REPORT

MERKUR Casino Aberdeen

External Terrace Noise Impact Assessment

Client: MERKUR Slots UK Limited
Reference: PR2001_209_FINAL_R1
Date: 16/06/2025

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1 Introduction

1.1 Background

Archo Consulting Ltd have been appointed to undertake a noise impact assessment for a proposed new outdoor terrace area at Merkur Casino, 61-63 Summer St, Aberdeen AB10 1SJ. The outside section of the premises is currently only used for patrons who choose to smoke and plans exist to convert this area into an outside terrace where patrons can socialize and have drinks.

An assessment of potential noise impacts from the proposed new outside terrace has been undertaken to ensure that noise impacts from patrons using the area do not occur at the closest noise sensitive receptors to the site. The assessment has been undertaken in accordance with the relevant criteria and approach outlined within The University of Salford's Noise from Pubs and Clubs NANR 92 document.

This noise assessment report has been prepared in conjunction with the noise management plan for the terrace area which should be read in conjunction with this report.

All measurements, calculations and methodologies are presented within this report.

1.2 Site Description and Context

The site is located at 61-63 Summer St, Aberdeen AB10 1SJ and is operational between the following hours:

- Mon-Thur: 6pm – 5am
- Fri: 2pm – 6am
- Sat & Fri: 12noon - 6am

The external terrace area has a maximum capacity of 25 people. The drawings indicating the design of the site are presented in **Appendix A**.

The closest noise sensitive receptors (herein after known as NSR1) to the location of the terrace area are the residential receptors on Huntly Street. The location of NSR1 in relation to the terrace is presented in **Appendix A**.

2 Standards

2.1 NANR 92

NANR 92 produced by Salford University is a document that details all of the methods used in the UK and Europe to assess noise impacts from pubs and clubs with the objective of determining how a rigorous UK method for assessment might be devised. The NANR 92 reference document is presented in **Appendix B**.

2.2 IoA Working Group Annex

Section 2.2.3 of NANR 92 details the Institute of Acoustics Working Group guidance and criteria on the control of noise from pubs and clubs. In terms of the method by which the assessment is undertaken **Table 1** below details the regulations and procedures reproduce from NANR 92:

Table 1: Limits Suggested in the IoA Annex

Venue Where…	Suggested Regulations	Outcome if Criteria Met
Entertainment < 30 times/year*	$L_{Aeq,15mins}$ (EN) should not exceed L_{A90} (WEN) by more than 5dB.	EN will generally be audible but not overly obtrusive inside the noise sensitive property
Entertainment > 30 times/year*	L_{Aeq} (EN) should not exceed L_{A90} (WEN) by more than 5dB And the L_{10} (EN) should not exceed L_{90} (WEN) by more than 5dB in any 1/3 octave band between 40 and 160Hz.	EN will generally be audible but not overly obtrusive inside the noise sensitive property
Entertainment > once/week or continues beyond 2300hrs	L_{Aeq} (EN) should not exceed L_{A90} (WEN) And L_{10} (EN) should not exceed L_{90} (WEN) in any 1/3 octave band between 40 and 160Hz.	EN will be virtually inaudible inside noise sensitive property.

Note – EN – Entertainment noise level, WEN = Representative background noise level without the entertainment noise, both measured 1m from the façade of the noise-sensitive premises.

**note more than once a week and ends by 2300hrs.*

2.3 Noise Rating Curves

Noise rating curves provide a method of measuring, specifying and controlling noise levels within buildings. They consist of single figure values corresponding to individual mid-frequency octave bands. The overall single figure NR value is determined by examining which curve the highest of the individual NR values for the frequency bands falls onto. **Table 2** reproduced from 'The Little Red Book of Acoustics: A Practical Guide (Second Edition)', (published by Blue Tree Acoustics) below provides examples of typical noise levels within different buildings and spaces.

Table 2: Typical Noise Levels for Different Spaces

Location	NR Value at Octave Band Centre Frequencies							dB(A)
	63	125	250	500	1k	2k	4k	
Quiet Restaurant	60	60	60	65	65	55	50	67
Busy Restaurant	60	70	75	75	75	75	70	80
Busy Pub/Bar	80	85	85	85	85	80	70	88
Music Bar/Nightclub	110	110	100	100	95	90	85	101
Classroom	55	55	55	60	60	60	55	65

Table 3 below presents typical NR curves for different spaces:

Table 3: NR Curves for Different Spaces

Noise Rating (NR) Curve	Application
NR 25	Concert halls, broadcasting and recording studios, churches
NR 30	Private dwellings, hospitals, theatres, cinemas, conference rooms
NR 35	Libraries, museums, court rooms, schools, hospitals operating theatres and wards, flats, hotels, executive offices
NR 40	Halls, corridors, cloakrooms, restaurants, night clubs, offices, shops
NR 45	Department stores, supermarkets, canteens, general offices
NR 50	Typing pools, offices with business machines
NR 60	Light engineering works
NR 70	Foundries, heavy engineering works

NANR 92 states that a commonly used and accepted method of assessing noise impacts from such sources is through the use of NR curves. Based on experience and industry standard practice it is widely considered acceptable to use a threshold of NR25 for residential units which is also the threshold presented within NANR 92. Therefore, this threshold has been referenced for this assessment.

2.4 World Health Organisation (WHO) (1999) Guidelines for community noise

These guidelines present health-based noise limits intended to protect the population from exposure to excess noise. They present guideline limit values at which the likelihood of particular effects, such as sleep disturbance or annoyance, may increase. The guideline values are 50 or 55dB L_{Aeq} during the day, related to annoyance, and 45 dB L_{Aeq} or 60dB L_{Amax} at night, related to sleep disturbance.

3 Noise Surveys

3.1 Baseline Noise Survey

In order to quantify the existing background noise levels at the closest noise sensitive receptors to 61-63 Summer St, Aberdeen a baseline noise survey was undertaken between 11th and 12th June 2025. Measurements were made in the external smoking area next to the residential receptors which was considered the most representative location in terms of noise levels experienced by the closest residential receptors. The baseline position is denoted MP1.

3.2 Methodology and Instrumentation

All noise measurements were conducted with regard to the procedures and guidance contained in BS 7445, parts 1 and 2.

During the baseline survey the following factors influencing ambient sound scape were noted:

- Noise from the local road network was audible;
- Sound from trees and other vegetation in the light breeze influenced the ambient soundscape; and,
- Sound from occasional people on the road outside was periodically audible.

Table 4 below details the equipment instrumentation used in the noise survey and the calibration due date at the time of the measurements:

Table 4: Survey Instrumentation

Instrument	Serial No.	Calibration Due Date at Time of Survey
Norsonic 140 Class 1 Sound Level Meter	1406433	October 2025
Norsonic 1209 Preamplifier	21318	June 2026
Norsonic 1225 Microphone	226973	June 2026
Nor 1252 Acoustic Calibrator	31717	June 2026

The sound level meter was fully calibrated, traceable to UKAS standards and satisfied the requirements of BS EN 61672-1:2013[1] for a 'Class 1' Sound Level Meter (SLM).

The SLM was set to record with a 'fast' time constant and A-weighting. The following parameters were recorded:

- L_{Aeq} – the equivalent continuous sound pressure level over the measurement period;
- L_{Amax} – the maximum sound pressure level occurring within the defined measurement period;
- L_{A90} – the sound pressure level exceeded for 90% of the measurement period and is used within BS 4142 as a descriptor of background noise level; and
- L_{A10} – the sound pressure level exceeded for 10% of the measurement period.

Appendix D presents descriptions of these terms.

The noise measurements were conducted with the SLM mounted on a tripod at heights between 1.2m and 1.5m above ground level. Measurements could not be made 3.5m away from any reflecting surface i.e. in free-field conditions and therefore a correction for reflections was applied. The instrument was calibrated before and after the survey using a portable calibrator. No significant deviation in the calibration level was observed. The survey was conducted during periods of weather favourable for noise measurements, i.e. no rainfall and wind speeds below 5m/s.

3.3 Measured Baseline Levels

Table 5 below presents the results of the baseline noise measurements.

Table 5: Baseline Noise Measurements

Location	Start Time (HH:MM)	Duration (HH:MM)	L_{Aeq}	L_{Amax}	L_{A10}	L_{A90}
MP1	15:45	11:15	55.4	89.7	55.6	52.4
	23:00	08:00	54.7	88.4	53.5	45.6

Statistical analysis was performed on the measured L_{A90} values and it was determined that the statistical average was the most representative value to use for assessment as this represented the middle range of the values.

[1] British Standards Institution (2013). BS EN 61672-1:2013 Electroacoustics. Sound level meters. Specifications. BSI, London

3.4 Source Level Measurements

Since the predominant noise source from the terrace area will be from people talking to one another the assessment was undertaken using historic measured data from two patrons (male and female) talking and laughing on a similar terrace. This data was used in the noise model for people sitting at the different seating locations presented in **Appendix B** and a mixture of talking and laughing from both sexes was used.

Table 7 below presents the source noise levels used in the assessment:

Table 7: Source Noise Measurements

Element	Octave Band Noise Level (dB)								L_{Aeq}
	63	125	250	500	1k	2k	4k	8k	
Man Laugh	47.1	50.7	55.6	65.5	55.3	58.2	46.5	39.7	**64.8**
Woman Laugh	51.4	48.7	56.4	60.3	50.7	51.3	39.8	35.2	**59.4**
Man Talk	46.8	46.3	53.1	55.0	44.6	42.0	34.9	30.7	**53.7**
Woman Talk	47.1	49.4	52.7	50.8	43.4	39.6	41.0	40.5	**51.6**

4 Assessment Methodology

4.1 Noise Model Methodology

Using the drawings provided and presented in **Appendix A** the future external terrace area was modelled at 61-63 Summer St, Aberdeen AB10 1SJ. **Appendix A** also presents the location of the site in relation to NSR1 and MP1.

The following methodology was employed in generating the noise model:

- It is understood that the maximum capacity is for 25 people at any one time. Therefore, to provide a prudent and worst-case approach to assessment, the site was modelled with the full capacity of 25 people and uses the measured data from men and women talking and laughing presented in **Table 7**. This represents a prudent and worst-case approach which in reality is unlikely to occur if ever;
- The height of each person sitting was modelled at 1.2-metres to the source of the sound (head) which is the average height for a person sitting. 18 patrons were modelled sitting and the remaining 7 people were modelled standing;
- A combination of men and women talking and laughing was modelled into the assessment with the following ratio: 7 men laughing, 7 women laughing, 6 men talking, 5 women talking. This was spread evenly around the site;
- Since the site will be in use during the day time and nighttime the assessment has been undertaken referencing the measured both daytime and nighttime background noise levels;
- All calculations are presented in **Appendix E**.

