

Star City Multi Use Entertainment Facility

Project Application Acoustic Assessment



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Prepared for

Tabcorp c/o APP Corporation

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1.0 Introduction

This Acoustic Assessment details the design and constructions necessary for the proposed Multi Use Entertainment Facility (MUEF) at Star City to comply with relevant noise and vibration emission and intrusion requirements.

This acoustic assessment forms part of the Section 75W modification application to the original Part 3A approval for the following modifications:

- Expansion of the existing ballroom from 1200 seated and 1500 standing patrons to 3000 and 4000 respectively;
- A new pre-function space on level 3;
- Provision of associated services including loading dock and lift and stair access;
- Additional patron amenity facilities;
- Conversion of the existing Level 17 “Astral” bar and dining room to private gaming areas;
- Service corridor connecting back of house areas to plant and storage areas;
- Addition of a pergola structure over the roof terrace of the Pirrama Road infill building; and
- Replacement of the existing external lift, lift overrun enclosure and roof signage to the existing hotel tower.

The location of the MUEF in relation to the rest of the Casino is shown in [Figure 1](#) below and [Figure 2](#) shows the Casino as it currently exists.

Figure 1 MUEF Site Location

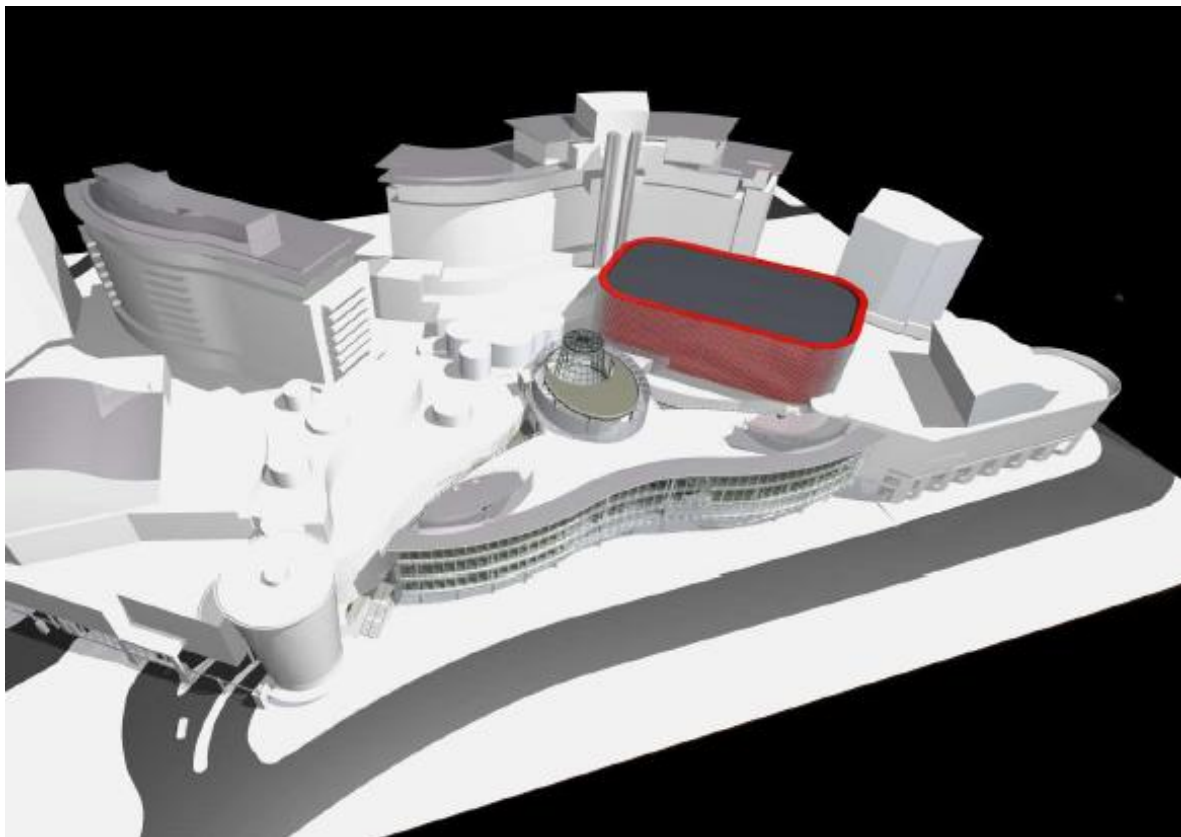
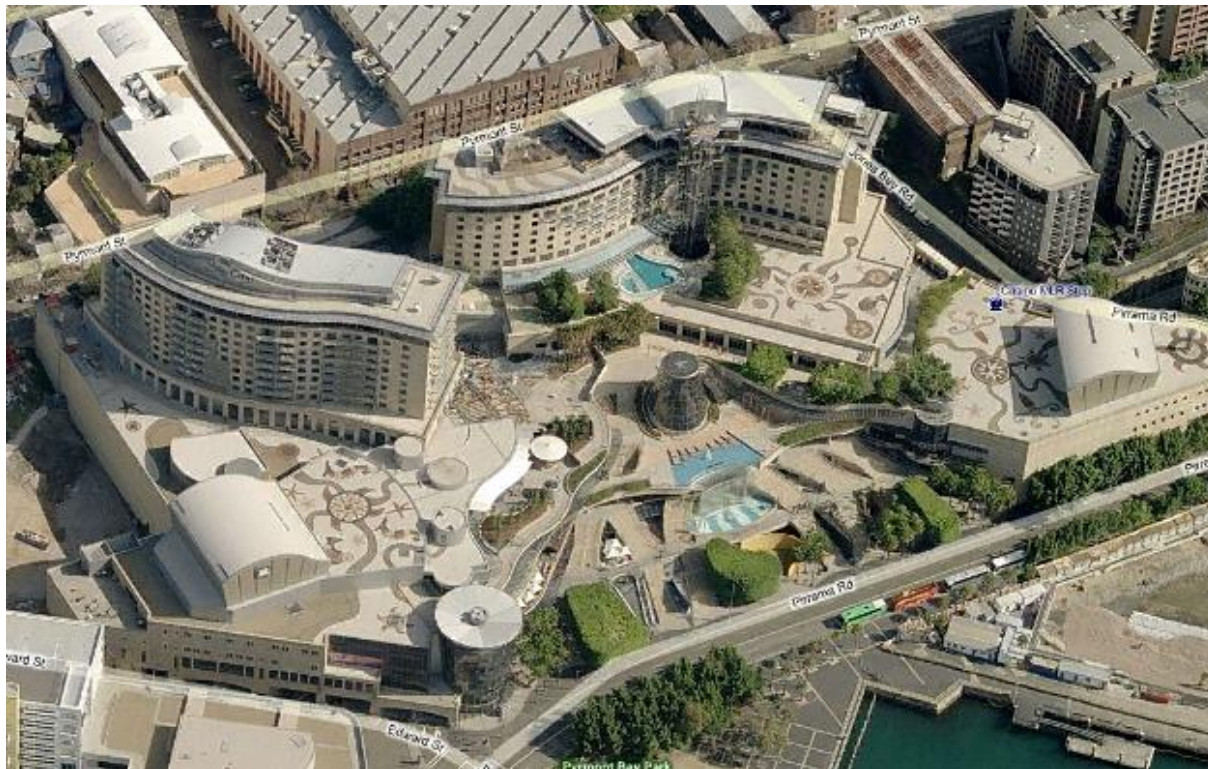


Figure 2 Casino Site Location



The purpose of this acoustic study is to investigate:

- The potential for noise and vibration emission from the proposed MUEF ;
- The potential for noise and vibration intrusion into the proposed MUEF; and
- Recommend indicative acoustic treatments to treat noise and vibration emission from and intrusion to the proposed MUEF.

