for normal speech with a long-term overall L_{Zeq} level of 0 dB.

frequency	125	250	500	1000	2000	4000	8000	Overall L_{Zn}
average L_1	0.8	2.8	1.8	-2.6	-5.0	-6.6	-8.5	5.6
average L_{10}	-1.9	-2.4	-2.1	-7.6	-11.5	-11.3	-13.4	3.0

Table B4 gives approximate directivity indices of a human talker in each octave band frequency which can be used to calculate the sound power of a talker.

Table B4 Approximate directivity indices (DI) for human talker

frequency	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
DI dB	1.2	1.9	1.6	1.8	3.4	4.2	4.6

In some situations, it can be useful to account for directional losses of the human voice associated with the directions that talkers are facing in a venue. Table B5 gives normalised approximate total direct-field sound pressure levels in each octave band frequency for a group of talkers who are equally distributed around 360°, relative to the total level that would result with all talkers facing the same direction.

Table B5 **Approximate reduction in total sound pressure levels for group of talkers facing all directions compared to all talkers facing the same direction.**

frequency	**125**	**250**	**500**	**1000**	**2000**	**4000**	**8000**
relative level dB	-1.2	-1.9	-1.6	-1.8	-3.6	-4.4	-5.0

6 Appendix: References

Research into noise source levels within/from licensed premises has been undertaken internationally, domestically, as well as in-house by AAAC Consultancies as part of many noise assessments previously conducted.

References include:

1. J H Rindel - *The Acoustics of Places for Social Gatherings,* EuroNoise 2015 Maastricht.
2. J H Rindel - *Verbal communication and noise in eating establishments,* Applied Acoustics 71 (2010)
3. J H Rindel - *Acoustical capacity as a means of noise control in eating establishments* Joint Baltic-Nordic Acoustics Meeting June 2012 Odense.
4. G Leembruggen - *Predicting Patron Noise Levels in Restaurants and Bars -An extension to J.H Rindel's Method.* AAS Paper Number 105 AAS Conference 2021
5. Rindel, J.H et al - *Dynamic sound source for simulating the Lombard effect in room acoustic modelling software*. Internoise 2012 New York city.
6. Cushing et al - *Vocal effort levels in anechoic conditions*. Applied Acoustics vol 72 2011.
7. M Hayne et al - *Prediction of Noise from Small to Medium Sized Crowds*, AAS Paper Number 133 AAS Conference November 2011
8. Publication - *Noise from Pubs and Clubs Phase 1*, W. J. Davis et al – October 2005
9. Publication - *New Orleans Sound Ordinance and Soundscape – Evaluation of Recommendations*, David S. Woolworth, August 2013

Other Published AAAC Guidelines:

AAAC Career Opportunities Ver 1.pdf

AAAC Member Disputes Complaints Procedure 2017.pdf

AAAC Guideline for Apartment and Townhouse Acoustic Rating V1.0.pdf

AAAC Guideline for Apartment and Townhouse Acoustic Rating Explanatory Note.pdf

AAAC Guideline for Child Care Centre Acoustic Assessment V3.0.pdf

AAAC Commercial Building Acoustics Guideline V2.0.pdf

AAAC Guideline for Educational Facilities Acoustics V2.0.pdf

AAAC Guideline for Healthcare Facilities V2.0.pdf

AAAC Guideline for Report Writing V2.0.pdf

AAAC Guideline for Selection of an Acoustical Consultant V1.0.pdf

AAAC Wind Farm Position Statement.pdf

AAAC Wind Farm Review 1 June 2015.pdf

AAAC Building Acoustic Scope of Work Document - Version 1.0

AAAC Guideline for Gymnasium & Exercise Facility Assessment V1.0

For definition of terms, see the Terminology Tabs on the AAAC website.

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