4.2 Assessment Criteria

In accordance with the recommendations presented in NANR 92 detailed in **Section 2**, there are two commonly used methods of assessing potential noise impacts from entertainment noise: firstly, comparing the predicted level at the receptor against the measured background level as per the IoA Working Group Annex detailed in **Section 2.2** and using Noise Rating Curves detailed in **Section 2.3**. To provide a prudent and worst-case approach to assessment, both of these approaches to assess potential noise impacts from the new terrace area have been used.

IoA Working Group Annex Assessment

Since the terrace area will likely only be used during periods of favourable weather it could be assumed that > 30 times/year will be the frequency of use and the area will be open for use after 23:00. In accordance with the recommendations presented in **Table 1** from the IoA Working Group Annex for assessing entertainment noise the following approach represents the most stringent:

- L_{Aeq} (EN) should not exceed L_{A90} (WEN) And L_{10} (EN) should not exceed L_{90} (WEN) in any 1/3 octave band between 40 and 160Hz.

It should be noted that the outside area incorporates a 2-metre high wooden fence around it and will be partially covered with a roof section to provide shelter to the patrons. It can be assumed that the majority of the time patrons will be under the shelter due to weather conditions. This shelter will provide some attenuation to the neighbouring buildings and has been modelled into the assessment as a barrier breaking the line of site for at least 50% of the patrons (worst-case scenario). In reality the external area will very rarely be at full capacity of 25 and therefore this assessment represents a highly prudent and unlikely worst-case scenario.

Using this guidance, the assessment has been broken down into two sections: firstly, assessing the predicted LAeq (EN) against the measured LA90 (WEN) and secondly the LA10 (EN) against the LA90(WEN) in any of the 1/3 octave bands between 40 Hz and 160 Hz.

NANR116: ‘Open / Closed Window Research

The Building Performance Centre – School of the Built Environment at Napier University published a research paper in April 2007 entitled *NANR116: ‘Open/Closed Window Research’ Sound Insulation Through Ventilated Domestic Windows* which detailed the measured sound attenuation which can be achieved by partially open windows with different opening areas. Different types of window were tested and the window which is common in residential buildings and achieved the lowest performance in the tests is the side swing reversable (denoted Type B in the paper). It was determined that with an opening of 200,000 mm^2 (representative of a large opening) a sound reduction value of $D_{n,e,W}$ ($C;C_{tr}$) 16 (-1; -2) was achieved. **Table 8** below reproduces the octave band attenuation values for this type of window.

Table 8: Measured Attenuation for Partially Open Window

Window	Attenuation at Octave Band Centre Frequencies							Dn,e,W (C;Ctr)
	63	125	250	500	1k	2k	4k	
Side Swing Reversable (B)	20.8	13.3	12.9	18.1	12.0	18.3	20.5	16 (-1; -2)

The attenuation values presented in **Table 8** above were used to assess potential noise impacts as this represents a prudent and worst-case scenario.

5 Noise Impact Assessment

5.1 Assessment 1 – Patrons

IoA Working Group Annex Assessment

Using the methodology presented in **Section 4.1** the noise model was developed and the potential noise impacts to NSR1 were calculated. These assessments are presented in **Table 9** and **Table 10** respectively:

Table 9: Noise Impact Assessment – L_{Aeq} against Measured L90

Receptor	Predicted Level at Receptor (dBA)	Measured Background Noise Level (L_{A90})	Difference (dB)
NSR1	41.6	52.4 (daytime)	**-10.8**
		45.6 (nighttime)	**-4.0**

The predicted L_{Aeq} level at NSR1 from the external terrace area with fence and roof section in place is *less* than the measured background in the area during both the daytime and nighttime. Therefore, this criterion has been satisfied and no further mitigation measured are deemed necessary. It is recommended that patrons are encouraged to respect local neighbours by keeping noise levels to a minimum and using the shelters whenever possible.

Table 10: Noise Impact Assessment – L_{A10} against Measured L_{A90} between 40Hz and 160 Hz

Parameter	1/3 Octave Band Noise Level (dB)						
	40 Hz	50 Hz	63 Hz	80 Hz	100 Hz	125 Hz	160 Hz
Predicted Level at NSR1	36.8	34.0	30.1	25.4	27.2	27.3	23.8
Measured L_{A90} (WEN)	47.7	49.8	47.1	48.5	50.7	45.0	44.2
Difference	***-10.9***	***-15.8***	***-17.0***	***-23.1***	***-23.5***	***-17.7***	***-20.4***

It can be seen from **Table 10** above that the predicted L_{A10} levels at NSR1 are significantly below the measured L_{A90} background levels between 40Hz and 160Hz during the nighttime. Therefore, this criterion is satisfied and no further mitigation measures are deemed necessary.

Noise rating Curve Assessment

In accordance with the recommendations presented in NANR 92 and to provide a prudent and worst-case approach to assessment, the predicted noise impacts to NSR1 have been assessed against the internal noise rating criteria of NR25. The assessment uses the predicted attenuation achieved by a partially open window presented in **Table 8**. **Table 11** below presents the assessment of internal noise levels at NSR1 during the nighttime:

Table 11: Noise Impact Assessment – NR25 Curve

Parameter	Octave Band Noise Level (dB)						
	63	125	250	500	1000	2000	4000
Predicted Level at NSR1	34.6	34.2	37.4	43.5	30.9	31.0	16.7
Window Attenuation	20.8	13.3	12.9	18.1	12	18.3	20.5
Predicted Level in Room	13.8	20.9	24.5	25.4	18.9	12.7	-3.8
NR25 Values	55.2	43.7	35.2	29.2	25	21.9	19.5
Difference	-41.4	-22.8	-10.7	-3.8	-6.1	-9.2	-23

Table 11 above indicated that, with a partially open window, predicted noise levels within NSR1 are below the NR25 curve.

Based on the results of the assessment, noise impacts are not anticipated and therefore, no further mitigation measures are deemed necessary.

5.2 Further Site Context in Relation to Assessment

In addition to the above assessment a Noise Management Plan titled *PR20501_209_MERKUR Casino Aberdeen Noise Management Plan_DRAFT* has been developed exclusively for the use of this site which outlines protocol and requirements for staff behaviour when using the terrace in order to protect local residents. The plan has been developed based on good industry practice and experience of other similar sites. The results of the assessment have been used to develop the plan and it should be read in conjunction with this report.

As per the methodology, the assessment has been undertaken using an absolute worst-case scenario approach where the terrace is at full capacity and every single person is generating moderately high levels of noise. This scenario is very unlikely to occur, particularly given the pattern of weather within the area. Since the worst-case scenario assessment to NSR1 complies with the assessment criteria no further mitigation is required and the site is considered suitable for use as an outdoor terrace.

It is recommended that patrons are encouraged to respect residents when using the outside terrane area by keeping conversations and other noise levels as low as possible. Additionally patrons should be encouraged to stay under the roof section as much as possible which provides a degree of acoustic screening.

Additionally WHO criteria specifies a threshold for annoyance of 50dB in external areas. It can be seen from the assessment that a worst-case noise impact of 41.6dB is predicted which is less than the WHO criteria at the closest receptor. Therefore, WHO criteria will be satisfied.

It should be noted that, if any machines are to be located in the outside area the sound generated by them is negligible in comparison to sound generated from patrons and the machines all have volume control which can be adjusted by staff.

6 Conclusion

An assessment of predicted noise impacts from a new external terrace area for the planned terrace area has been undertaken at Merkur Casino, 61-63 Summer St, Aberdeen AB10 1SJ.

Baseline noise levels were made at the site during the daytime at a location representative of the closest noise sensitive receptors which are the residential properties on Huntly Street. Source noise level measurements of male and female patrons talking and laughing on a similar external terrace have been used to undertake the assessment.

The noise impact assessment was undertaken using the architect drawings which incorporated a fence surrounding the external terrace area and a partial roof section. The assessment referenced the NANR 92 guidance for assessing entertainment noise.

The assessment of predicted noise levels at NSR1 against the measured background level indicate that predicted levels are below the background when the terrace is in use at full capacity. Additionally predicted L_{A10} values at NSR1 are significantly below the measured L_{A90} values between 40Hz and 160Hz. Both of these elements satisfied the recommended criteria from the IoA Working Group Annex.

The assessment of predicted noise levels within NSR1 with a partially open window indicated that levels will be below the criteria of NR25 as recommended by NANR 92.

Based on the outcome of the assessment, noise impacts are not anticipated from the new Terrace Area and no further mitigation measures are deemed necessary. The noise management plan developed exclusively for this site will be adopted by the staff and should be read in conjunction with this report.

Appendix A – Site Layout, Noise Sensitive Receptor (NSR1) and Baseline Monitoring Position (MP1)

TOTAL GAMING AREA: 428.09m²

TOTAL NON-GAMING AREA: 302.82m²

GENERAL NOTES
THIS DRAWING IS TO BE READ IN CONJUNCTION WITH ANY SPECIFICATION AND/ OR SCOPE OF WORKS PROVIDED. ALONG WITH THE TENANT'S/ CENTRE MANAGEMENT SHOPFIT GUIDE. SHOULD THERE BE ANY DISCREPANCY BETWEEN THIS DRAWING AND THE SAID DOCUMENTS, PLEASE CONTACT THE PROJECT MANAGER FOR CLARIFICATION.

SETTING OUT
THE CONTRACTOR SHALL NOTE THAT ALL DRAWINGS HAVE BEEN PREPARED FROM DIGITAL SURVEY PLANS OR 'AS EXISTING' DRAWINGS PROVIDED BY OTHERS, AND AS SUCH ACCURACY CANNOT BE ASSUMED. IT IS THE CONTRACTOR'S SOLE RESPONSIBILITY TO CARRY OUT A SITE SURVEY, SITE DIMENSIONS AND PROCURE RODS AT A MINIMUM SCALE OF 1:20 FOR APPROVAL BY DESIGNERS. ALL DETAILS WILL BE SUBJECT TO THE APPROVAL OF CONTRACTOR'S RODS AND SITE SET STRIP OUT.

DO NOT SCALE FROM THIS DRAWING, ALL DIMENSIONS ARE IN MILLIMETRES UNLESS OTHERWISE STATED.

DIMENSIONS ON SITE AND ALL EQUIPMENT SIZES TO BE VERIFIED PRIOR TO WORK COMMENCING.

WORKS TO EXISTING SHOP UNIT
1. CARRY OUT ALL NECESSARY PROTECTION OF THE LANDLORD'S STRUCTURE, FASCIA, SOFFITS, WALLS AND FLOOR FINISHES.
2. ERECT TEMPORARY HOARDINGS AS REQUIRED BY THE LANDLORD OR LOCAL AUTHORITY.
3. CAREFULLY REMOVE WHERE APPLICABLE/ SHOWN UPON THE DRAWINGS EXISTING SHOPFRONTS, ROLLER SHUTTERS, DOORS, PARTITIONS, FASCIA'S, SIGNS ETC. N.B. EXERCISE CARE WHEN REMOVING GLASS.
4. CAREFULLY DEMOLISH ALL UNWANTED PARTITIONS AND STRIP OUT FIXTURES AND FITTINGS, FLOOR FINISHES, WALL AND CEILING FINISHES AS STATED UPON THE DRAWING OR INSTRUCTED BY THE PROJECT MANAGER.
5. WHERE EXISTING ITEMS ARE TO BE RETAINED, PROVIDE ADEQUATE PROTECTION TO AVOID DAMAGE DURING THE WORKS.
6. MAKE GOOD, REPAIR, REINSTATE AS REQUESTED BY THE PROJECT MANAGER, ANY OR DISTURBED SERVICES, IRRESPECTIVE OF CAUSE.
7. REMOVE ALL RUBBISH, DEBRIS AND WASTE FROM THE AREA OF WORKS, AND FROM THE SITE.
8. BEFORE ANY NEW WORKS COMMENCE, NOTIFY THE PROJECT MANAGER OF ANY DISCREPANCIES BETWEEN THE SITE AND THE DRAWINGS/ SCOPE OF WORKS.

HOARDINGS (WHERE REQUIRED)
ALL HOARDINGS ARE TO COMPLY WITH THE LANDLORD'S, FIRE OFFICER'S AND LOCAL AUTHORITY REQUIREMENTS FOR DESIGN, FIRE RATINGS AND MEANS OF ESCAPE. NO OPENINGS ARE ALLOWED WITHIN THE HOARDING UNLESS OTHERWISE REQUESTED. THE INTEGRITY OF THE HOARDING IS TO BE MAINTAINED UNTIL THE SHOPFRONT, INCLUDING THE GLASS AND SHUTTERS, ARE INSTALLED. ALL OPENINGS MUST BE COVERED AND ALL GLAZING OBSCURED UNTIL THE INTERIOR OF THE SHOP IS COMPLETED.

FIRE SAFETY DETAILS
ALL FIRE NOTICE SIGNS MUST COMPLY WITH THE EUROPEAN SAFETY SIGN DIRECTIVE 02/58/EEC AND BS5499 PART 1. PLUS BE IN ACCORDANCE WITH THE HEALTH AND SAFETY (SAFETY SIGNS AND SIGNALS) REG. 96. ALL FIRE EXIT FURNITURE AND FIRE FIGHTING EQUIPMENT MUST BE TO THE APPROVAL OF THE FIRE OFFICER AND COMPLY TO BS EN 1125. ALL STAFF ARE TO BE FULLY CONVERSANT WITH ALL FIRE ALARM PROCEDURES AND EVACUATION METHODS, PLUS THE USE OF FIRE FIGHTING EQUIPMENT.

SURFACE SPREAD OF FLAME
ALL WALL AND CEILING FINISHES ARE TO COMPLY WITH THE FOLLOWING MINIMUM STANDARDS: C-s3, d2 : GENERAL RETAIL AND ANCILLARY AREAS.

EMERGENCY LIGHTING
ENSURE ALL EXISTING FITTINGS BEING RETAINED MEET CURRENT REGULATIONS AND ARE IN FULL WORKING ORDER. INSTALL NEW FITTINGS WHERE INDICATED UPON THE DRAWINGS AND IF THE EXISTING LIGHTS DO NOT COMPLY. ALL EMERGENCY LIGHTING MUST COMPLY WITH THE HEALTH AND SAFETY (SAFETY SIGNS AND SIGNALS) REG.96 AND BS 5266 PART 1. THEREFORE MAINTENANCE ILLUMINATION FOR A MINIMUM PERIOD OF THREE HOURS VIA A SELF CONTAINED BATTERY BACK UP.

EXISTING SWITCH GEAR/ FUSE BOX/ WIRING
ELECTRICAL CONTRACTOR IS TO ALLOW FOR RECONFIGURING EXISTING SWITCH GEAR AND FUSE BOARD TO SUIT NEW LAYOUT. ALL EXISTING ELECTRICAL GOODS ARE TO BE FULLY TESTED AND REPLACED IF NECESSARY, TO COMPLY WITH IEE REGULATION. EXISTING WIRING, IF RETAINED, IS TO BE CHECKED TO MEET CURRENT IEE REGULATIONS AND TO BE REWIRED WHERE NECESSARY.

ELECTRICAL INSTALLATION
THE ELECTRICAL CONTRACTOR IS TO ALLOW FOR WIRING AND INSTALLATION OF ALL THE NEW FREE ISSUE LIGHTS SUPPLIED BY THE CLIENT, ALONG WITH THE SUPPLY AND INSTALLATION OF ANY NEW LIGHTING THE THE BACK OF HOUSE AREAS; AND ELECTRICAL POINTS IF APPLICABLE AND INDICATED UPON THE DRAWINGS (IE SOCKETS, FUSE SPUR). EXISTING FITTINGS BEING RETAINED ARE TO BE CHECKED TO ENSURE THAT THEY ARE IN FULL WORKING ORDER AND LIGHTS RAE TO BE RELAMPED. THE CONTRACTOR IS ALSO TO LIASE WITH ALL OTHER NOMINATED SUBCONTRACTORS SO AS TO PROVIDE THE NECESSARY ELECTRICAL POINTS/ POWER SUPPLY REQUIREMENTS. THE WHOLE ELECTRICAL INSTALLATION IS TO BE CARRIED OUT IN ACCORDANCE WITH THE CURRENT EDITION OF IEE REGULATIONS AND IS UNDERTAKEN BY AN NIC IEE APPROVED CONTRACTOR. THE CONTRACTOR IS TO PROVIDE AN NIC EIC COMPLETION CERTIFICATE UPON COMPLETION.

ELECTRICAL INSTALLATION - FURNITURE
THE ELECTRICAL CONTRACTOR IS TO LIAISE WITH THE FURNITURE MANUFACTURER ON WIRING OF FURNITURE.

MAIN CONTRACTOR TO SUPPLY, INSTALL & FIT ALL THE GENERAL ELECTRICAL REQUIREMENTS TO THE RETAIL AREA & TO PROVIDE CONDUITS AND POWER SUPPLY TO ALL OTHER SERVICES, PROVIDE BY SPECIALIST SUB-CONTRACTORS. THE MAIN CONTRACTOR IS TO MAKE GOOD AS NECESSARY, ALL EXISTING SCREED IN PREPARATION FOR LAYING NEW FLOOR.

FIRE ALARM SYSTEM
THE CONTRACTOR IS TO ALERT/ ADAPT OR PROVIDE NEW WHERE NECESSARY, THE EXISTING FIRE ALARM PANEL, DETECTION AND WARNING SYSTEM TO SUIT THE NEW LAYOUT. ANY EXISTING FITTINGS BEING RETAINED ARE TO BE FULLY TESTED TO ENSURE THAT THEY ARE IN FULL WORKING ORDER. ALL NEW OR ALTERED SYSTEMS ARE TO BE COMPATIBLE WITH THE LANDLORDS SYSTEM AND IN ACCORDANCE WITH BS5839 PART1 2017. NEW CABLING IS TO BE MICC RED SHEATHED 750W GRADE. ALL WORK IS TO BE APPROVED BY THE LOCAL FIRE DEPARTMENT AND TEST CERTIFICATION IS TO BE PROVIDED UPON COMPLETION.

SPRINKLERS (WHERE NECESSARY)
SPECIALIST SUBCONTRACTOR TO ALTER AND ADAPT EXISTING SPRINKLER HEAD POSITIONS OR FIT NEW TO SUIT CEILING LAYOUT. SPRINKLERS AT HIGH LEVEL TO REMAIN AS EXISTING BUT BE FULLY TESTED AND REPLACED WHERE NECESSARY. ALL WORKS TO BE CARRIED OUT BY LPC APPROVED CONTRACTOR AND FULL DETAILS, DRAWINGS AND CALCULATIONS ARE TO BE PROVIDED FOR THE APPROVAL OF LANDLORD AND LOCAL FIRE OFFICER PRIOR TO INSTALLATION. TEST CERTIFICATION IS TO BE PROVIDE UPON COMPLETION. ALL WORKS TO BE IN ACCORDANCE WITH BS5306 PART2 2/11/95.

NEW PARTITION AND DOOR(s)
ALL NEW WALLS AND DOORS ARE TO ACHIEVE A MINIMUM OF 1/2 HOUR FIRE RESISTANCE UNLESS OTHERWISE STATED. DOOR FRAMES ARE TO HOUSE SMOKE SEAL AND INTUMESCENT STRIPS. THE DOOR IS TO BE 44mm SOLID CORE AND FITTED WITH DOOR CLOSER, ALL TO THE APPROVAL OF THE FIRE OFFICER.

EXTERNAL SIGNAGE
MAIN CONTRACTOR IS TO LIASE WITH THE SPECIALIST SUB-CONTRTACTOR TO FIX SUITABLE FIXING GROUNDS AND LOCAL POWER ADJACENT TO THE SIGN LOCATIONS. A TIME CLOCK WILL BE REQUIRED FOR CONTROL OF ALL EXTERNAL SIGNS AND BE LOCATED AT REAR OF THE STORE. A RECESSED FIREMAN'S SWITCH IS REQUIRED FOR ALL NEON FASCIA SIGNAGE LOCATED. FACE PLATE TO BE FINISHED TO MATCH SNOWDRIFT 0502-Y WITH ALL WRITING IN RED.

M & E VENTILATION/ AIR CONDITIONING
ALL WORKS TO COMPLY WITH BS5720 1979 AND PART F1 OF THE BUILDING REGULATIONS, PLUS ANY LANDLORD'S REQUIREMENTS. DRAWINGS AND CALCULATIONS ARE TO BE PRODUCED BY A SPECIALIST SUBCONTRACTOR FOR APPROVAL. THE MAIN CONTRACTOR IS TO LIASE WITH SUBCONTRACTORS FOR ANY BUILDING WORKS THEY REQUIRE.

REVISIONS

Revision Log:

Rev:	Description:	By:	Date:

LICENCE

FIT OUT TYPE
ABERDEEN SPORTS BAR

PROJECT
MERKUR CASINO
178 GEORGE STREET
ABERDEEN
AB25 1BS

DESCRIPTION
PROPOSED LICENCE PLAN

DRAWN BY	SCALE	DATE
LR	1:75	22/05/25

DRAWING No.	REVISION
999-PR-25	01

LICENSE PLAN LEGEND

LINE TYPE	LINE TYPE DESCRIPTION
(red line)	GAMING AREA
(blue line)	EXTENT OF PREMISES
(green line)	NON-GAMING AREA

GAMBLING ACT 2005 LICENSING PLAN
Anything shown on this plan, which is not required by The Gambling Act 2005 (Premises Licences and Provisional Statements) Regulation 2007 is for illustrative purposes only, and does not form part of the premises licence.

MERKUR SLOTS

Appendix B – NANR 92

University of Salford
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HEPWORTH ACOUSTICS
noise and vibration consultants

Noise from Pubs and Clubs
Final Report

Report for the Department for Environment, Food and Rural Affairs by

March 2005
Contract no. NANR 92

Abstract

A review of available data on entertainment noise from pubs and clubs has been conducted with the aim of determining how a rigorous UK method for assessing it might be devised. There is considerable evidence that a noise annoyance problem exists and significant variation in how it is measured and assessed across the country. There is therefore a clear need for a universal, validated UK assessment method. Several candidate assessment methods are identified. These include methods specifically proposed for pub and club noise, those for general low-frequency noise, those relying on absolute criteria and those based on relative assessments.

A validation programme is described which would enable comparison of objective rating methods to listener perceptions of entertainment noise obtained under rigorous laboratory conditions. Seven factors are identified which may affect the magnitude of the recorded subjective response. These are: sound level, background level, differences between listeners, the context into which the sound intrudes, music type, bass level and bass beat. The validation programme would be supported by a series of field measurements. The two main outputs of the programme would be an optimised UK assessment method and a deeper understanding of the factors affecting perception of noise from pubs and clubs.

Contents

1 Introduction

1.1 This is the final report for a contract let by the Department for Environment, Food and Rural Affairs to review existing knowledge of noise from entertainment sources from pubs and clubs. The overall aim of this work is to recommend criteria and measurement methods for assessing the noise from pubs and clubs for use by Environmental Health Officers (EHOs) and others. In the current project, published information on pubs and clubs has been analysed and a shortlist of suitable assessment methods drawn up. A scheme for rigorously evaluating the assessment methods has been devised and it is shown how this should lead to an optimal assessment method.

1.2 There is an extensive research-based literature on noise and its impact on communities. Generally, this takes the form of an attempt to predict the subjective response of a community using a quantitative measure derived from physical measurements of the noise. The most noticeable feature of this whole literature is the poor performance of the prediction (Schultz, 1982). In particular, a new metric is often found to predict annoyance well for the airport or road where it is developed. However, subsequent attempts to use it to predict annoyance for a similar noise source somewhere else often fail. There are a number of reasons for this, including: over-simplification in modelling both physical and psychological aspects of human auditory response, measuring too few physical characteristics of the noise and significant non-acoustic determinants of subject response. The latter can easily be understood by considering that a noise with many ‘annoying’ features may be much less annoying in some contexts than in others. For example, the response of an individual to a noise might be influenced by their relationship with the producer, by their perception of any information it carries (such as speech), or by their view of its appropriateness.

1.3 Hence, any project to develop a new noise rating must begin by conceding the difficulty of the task. Nevertheless, quantitative methods and rating criteria are essential if effective policies for noise control are to be developed. The risks of mis-prediction identified above may be minimised if an attempt is made to identify and control the problems listed above. For example, it may be that a substantial proportion of the annoyance from pub noise is caused by low-frequency components which are not well characterised by a single measurement of L_{Aeq}.

1.4 Perhaps partly because of the past failure of many predictive noise metrics, there is a general trend towards the use of L_{Aeq} to assess all noise. There are still many assessment criteria for different kinds of noise in different contexts, but they can be broadly divided into two types: fixed and relative. Fixed ratings specify a limit that the noise should not exceed. For example, BS 8223 (1999) gives desirable maximum noise levels inside various different buildings and rooms, expressed as L_{Aeq} values. Relative ratings compare the noise level (usually L_{Aeq}) with the background noise level without the noise source (usually L_{A90}). The noise level is allowed to exceed the background by only a certain amount. The most widely applied UK example of a relative method is BS 4142 (1997).

1.5 Noise from pubs and clubs is currently assessed in the UK using a variety of different schemes. However, there is currently no strong evidence that any one rating scheme is optimal, despite strong interest in the problem being expressed by several stakeholders. Meanwhile, the legislative framework for noise problems in England and Wales is changing. Perhaps the most significant development which may affect assessment of pub and club noise is the Clean Neighbourhoods and Environment bill. This draft bill, if enacted, would extend the Noise Act 1996 to cover licensed premises. The Noise Act 1996 is based on a relative criterion of assessing L_{Aeq} against the background level.

1.6 Noise issues relating to pubs and clubs include entertainment noise, noise from mechanical services equipment, noise from customers arriving and leaving, and noise from deliveries to the venue. These noises differ in character and hence in the way they must be assessed. Noise from mechanical services equipment is a frequent issue with pubs and clubs but is generally assessed using BS 4142. Noise from customers arriving and leaving is also frequently cited as an issue but it is less under the control of the pub and would seem to fall more into the character of 'people noise'. Though noise produced by people is certainly an issue, particularly in urban areas, there is not yet an adequate body of data which could support the development of a rating method for this source. Obtaining that data and developing a rating method for people noise would require a much larger project than one focussed on noise radiating directly from pubs and clubs. Entertainment noise seems more amenable to rating, but there is currently no established single method and several different techniques have been proposed by others. It is therefore sensible that this project is concerned solely with the impact and effects of entertainment noise arising from pubs and clubs.

1.7 In the next section, the available information on the assessment of noise from pubs and clubs is analysed. Evidence of the noise problem is discussed, followed by analysis of UK and international methods for rating and control. Section two concludes with a summary of the assessment methods that could form the basis for a final, optimised method. Section three outlines the rationale for progressing from several candidate methods to a single optimal one. Section four discusses in detail the scientific programme that would be needed to accomplish this.

2 Analysis of existing information

2.1 Evidence of the problem

2.1.1 Typical noise levels

2.1.1.1 Hepworth Acoustics Ltd has a database of over 600 individual noise measurements carried out in around 80 licensed premises throughout the United Kingdom. Many of these measurements relate to sound levels within branded bars and night clubs, where the operator desires similar noise levels in all premises of the same brand throughout the country. These measurements have usually been carried out to obtain data for the acoustic design of new premises, although some measurements have been carried out in response to noise complaints.

2.1.1.2 The measurements cover a wide range of premises from bars with no music and restaurants to themed music bars and nightclubs. The measurements have been carried out at a number of locations within the venues, but have normally been designed to obtain data on the highest sound levels within the premises, to ensure that the acoustic control measures are designed using appropriate source levels. This means that most of the measurements were carried out on a busy trading night when music was played at maximum volume.

2.1.1.3 The database has been built up over a number of years, and there are some variations in the data recorded on different surveys. All of the noise measurements carried out recorded both A-weighted broadband and unweighted octave band L_{eq} values as a minimum. Most measurements also recorded both A-weighted and octave band L_{max} values. Other noise indices, such as L_1, L_{10} and L_{50} were recorded on some of the surveys.

2.1.1.4 The results from the database show a wide range of measured levels. Noise levels measured in bars and restaurants during quiet periods showed noise levels of 65-70 dB $L_{Aeq.}$ Noise levels of up to 88 dB L_{Aeq} were measured during busy periods in bars not playing music i.e. just customer noise. Many bars playing music had noise levels of 90 – 95 dB L_{Aeq} during busy periods, with noise levels on dance floors of night clubs measured at up to 105 dB L_{Aeq}.

2.1.1.5 The range of measured levels at the 63 and 125 Hz octave bands was slightly wider than for the A-weighted levels. (These frequency bands are often dominant in amplified music.) Noise levels up to 115 dB L_{eq} in the 63 Hz octave band and 110 dB L_{eq} in the 125 Hz octave band were recorded on dance floors of night clubs.

2.1.1.6 Maximum noise levels are obviously higher than L_{eq} values, although there is no constant difference between the two indices. Differences of between 5 and 15 dB have been noted between L_{eq} and $L_{max, fast}$ levels for both A-weighted and octave band measurements. The type of music being played and the level of compression of the music will have influenced the difference between the noise indices.

2.1.2 The popular press

2.1.2.1 Stories about pub and club noise are a staple of local newspapers, particularly where the problem is longstanding or confrontational – for example, Hampstead & Highgate Express (2004). Sometimes these stories find their way into the national press. Often these are short fillers, précis of the local paper account of the dispute, as in The Mirror (2002) and Bone (2004). A different kind of article is sometimes carried by the broadsheets when covering trends in urban living. Property pages not infrequently devote several columns to discussing the advantages and disadvantages of modern urban living, and noise is usually identified as an issue. Arnot (2002) is an example of this kind of article and it includes several miniature case studies of new city dwellers trying to accommodate to entertainment noise.

2.1.3 Sociological investigations

2.1.3.1 Perceived quality of life of urban populations is a topic which has received considerable attention from social scientists over the last twenty years. However, there are few research outputs which deal specifically with the effects of pub and club noise on neighbourhoods. The only directly relevant study (MCM Research Ltd, 2003) explored the possible effects of the recent change in the licensing laws on noise from pubs and clubs. The views of a range of stakeholders were sought by interview and questionnaire. The results showed a widespread concern at the extent of the noise problem, though it was noted that national surveys of background noise levels revealed only a small increase in L_{A90}. The authors recommended the development of national assessment methods and criteria for pub and club noise.

2.1.3.2 Refereed social science journals do not seem to contain any research as directly relevant as the MCM study. There are two papers which do seem at least peripherally relevant. The first addresses the nuisance caused to local residents by rock concerts held at a football stadium (Chase and Healey, 1995). It is reported that staging rock concerts at the stadium has increased the negative effects generated, particularly noise levels. However, contrary to anecdotal evidence, football-induced nuisance is perceived as being a greater problem overall, possibly due to the higher frequency of matches. The second paper (Bromley et al., 2003) examines use of a city centre environment by different groups of people. It is found that “The evening clientele visit less frequently and are disproportionately drawn from the older and higher status social groups, whereas later at night, pubs and clubs are visited more frequently, and by imbalances of the young, lower status groups, and students.” City centre users are segregated in time, so noise from pubs and clubs is likely to be made by one social group and impinge on other groups. It could be hypothesised that we are more tolerant of noise produced by people from our own social group, so this study would seem to indicate an increased risk of nuisance.

2.2 UK response to the problem

2.2.1 Associated rating methods

2.2.1.1 Before noise from pubs and clubs was addressed in specific regulations, there were of course, various regulations aimed at controlling other kinds of noise. One important precursor is BS 4142 (1997). This standard attempts to provide an objective rating method for noise in such a way that the rating will correlate with the likelihood of complaints. The method explicitly excludes prediction of annoyance and is specified only for industrial noise affecting residential buildings. However, it became widely used outside its specification because it provided a simple method in an area perceived to be very complex – predicting subjective reaction to noise. The rating is based on a simple L_{Aeq} measurement with added decibel penalties for perceived tonality or intermittence. Noise from pubs and clubs will has been widely assessed using BS 4142 prior to the attempt to introduce specialist ratings.

2.2.1.2 Live pop concerts and the like can produce similar sound levels at source to some of those coming from pubs and clubs. Open-air concerts are currently guided by the 'Code of Practice on Environmental Noise Control at Concerts' issued by the Noise Council (1995). This stipulates limits according to the number and category of event. The night-time criterion is that between 2300 and 0900, music should not be audible in any noise-sensitive room with an open window. Broadband levels are measured with 15-minute L_{Aeq} 1 m from the noise-sensitive façade from 0900 to 2300 and background levels by L_{A90}. Noise from indoor venues is limited to 5 dB over background. The Code of Practice (in a note on the guideline) states that an additional criterion may be needed to control low-frequency sound, and refers the reader to (Griffiths et al., 1993). Griffiths et al. reported that 80 dB at the receiver in the 63 or 80 Hz octave bands was sufficient to cause disturbance. Noise limits from outdoor events are summarised in Table 1.

Concert days per year, per venue	**Venue Category**	**Guidelines**
1 – 3	Urban Stadia/arenas	MNL should not exceed 75dB(A) over a 15 minute period
1 –3	Other Urban/rural venues	MNL should not exceed 65dB(A) over a 15 minute period
4 – 12	All venues	MNL should not exceed L_{A90} by more than 15dB over a 15 minute period

MNL (Music Noise Level) is the L_{Aeq} of the music measured at 1m from the façade between 0900 and 2300 hrs.

Table 1. Outdoor event noise limits in the Noise Council Code of Practice

2.2.2 Rating criteria – the inaudibility debate

2.2.2.1 BS 4142 and the Entertainment Noise CoP are examples of rating methods which use objective criteria, whether absolute or relative. An interesting attempt has been made, however, to promote a subjective criterion: that of inaudibility. Craik and Stirling (1986) reported survey results showing that music becomes annoying at levels just above the perception threshold. In a further paper Craik (2000) uses this survey result to criticise any method which allows the noise level to significantly exceed the background level. The 2000 article concludes by proposing subjective audibility as a criterion for rating amplified music. Williamson (2000) discusses the extensive experience of using inaudibility in Edinburgh and concludes that it presents no practical difficulty.

2.2.2.2 The case against inaudibility was made in the same pages (Bowdler, 2000; Dibble, 2000). Bowdler objects for two reasons: the criterion is unfair to the noise-maker because it depends on the background level at the complainant’s house, and that the test is usually too severe. Dibble suggests that inaudibility is too variable (whose inaudibility?) and points out that, if an A-weighted method like BS 4142 does not predict annoyance due to bass-heavy music, this is not surprising. He claims that, for music, L_{10} correlates well with perceived loudness. Dibble proposes a measurement method using a 1/3 octave analyser, with a criterion that L_{eq} should not exceed L_{90} in each band.

2.2.2.3 In another paper, Dibble (1997) repeats his criticism of the use of A-weighting to evaluate amplified music. He suggests that many complaints are due to low and poorly-characterised sound insulation at low frequencies. As well as moving away from A-weighted measures, he suggests that more research is needed on the prevalence of panel modes and airborne transmission generally at low frequencies.

2.2.3 Institute of Acoustics Working Group

2.2.3.1 In 1996, the Institute of Acoustics established a working group to produce guidance and criteria on the control of noise from pubs and clubs. The mandate of this group makes it the clear precursor for the current work. Unfortunately, the group was unable to produce a formal Code of Practice because industry representatives withdrew and because trials of proposed criteria produced inconclusive results (Hinton and Connor, 1999). Further, the IOA decided that the criteria were not robust enough to be published as such and so the only formal output from the working group was the Good Practice Guide (Institute of Acoustics, 2003). The annex containing the proposed criteria was, however, published in an article (Hinton and Somerville, 2003) to stimulate discussion. Following their withdrawal from the IOA group, the industry representatives have produced a guide to noise control for licensees (British Beer & Pub Association, 2003); this mirrors the IOA Good Practice Guide very closely.

2.2.3.2 In the IOA Annex, objective criteria are set out to ensure that two conditions are met: 1) that for premises where entertainment takes place on a regular basis, noise is inaudible inside noise sensitive premises at all times (It is said that the term 'regular' needs to be defined locally and with a regard to local expectations); 2) if entertainment takes place on a less frequent basis, the music should be inaudible inside noise sensitive property between the hours of 2300 and 0700. Noise is considered to be inaudible when it is at a sufficiently low level such that is not recognizable as emanating from the source in question and it does not alter the perception of the ambient noise environment that would prevail in the absence of the source in question. The IOA Annex expresses numerical limits in the form of Table 2.

Venue Where…	Suggested Regulations	Outcome if Criteria Met
Entertainment < 30 times/year*	$L_{Aeq,15mins}$ (EN) should not exceed L_{A90} (WEN) by more than 5dB.	EN will generally be audible but not overly obtrusive inside the noise sensitive property
Entertainment > 30 times/year*	L_{Aeq} (EN) should not exceed L_{A90} (WEN) by more than 5dB And the L_{10} (EN) should not exceed L_{90} (WEN) by more than 5dB in any 1/3 octave band between 40 and 160Hz.	EN will generally be audible but not overly obtrusive inside the noise sensitive property
Entertainment > once/week or continues beyond 2300hrs	L_{Aeq} (EN) should not exceed L_{A90} (WEN) And L_{10} (EN) should not exceed L_{90} (WEN) in any 1/3 octave band between 40 and 160Hz.	EN will be virtually inaudible inside noise sensitive property.

EN = Entertainment noise level, WEN = Representative background noise level without the entertainment noise, both measured 1m from the façade of the noise-sensitive premises.
* Not more than once a week and ends by 2300hrs.

Table 2. Limits suggested in the IOA Annex

2.2.3.3 Measurement advice was also offered with the annex. Some of the criteria provided do require the use of a 1/3 octave band real time spectrum analyzer with percentile and L_n capabilities, therefore additional advice/guidelines were offered for people without the necessary equipment or expertise. These are summarized below:

With the sound level meter set to 'fast'

a. Measure the broadband $L_{Aeq,T}$ ($L_{Aeq,1min}$ suggested)

b. Conduct an ear-eye estimation of the broadband L_{Amin}

c. Make a series of estimated octave band un-weighted L_{max} carried out at the same time as a) using either the 63 or 125Hz octave band filter, as these encompass the main bass beat frequencies

d. Make a series of ear-eye estimates of octave band L_{min} at the same time as b) and using the same octave band filter as c).

2.2.3.4 Using these measurements it is then possible to calculate the differences between L_{Aeq} when the entertainment noise is present and the L_{Amin} without the entertainment noise; and between the L_{max} of the bass component of the music and the L_{min} in the absence of the music. The maximum acceptable for either of these two differences is 6 or 7 dB for venues where entertainment takes place more than 30 times a year, not more than once a week and ends before 2300 hrs. For venues where entertainment takes place more than once a week or continues beyond 2300 hrs a stricter allowed level difference of 1 or 2 dB is given.

2.2.4 Current measurement and assessment practice

2.2.4.1 In the absence of a widely accepted measurement and assessment methodology for assessing noise from pubs and clubs, a variety of differing methodologies have been adopted by local authorities and consultants. The assessment methodologies generally fall into two groups, those that use an absolute criterion and those that use a comparative criterion. The two approaches are illustrated by examples from different local authority noise criteria for planning applications or Public Entertainment Licences. The local authorities that have objective criteria for music noise tend to be the exception (at about 15% of the total), and most local authorities do not have any objective criteria for assessing music noise from new or existing developments.

2.2.5 Absolute Criteria

2.2.5.1 The authors have seen examples of consultants and some local authorities using A-weighted target values for music intrusion within residential properties, generally based on World Health Organisation values. However, it is generally considered inappropriate to use only A-weighted target levels for music noise intrusion, because the impact of the bass elements of the noise. A relatively common application of absolute criteria is to use Noise Rating Curves to provide a target level in design work. The attraction of using a NR Curve is that it provides an absolute limit value in each octave band, whereas using an A-weighted level means that for a given dB(A) value, the allowable level of low frequency noise depends on the noise level at other frequencies. For a situation where there is little mid and high frequency noise transmission, a higher level of bass will be allowable without exceeding the dB(A) limit.

2.2.5.2 An example of the absolute limit type of approach is given below. The extract is taken from standard planning conditions used by Sheffield City Council for city centre planning applications

Before the use of the building for Food and Drink purposes (Use Class A3) is commenced a scheme of sound attenuation works shall have been installed and thereafter retained. Such a scheme of works shall …be capable of restricting noise breakout from Class A3 use to the flats above to levels complying with the following:

Bedrooms Noise Rating Curve NR25 (2300 to 0700 hours)

Living Rooms Noise Rating Curve NR35 (0700 to 2300 hours)

(Noise Rating Curves shall be measured as a 15 minute linear Leq at the octave band centre frequencies 31.5 Hz to 8 kHz)

2.2.5.3 The use of NR Curve design criteria is commonly used by a number of consultants, particularly when providing advice on new developments. For a new-build development, it is not possible to accurately assess future ambient noise levels within the quietest parts of the building in order to provide a baseline for a comparative criterion. The use of appropriate NR Curve criteria enables noise mitigation measures to be specified. There is a considerable variety of noise indices used for assessment against the NR Curve, with L_{eq}, L_{max} and L_{10} indices all having been used. In all cases, though, compliance with an NR curve should mean that the noise spectrum does not exceed the curve in any frequency band.

2.2.6 Comparative Criteria

2.2.6.1 These criteria tend to be used more for assessing the potential impact of existing entertainment premises on proposed new residential premises, or setting acceptable levels for existing entertainment premises.

2.2.6.2 The first example illustrated is produced by Kirklees Metropolitan Borough Council. Their guidelines for new noise sensitive premises near to existing places of entertainment contains the following :

Developers should show that noise from the place of entertainment shall not be audible inside habitable rooms of the new development. Inaudibility shall be defined as :

Zero increase in the $L_{Aeq,1\,min}$ (music playing) over the background L_{A90} (music off)

and

Zero increase in the $L_{10,T}$ vs $L_{90,T}$ exceedance in each 1/3 octave band between 40Hz and 160 Hz.

These figures equate to exceedances of 5 dB outside an open window.

2.2.6.3 The wording of the above condition was taken from a draft version of the Good Practice Guide (Institute of Acoustics, 2003).

2.2.6.4 Another example of this type of criterion is the Standard Public Entertainment Licence Noise Conditions used by the London Borough of Camden. This contains the following requirements.

After 2300hrs applicable to all entertainment premises

1. *The noise climate of the surrounding area shall be protected such that the A-weighted equivalent continuous noise level (LA_{eq}) emanating from the application site, as measured 1 metre from any facade of any noise sensitive premises over any 5 minute period with entertainment taking place shall not increase by more than* ***3dB*** *as compared to the same measure, from the same position, and over a comparable period, with no entertainment taking place.*
2. *The unweighted equivalent noise level (L_{eq}) in the 63Hz Octave band, measured using the "fast" time constant, inside any living room of any noise sensitive premises, with the windows open or closed, over any 5 minute period with entertainment taking place, should show* ***NO*** *increase as compared to the same measure, from the same location(s), and over a comparable period, with no entertainment taking place.*
3. *No sound emanating from the establishment should be audible within any noise sensitive premises between 23.00 and 07.00 hours.*

2.2.7 Design Targets

2.2.7.1 The above are examples of criteria used by local authorities for enforcement purposes. At the design stage of projects, consultants are often required to provide advice on the level of sound insulation required within a building. Sometimes there may be contractual requirements or detailed planning conditions to meet, but often the brief is that the consultant should ensure that there will not be a noise problem, and the consultant is required to propose a suitable criterion. As mentioned previously, Noise Rating Curves are used by a number of consultants. Noise Rating Curves 20 and 25 are used by some when assessing noise impact for residential properties at night, although other Noise Rating Curves have been used on some projects. The noise index used for specifying the Noise Rating Curve, whether L_{eq}, L_{10} or L_{max}, is variable, and obviously affects the strictness of the criterion.

2.2.7.2 The other approach used at the design stage is to use the comparative approach, although this generally cannot be used if the noise source and receivers are within the new building. Where this approach is possible, it is usual for existing octave band L_{90} values to be measured. Attenuation is then designed to ensure that octave band music noise breakout from the new development does not exceed the measured existing octave band L_{90} values. Once again, the practice of assessing the music breakout varies with L_{max}, L_{eq} or L_{10} indices used by different organisations as the parameter not to exceed the background levels.

2.3 International response to the problem

2.3.1 Codes for entertainment noise

2.3.1.1 Regulations applying to pub and club noise in ten European countries are summarised and compared by (Desarnaulds et al., 2003). The regulations vary widely between countries but there are some observable trends and groups in both the types of criteria (e.g. level just outside the club), the methods of expressing them (e.g. L_{Aeq}) and the limit values allowed (e.g. 3 dB above background). There are three main types of criteria: levels at a noise-sensitive property, levels outside the noise-making property and sound insulation requirements where both source and receiver are part of the same building. Most of the ten countries use more than one of the three types; France and Italy use all three. Criteria for allowable levels inside or outside the noise-sensitive property in eight countries are summarised in Table 3.

Country	**Text**	**Descriptor**	**Requirements inside, dB(A)**	**Requirements outside, dB(A)**
Switzerland*	DEP	$L_{Aeq(10s)}$	24	34
Germany	VDI 2058B11	L_{Aeq} L_{AFmax}	25 35	40 – 45 (DIN 18005)
France	Recommendation CNB (1993)	L_{Aeq}	22	-
Italy	DPCM 14/11/97 No280	$L_{Aeq\ (1\ min)}$	25	40 (open window)
Norway	NS 8175-1997	L_{AFmax}	22 – 37	25 – 45
Netherlands	Catering order (1998)	$L_{Aeq\ (19-07)}$ L_{AFmax}	25 45	40 60
Sweden	SOSFS 1996:7	L_{Aeq}	25	-
United Kingdom	Code of practice concerts**	$L_{Aeq\ (15mins)}$		75 (stadia) 65 (other)

* Exploitation after 1985, night time (22-7h) downtown; ** Max. 3 open air concerts/year.

Table 3. European limits at the noise-sensitive property, after (Desarnaulds et al., 2003).

2.3.1.2 In five countries, there are also criteria for maximum levels outside the noise-making building, referred as 'emergence' by Desaurnaulds et al and summarised in Table 4.

2.3.1.3 Finally, six countries also specify sound insulation requirements. These vary widely, but all are based on weighted airborne criteria – typically $D_{nT,w}$ with or without C_{tr}. In France (Decret 98-1143), D_{nT} is also specified in octave bands, with stringent targets of 66 or 75 dB in the 125 or 250 Hz bands for an emission level of 99 dB in those bands.

2.3.1.4 There are several interesting features of this comparison:

- The most significant feature is that all are A-weighted. The French sound insulation targets seem to be the only non-UK European regulation which specifically addresses low-frequency annoyance. Desarnaulds et al do not comment on this, but using A-weighting to assess noise which includes amplified music would seem to be a problem in the light of UK experience.

- Inside the noise-sensitive property, limits are about 25 dB(A), outside about 40 dB(A)
- L_{Aeq} levels outside the club are limited to about 3 dB over background.

Country	Text	Descriptor, music	Descriptor, background noise	Requirement on emergence, dB(A)
France*	Decret 98-1143	$L_{Aeq\ (1h)}$	L_{Aeq}	< 3
Italy	DPCM 280 14/11/97	$L_{Aeq\ (1\ min)}$	$L_{Aeq\ (1\ min)}$	< 3
Netherlands	Catering order 1998	$L_{Aeq\ (19\text{-}7h)}$	$L_{A95\text{-}}$	< 0
Portugal	Noise code 2000	$L_{r\ (22\text{-}7h)}$ **	L_{Aeq}	≤ 3
UK***	Code of practice, concerts	$L_{Aeq\ (15\ min)}$	$L_{A90\ (4h)}$	< 5

Limit for each octave band 125Hz to 4kHz (measurement method: NF s 31-010); **Lr = L_{Aeq} (music + background noise) + $K_{t,i}$ (tonal and impulsive 0,3 or 6) – Kd (duration, 0 to 4); *** Maximum 30 indoor events/venue/year

Table 4. European limits outside the pub/club, after (Desarnaulds et al., 2003).

2.3.2 Codes for low-frequency noise

2.3.2.1 Besides standards aimed specifically at pub and club noise, there are also codes regulating general low-frequency noise in several European countries. In general, these do not deal specifically with noise from pubs and clubs, but they may be applicable where music noise contains strong low frequency components. Low-frequency assessment methods were recently surveyed extensively by Leventhall (2003) for DEFRA. This work was followed by Moorhouse et al. (2004), who aimed to develop a UK rating method. The Moorhouse report includes an analysis of European practice in regulating low frequencies. Criteria already in use in Germany, Sweden, Denmark, the Netherlands and Poland were reviewed and compared. These work by comparing the third-octave spectrum of the noise to a reference curve. If the spectrum exceeds the curve, some subjective reaction is predicted and this is usually labelled 'disturbance'. The low-frequency methods are similar to the way some UK consultants use Noise Rating curves. The frequency range covered by these methods is generally small, but it does extend into the lower range of amplified music. For example, the German standard (DIN45680, 1997) covers 8-100 Hz. In another study by (McCullough, 2004), Environmental Health Officers made subjective ratings of real pub and club noise. Field recordings of the noise were evaluated according to several standards and good correlations were found when DIN 45680 was used.

2.3.2.2 Based on laboratory experiments with real and simulated low-frequency noise, Moorhouse et al. derived a proposal for a UK low-frequency noise criterion. Their test sounds were typical of the kind of noise complained of by UK low-frequency noise sufferers and so did not include music. Nevertheless, following the promising results of McCullogh, both DIN 45680 and the proposed UK variant should be investigated further as assessment techniques for pub and club noise. The Moorhouse proposed method is as follows:

Record L_{eq}, L_{10} and L_{90} in the third octave bands between 10Hz and 160Hz.

If the L_{eq}, taken over a time when the noise is said to be present, exceeds the values in Table 5 it may indicate a source of LFN that could cause disturbance. If the noise occurs only during the day then 5dB relaxation may be applied to all third octave bands. If the noise is steady then a 5dB relaxation may be applied to all third octave bands. A noise is considered steady if either of the conditions a. or b. below is met:

a. L10-L90 < 5dB

b. the rate of change of sound pressure level (Fast time weighting) is less than 10dB per second where the parameters are evaluated in the third octave band which exceeds the reference curve values (Table 5) by the greatest margin.

1/3 octave band frequency (Hz)	10	12.5	16	20	25	31.5	40	50	63	80	100	125	160
Unweighted L_{eq} (dB)	95	87	79	71	63	56	49	43	42	40	38	36	34

Table 5. Proposed reference curve for evaluating low-frequency noise, after (Moorhouse et al., 2004).

2.3.3 Non-UK experience

2.3.3.1 Noise from 'rave' parties in Hong Kong is assessed by Wong et al. (2001). They describe their experience of using L_{Aeq} to predict annoyance. Like Dibble (2000) they find that, even when the music does not increase L_{Aeq}, people are still disturbed. Also like Dibble, they attribute this annoyance primarily to modulated low-frequency sound. Regulations in force in Hong Kong at the time are given, and they vary depending on whether the event takes place in an indoor or outdoor venue. Different levels for both airborne noise and structure-borne noise are also mentioned in the criteria, though 'inaudibility' remains undefined:

	Indoor Venue	**Outdoor Venue**
Day and Evening (0700hrs – 2300hrs)	60 – 70dB(A), airborne 50 – 60dB(A), structure-borne	$L_{eq15min}$ at façade >L_{eq5min} for background +10dB(A)
Night (2300hrs – 0700hrs)	Inaudible inside the noise sensitive premises	Inaudible inside the noise sensitive premises

Table 6. Hong Kong noise limits for entertainment noise, after (Wong et al., 2001).

2.4 Psychoacoustic Investigations

2.4.1.1 The bulk of the literature relating to noise from pub and clubs is very applied – relating directly to field measurements of real noise. Separate fom this, there is also a large literature on laboratory-based tests of human response to noise. Most of these psychoacoustic investigations are not directly applicable to pub and club noise because they deal with signals which are different from amplified entertainment noise in some respect. A generalised 'lab' form of pub and club noise would have the following characteristics: low frequency, perhaps pink noise rather than sinusoidal, amplitude modulated (but at very low frequency – 2 Hz or so). There are few papers dealing with annoyance due to such a specific signal. One is by Kuwano et al. (1999), who asked subjects to rate loudness, noisiness and annoyance for several artificial signals, including 4 Hz amplitude-modulated pink noise, band-pass-filtered between 20 and 1000 Hz. They reported that subjective loudness, annoyance and noisiness were well correlated. Several objective measures from the sound quality literature were tried (roughness, sharpness and so on) and the best correlation with the subjective response was given by loudness level according to ISO 532 (1975). In another study, Bradley (1994) investigated annoyance caused by low-frequency amplitude-modulated sounds as part of a project on rumble in ventilation systems. He found that annoyance was best predicted using a combination of level and modulation strength.

2.5 Candidate rating methods

2.5.1.1 Having surveyed the existing rating methods it is apparent that there is no strong consensus among academics and practitioners. The group of methods considered for validation should therefore be drawn quite broadly. The objective criteria tested should certainly include: the IOA working group annex, a Noise Rating curve method, the WHO absolute L_{Aeq} values, at least one low-frequency noise code and a subjective audibility test. Based on the literature reviewed, a recommended list of criteria appears in Table 7 below. Measurement period should be regarded as an additional parameter for all the measurements – for example, one minute, fifteen minutes, etc.

Name	Parameter	Type
IoA working group annex	L_{Aeq} vs L_{A90} plus L_{10} vs L_{90} in 40-160 Hz 1/3 octave bands	Relative
BS 4142 / Noise Act 1996	L_{Aeq} vs. background (L_{A90}, L_{A99}, etc.)	Relative
Noise Rating curve	1/3 octave (L_{eq}, L_{10} or L_{max}) vs. NR curve	Absolute
Absolute L_{Aeq}	L_{Aeq}	Absolute
DIN 45680 / Moorhouse	10 – 160 Hz 1/3 octave L_{eq} vs reference curve	Absolute
Inaudibility	Subjective	Relative

Table 7. Schedule of proposed criteria for validation.

3 Rationale for developing a new rating method

3.1 Given the evidence reviewed above, it seems reasonable to think that an optimal method for rating entertainment noise from pubs and clubs can be developed. The optimal method should seek to adequately predict the subjective response of people exposed to pub and club noise. At this stage, it is not possible to specify the optimal method. Instead, we can specify the experimental procedure by which it can be developed and this is done in the rest of this report. It is possible to state some likely features of the final rating method. The method must take account of the significant physical features of the noise. These will certainly include level (probably by A-weighted L_{eq}). Almost certainly, some form of measure of bass prominence will be needed, perhaps based on L_{eq} in 63 and 125 Hz octave bands. The method may also need to take account of temporal features, like bass beat, perhaps evaluated by $L_{10} – L_{90}$ in a low-frequency octave band. It is also not yet clear if a measurement of background noise is essential for adequate prediction of the listener response. Finally, the assessment method should be as simple as possible without sacrificing accuracy.

3.2 The only sensible way to develop an optimal rating method is by constructing tests in which listeners are exposed to pub and club noise and are asked to subjectively rate the noise in some way (annoyance, loudness or audibility, for example). An audio recording of the noise can then be analysed for the kinds of physical features identified above. If a computer is used to do this, a large number of objective rating schemes (and variants of them) can be compared. The result of each objective rating scheme can then be compared to the subjective responses. The extent to which a particular rating scheme matches the subjective responses can be quantified with statistical methods and the best rating scheme identified. The design of this validation process, particularly the subjective measurements, involves making decisions on many factors. These are considered below, in section four.

4 Validation test design

4.1 Field versus laboratory testing

4.1.1 Laboratory testing produces more reliable judgements from subjects and gives more control over the sound fields being heard, but inevitably lacks some of the context in which the original sound might be heard by a particular listener. A proper investigation of the physical features of pub and club noise can be carried out much more easily in the laboratory, because sounds can be altered to vary one physical parameter at a time and parameter values can be set precisely. It is also the only way to accurately quantify the difference in response from a group of listeners exposed to exactly the same sound. (The variance across subjects gives a valuable indication of the error to be expected when using the final rating method to predict listener response to noise from a pub.) Finally, it is easier to build confidence in lab tests because they are more easily refined through pilot tests. Therefore, the main plank of the validation programme should be based on laboratory tests.

4.1.2 The artificiality of laboratory testing can be reduced by appropriate instruction to the subject (for example, “Imagine you are sitting quietly in your living room during the day.”) However, it is very hard to recreate the experience of a listener disturbed by a noise in their own home. In particular, noise sufferers often speak of a feeling of being invaded because they identify closely with their own private physical space. It may well be that subjective response to a physical feature of the noise (e.g. bass beat) is different in the listener’s own home. Field studies also present a good opportunity for capturing qualitative data from a subject. When allowed to express a view in their own words, subjects often provide the experimenter with very valuable contextual information about their experience of the noise. This can help to provide a deeper understanding of the results of controlled experiments conducted in the lab, and may help in designing the lab tests to reflect the listener’s real experience. In the experience of the authors, this sort of narrative account is usually much richer when obtained in the listener’s home. It is therefore suggested that the laboratory validation should be supplemented by a programme of field case studies.

4.2 Laboratory psychometric method

4.2.1 The term psychometric method refers to the way in which a task is presented to the subject and the response obtained from them. For the tests envisaged here, there are two psychometric methods that would be appropriate: the method of limits and the method of adjustment. In either case, some factor of the sound field, such as its level, is to be varied. In the method of limits a number of fixed sounds is played to the subject, who is asked to give each one a ‘score’ to indicate how much it annoys them, how pleasant they find it, etc. In the method of adjustment, the variable under investigation is adjusted until it achieves a certain response from the subject, for example it is adjusted so that they can just hear it (this is how hearing thresholds are tested). Either the subject or the experimenter could make the adjustments. In both methods the aim is to find a correlation between an objective quantity (as measured by the acoustic instrumentation) and a subjective quantity (as indicated by the subjects).

4.2.2 The method of limits is the best-established method for measuring reactions to environmental noise. It represents the field situation where the listener usually has no control over the noise. However, it has a significant disadvantage of inefficiency: many fixed test sounds must be created, with the factor under test increasing slightly each time. An *a priori* decision must be made on an appropriate size for the step between each test sound. This method is often used where the variable investigated is complex and cannot easily be continuously adjusted (for example, clarity in a concert hall (Cox et al., 1993)).

4.2.3 The method of adjustment is well-suited to tests where the principle variable of interest is level or intensity. This is true of pub and club noise. Listeners could be asked to adjust the noise until it reached a 'just acceptable' level. The effects of secondary factors like bass prominence or fluctuation could be determined by investigating their effect on the just acceptable level. This method also has the advantage that it allows listeners to take control of the process. It has been suggested that if listeners are more comfortable with the test, they are likely to give more accurate results, more quickly (Barron, 1971). As well as being quicker, the method of adjustment is also simpler because it gives the subjective threshold directly, reducing the statistical analysis needed.

4.3 Laboratory sound reproduction

4.3.1 There are several ways of presenting sounds to subjects that could be used here. Headphones, listening rooms, anechoic rooms and ordinary rooms will be briefly considered. Headphone reproduction has the advantage of convenience. Signals can come from a small tape recorder or portable computer and any reasonably quiet room used for reproduction. The researcher can come to the subject, which might increase participation rates. The main problem is that gross spatial reproduction errors are likely to affect at least some subjects. If mono or stereo recordings are used, then it is likely that the sound source will appear to a subject to be positioned inside his own head. Binaural recording improves on this by making recordings designed for headphone reproduction. A dummy head with microphones at the ear entrances is used to make the recording. Headphones accurately reproduce the signals arriving at the ears of the dummy head. However, some listeners will have different head and ear shapes to the dummy head and this often results in front-back reversals, where sound sources in front of the dummy head are perceived by the subject to be behind them. This project requires consistent rather than accurately spatialised sound reproduction, so headphone techniques are at a disadvantage.

4.3.2 If loudspeakers are used, then spatial artefacts can be minimised. Multiple loudspeakers could be used with mono recordings to give a subjective experience of a diffuse source. This should help subjects to concentrate on the features of the noise rather than its location in space. However, the room used for loudspeaker reproduction is important. An anechoic chamber could be used to attempt to minimise any coloration from the room. This has the disadvantage of sounding unnatural (especially to lay listeners) and requiring a large number of loudspeakers to achieve a diffuse source. Alternatively, a ‘real’ living room could be used. This might allow a more realistic context for listener judgements, at the expense of experimental reproducibility.

4.3.3 A good compromise between these two extreme rooms would be to use a standard listening room. These are designed to sound ‘natural’ with an appropriate reverberation for their size, but the reverberation time must conform to a strict target. It is important that the room used is well characterised, this helps to make the derived rating method more dependable.

4.4 Laboratory variables

4.4.1 There are a large number of physical variables which could be evaluated for pub and club noise and which might play a role in shaping subjective response. Ideally, one would measure the effect of each one in subjective tests. Psychoacoustic tests are time-consuming, expensive, difficult (especially for the subjects) and prone to error, so the number of variables investigated must be reduced to a small number. The first variable of interest must be the overall level of the sound. Most of the candidate rating methods in Table 7 use L_{Aeq} so one test should be to vary this. The second variable should be programme material. Entertainment noise carries information and varies widely in content (speech/music, type of music and so on). The test sounds must represent a realistic range and it is also of interest to find how subjective reaction might vary for different content reproduced at the same level. (This variance will form part of the error margin of the final optimised rating method.) Several existing rating methods compare the noise level to the background level and this should be examined in the laboratory. Recordings of real background noise could be analysed and generalised to make shaped noise spectra. The pub noise would then be played to subjects under various conditions of background noise. The primary variable of interest would be the level of the background noise, but other characteristics might also be investigated if resources allow.

4.4.2 Entertainment noise often has prominent low-frequency content and this should be characterised by a third variable. If the L_{Aeq} is held constant, what is the subjective effect of varying the level of a low-frequency octave band? If resources permit, the effect of fluctuation rate (bass beat) might also be studied. These variables will probably require taking real recordings of pub and club noise and altering them in the lab.

4.5 Subjective criteria

4.5.1 The exact task of the listener in the laboratory must be considered carefully. This amounts to deciding what the final rating method is designed to predict. Annoyance, audibility and acceptability are three of the possible choices. The use of annoyance as a measure has a long history in environmental acoustics. It has the advantage of denoting what seems to be the principal reaction to unwanted sound. Unfortunately, its meaning seems to vary widely between individuals, so that a large subject group is needed for meaningful results and derived annoyance scales are sometimes found not to have wide applicability to cases outside the project that developed them (Schultz, 1982).

4.5.2 Audibility has the advantage of simplicity. Craik and Stirling (1986) also report that annoyance increases steeply with level above threshold, so audibility is a more reliable measure than annoyance. Given its current application as a rating criterion in Edinburgh, it should be investigated in the proposed programme. Of course, audiometry thresholds vary quite widely between individuals at low frequencies so audibility may not provide the closest correlation with objective data across many recordings. Inaudibility is also seen by some commentators as too strict a criterion.

4.5.3 The term ‘acceptability’ can be viewed as a compromise between annoyance and audibility. Unlike annoyance, it does not require defining a semantic scale (“how annoyed?”) and it should be easier to achieve a consensus understanding of the term among subjects. It probably represents a more objective test of noise than inaudibility. Crucially, it also preserves the context in which the noise is to be judged, so we might ask subjects to adjust the noise to a just acceptable level for a daytime living room. We would expect a lower acceptable threshold for the same noise in a night-time bedroom. The concept can be extended to cover a list of tasks into which the noise might intrude – for example, reading a book during the day, watching television during the evening, getting ready for bed, or perhaps even a daytime domestic chore. Context can also be used to deal with the frequency of events, since a given noise level may be acceptable for a monthly event but not for a daily one. Comparing thresholds of acceptability and audibility would also be informative, and could easily be done with the method of adjustment.

4.6 Subjects

4.6.1 The population targeted by this study are all UK adults who experience pub and club noise. The subject sample used in the tests should resemble this population as closely as is reasonably practical. Children are excluded not because they do not experience the noise but because the difficulties (ethical and methodological) involved in experimenting on them seem to outweigh the advantages of including them. The subjects should therefore cover a wide age range, be evenly distributed across gender and be untrained listeners. It is probably not worth stratifying the sample by class, ethnicity, or geographic location.

4.6.2 The number of subjects required is perhaps the hardest aspect of the programme to quantify. We expect the test results to be approximately normally distributed among the subjects so that the variance (error) decreases as the number of subjects is increased. We would like to be able to specify *n* so that the variance is small enough for correlation with objective measurement to be successful, and for the significance of the factors like music type to be determined. Unfortunately, it is not possible to do this analytically and we must use previous test programmes as an empirical guide. For example, sixteen untrained subjects have been found to give a good balance between accuracy and practicality for hearing defender tests at Salford. Although the measurements proposed here are not the same as the audiometry performed to test hearing defenders, it is expected that the variance between subjects will be similar, and so the test group could be about the same size.

4.7 Statistics

4.7.1 There are two main aspects of the test design. The first is to find the rating method that best explains the subjective results. This can be done by correlation applied to scatter graphs of the data. The second aspect of the test is to quantify the effect of the variables: music type, bass prominence, bass fluctuation, day/night context, across-subjects and within-subject. If the tests vary just one factor at a time, then a simple analysis of variance (ANOVA) can determine the statistical significance of each factor. Of course, some of the factors may interact with one another. For example, if the factors 'subject' and 'music type' interact, then some subjects will find music A more acceptable than music B, while another group of subjects feels the other way round. A correctly designed ANOVA can identify and measure the statistical significance of any such interactions. However, the number of factors now stands at seven: sound level, background level, subject, context (including audibility), music type, bass level and bass beat. Each factor will take several values. It will probably be uneconomic to test every combination of values, and so the test programme must be carefully designed to cover enough combinations of factors to allow several 'mini-ANOVAs'.

4.8 Field measurements

4.8.1 The objectives of the field studies are to provide listener context for the laboratory studies and a convenient source of (some of the) recorded entertainment noise for the lab work. These objectives are similar to those of the successful DEFRA low-frequency noise project (Moorhouse et al., 2004) and so a similar methodology could be adopted here. These objectives do not require anything approaching a comprehensive UK survey; ten to twenty cases should be sufficient. Case studies could be identified via EHOs and computer-based recording systems left unattended in a complainant's home for several days. (Unattended systems would record only level data, not audio.)

4.8.2 Subjective response in the field could be captured in a wide variety of ways. Past studies have used combinations of questionnaire, diary, interview and focus group, for example (Davies et al., 2001). The contextual information needed here is best obtained by qualitative means and the relatively small number of cases envisaged would allow a semi-structured interview to be used. This technique attempts to combine the advantages of objectivity, in that the interview structure is carefully designed beforehand, and adaptability, in that the interviewer can follow up and probe points of interest. For example, an interviewee may be asked a standard question about the features of the noise which are most disturbing. Their response might include a feature that the research team had not previously identified. On-the-spot clarification of this (e.g., why is it disturbing?) would be valuable and could help steer the design of the main laboratory tests.

4.9 Measurement position

4.9.1 The psychoacoustic tests described above envisage a straightforward situation where the noise is recorded inside a complainant's dwelling. The sounds played to participants in the laboratory would be designed to simulate this, and thus the rating method would predict subjective reaction to indoor levels. However, there are many applications where it is difficult to record or measure noise inside a dwelling. A correction term should therefore be available to the final rating scheme if measurements have to made outside a house. This correction term could be derived from a survey of airborne transmission data in the field. It is likely that the correction could be based on existing transmission data in the literature.

5 Conclusion

5.1 Noise from pubs and clubs has been identified as a significant problem for some time by several groups of observers. Reports of annoyance appear in several media, though peer-reviewed reports of studies are surprisingly rare. Nevertheless, there is considerable anecdotal evidence from acoustic consultants and local authorities to show that the effects of entertainment noise are widespread. Measured levels within pubs and clubs are certainly high enough for problems to be expected. Many bars playing music had noise levels of 90 – 95 dB L_{Aeq} during busy periods, with levels of up to 115 dB L_{eq}

in the 63 Hz octave band and 110 dB L_{eq} in the 125 Hz octave band recorded on the dance floors of night clubs.

5.2 Reports from practitioners also indicate that there is considerable variation around the UK in assessment method and criteria. A typical criterion in use in the UK would specify a limit on L_{Aeq} and another L_{eq} limit on one or two specific low-frequency octave bands. Some local authorities use absolute criteria, often expressed as L_{Aeq}, while others use relative criteria, and set limits for the noise L_{Aeq} exceeding the background level. Another absolute criterion popular with consultants is a Noise Rating curve, to which L_{eq}, L_{10} or L_{max} values might be compared.

5.3 Outside the UK, most countries rely on criteria based on L_{Aeq}, though it is noted that many of the L_{Aeq} limits inside noise-sensitive premises are very low. Germany, Sweden, Denmark, the Netherlands and Poland have criteria for assessing low-frequency environmental noise which might be usefully applied to amplified music noise from pubs and clubs.

5.4 There is a clear need for the UK to adopt a single rigorous method for assessing noise from pubs and clubs. The validation process should centre on laboratory psychoacoustic tests because the many variables involved in perception can be adequately controlled. The laboratory work should be supported by field investigations. The field measurements will act as a source of noise recordings and also provide listener context via semi-structured interviews.

5.5 The laboratory subjective tests should examine the effect of several factors on listener perception: overall noise level, background noise level, subject differences, music type, bass boost, bass beat and context (day/night/audibility).

5.6 This exploration of the factors governing perception of the noise is crucial to developing confidence that any new rating method is indeed optimal. The laboratory sounds should be rated by at least the shortlist of existing assessment methods listed in Table 7. The results should then be compared to the subjective results and the best rating schemes modified to optimise the match. This scheme will allow the development of validated assessment criteria and measurement methods for assessing the noise from pubs and clubs for use by Environmental Health Officers (EHOs) and others.

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Appendix C – Description of Acoustic Terms

Term	Description
Noise sensitive receptors	People, property or designated sites for nature conservation that may be at risk from exposure to noise and vibration that could potentially arise as a result of the proposed development/project
Noise and Vibration study area	The area assessed for noise and vibration impacts during this assessment
Baseline scenario	Scenarios with the proposed development/project not in operation
Decibel (dB)	A unit of noise level derived from the logarithm of the ratio between the value of a quantity and a reference value. It is used to describe the level of many different quantities. For sound pressure level the reference quantity is 20 µPa, the threshold of normal hearing is 0dB, and 140dB is the threshold of pain. A change of 1dB is only perceptible under controlled conditions. Under normal conditions a change in noise level of 3dB(A) is the smallest perceptible change.
dB(A)	Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) which differentiates between sounds of different frequency (pitch) in a similar way to the human ear. Measurements in dB(A) broadly agree with people's assessment of loudness. A change of 3 dB(A) is the minimum perceptible under normal conditions, and a change of 10 dB(A) corresponds roughly to halving or doubling the loudness of a sound. The background noise level in a living room may be about 30 dB(A); normal conversation about 60 dB(A) at 1 metre; heavy road traffic about 80 dB(A) at 10 metres; the level near a pneumatic drill about 100 dB(A).
LAeq,T	The equivalent continuous sound level – the sound level of a notionally steady sound having the same energy as a fluctuating sound over a specified measurement period (T). LAeq,T is used to describe many types of noise and can be measured directly with an integrating sound level meter.
LA10,T	The A weighted noise level exceeded for 10% of the specified measurement period (T). LA10 is the index generally adopted to assess traffic noise
LA90, T	The A weighted noise level exceeded for 90% of the specified measurement period (T). In BS 4142: 2014 it is used to define the 'background' noise level.
LAmax	The maximum A-weighted sound pressure level recorded during a measurement.

Term	Description
Rw	Single-number quantity which characterizes the airborne sound insulating properties of a material or building element over a range of frequencies.
Sound Reduction Index (SRI)	Laboratory measure of the sound insulating properties of a material or building element in a stated frequency band.

Appendix D – Technical Data and Calculations

Table 15: Noise Model Details

Table No. / Position	Source to NSR1 Distance	No. of People	Source	Sound Level (Lp/Lw)								dB(A)
				63	125	250	500	1k	2k	4k	8k	
1	8	2	Man Laugh	47.1	50.7	55.6	65.5	55.3	58.2	46.5	39.7	64.8
	8	2	Woman Laugh	51.4	48.7	56.4	60.3	50.7	51.3	39.8	35.2	59.4
	8	2	Man Talk	46.8	46.3	53.1	55.0	44.6	42.0	34.9	30.7	53.7
	8	2	Woman Talk	47.1	49.4	52.7	50.8	43.4	39.6	41.0	40.5	51.6
2	10	2	Man Laugh	47.1	50.7	55.6	65.5	55.3	58.2	46.5	39.7	64.8
	10	2	Woman Laugh	51.4	48.7	56.4	60.3	50.7	51.3	39.8	35.2	59.4
	10	2	Man Talk	46.8	46.3	53.1	55.0	44.6	42.0	34.9	30.7	53.7
	10	2	Woman Talk	47.1	49.4	52.7	50.8	43.4	39.6	41.0	40.5	51.6
3	13	2	Man Laugh	47.1	50.7	55.6	65.5	55.3	58.2	46.5	39.7	64.8
	13	2	Woman Laugh	51.4	48.7	56.4	60.3	50.7	51.3	39.8	35.2	59.4
	13	2	Man Talk	46.8	46.3	53.1	55.0	44.6	42.0	34.9	30.7	53.7
	13	1	Woman Talk	47.1	49.4	52.7	50.8	43.4	39.6	41.0	40.5	51.6
4	8.4	1	Man Laugh	47.1	50.7	55.6	65.5	55.3	58.2	46.5	39.7	64.8
	8.4	1	Woman Laugh	51.4	48.7	56.4	60.3	50.7	51.3	39.8	35.2	59.4

Table 16: Noise Impact Calculations for Terrace

Element	Sound Level (Lp/Lw)								dB(A)
	63	125	250	500	1k	2k	4k	8k	
Level at NSR1 (No Fence)	42	42	47	55	45	48	36	30	55
Attenuation Achieved by Roof and Fence Screening	-8.1	-10	-12	-15	-17.7	-20.6	-23.5	-24	-
Resulting Level at NSR1	34	32	35	40	27.3	27.4	12.5	6	41.6