Aspects of acoustical significance addressed in this report are:

- Acoustical design criteria;
- Noise and vibration emission including:
 - Airborne noise control – separation of the MUEF from other areas of the Star City development such as the Lyric Theatre, Main Gaming Floor, hotel and residential areas;
 - Airborne noise control – environmental noise emission (i.e. from live music and concerts) to nearby noise sensitive receivers;
 - Structure-borne noise and vibration control – separation of the MUEF from other vibration sensitive areas of the Star City development such as the Lyric Theatre;
 - Mechanical services noise control – noise emission from mechanical services associated with the proposed MUEF; and
 - Patron noise emission – from patrons using outdoor areas associated with the Multi Use Entertainment Facility.
- Internal noise levels within the MUEF including:
 - Structure-borne noise and vibration control – transmission of vibration from the light rail; and
 - Airborne noise intrusion from external sources through the facade;
- Construction noise and vibration assessment including:
 - Prediction of airborne and structure borne noise emission to nearby sensitive receivers;

- Prediction of vibration levels to nearby sensitive receivers; and
- Recommendation to manage adverse construction noise and vibration impacts;

The recommendations presented provide in principle treatments which, when appropriately developed during the detailed design stage of the project, will achieve compliance with the acoustic requirements of the documents listed in Section 1.1. Where treatments have not yet been developed, mandatory acoustic performance criteria have been provided.

The constructions and treatments set out within this document must be incorporated into the Project Star Multi Use Entertainment Facility development. Alternatively, the design and construction team should obtain detailed advice from an appropriately qualified acoustical consultant on acoustically-equivalent alternatives that meet or exceed the performance requirements set out in this report.

1.1 Reference documentation

The reference documentation used in the compilation of this report and establishment of acoustic criteria for the Multi Use Entertainment Facility is as follows:

Table 1 Reference Documentation

Document	Shorthand Name	Relevance
Fitzpatrick + Partners Drawings DOP 01-18	Architectural drawings	Design layout
Design Presentation August 2010 Fitzpatrick +Partners Sceno Plus	Design presentation	Design description
Director General's Environmental Assessment Requirements	DGR's	General acoustical requirements
City of Sydney Standard Conditions of Consent	Standard Conditions	Numerical noise emission requirements – Use and Mechanical Plant
Australian/New Zealand Standard AS/NZS 2107:2000: Acoustics – Recommended internal design sound levels and reverberation times for building interiors	AS/NZS 2107	Internal design noise level and reverberation time requirements
Australia/New Zealand Standard AS/NZS 1668.1:1998: The use of ventilation and air conditioning in buildings - Fire and smoke control in multi-compartment buildings	AS/NZS 1668:1	Internal noise levels due to the operation of fire mode emergency equipment
EPA Environmental Noise Control Manual Chapter 151	ENCM	Control of noise emission due to the operation of emergency generators
Department of Environment, Climate Change and Water Interim Construction Noise Guideline	DECCW ICNG	Construction noise acoustical requirements
Department of Environment, Climate Change and Water 'Assessing Vibration: a technical guideline', (DECCW, 2006)		Construction vibration requirements
Department of Environment, Climate Change and Water's Environmental Criteria for Road Traffic Noise	ECRTN	Additional traffic generated by the proposed facility
Office of Liquor Gaming and Racing <i>Liquor Administration Board Noise Condition</i>	OGLR	Patron noise emission

2.0 Construction Noise and Vibration Criteria

2.1 Summary of acoustic performance requirements

This section will establish the criteria used to address the following acoustical issues:

- Construction noise and vibration management levels; and
- Additional traffic generated by the construction activities on nearby roads.

A full presentation and explanation of acoustic performance requirements is set out in Appendix A. This section presents a summary only.

2.2 Construction noise management levels

In July 2009 the NSW Department of Environment, Climate Change and Water (DECCW) published the *Interim Construction Noise Guidelines (ICNG)* for use in construction noise assessments. This document replaces the previous guidelines contained in the *Environmental Noise Control Manual (ENCM)* and is used as the basis for establishing construction noise criteria for the proposed development.

Under the existing DECCW policy a construction noise management plan is required to be compiled by the Contractor, prior to construction commencing. Noise level objectives must be set for the daytime and evening periods, and must be complied with where reasonably practicable. Work that is proposed outside of standard working hours, as defined in the *ICNG*, generally requires strong justification.

The noise management plan should detail the 'best practice' construction methods to be used, presenting a reasonable and feasible approach. The plan should identify the extent of the residential area affected and assess the impact on residents. The plan should detail any community relation programs that are planned e.g. prior notification for particularly noisy activities, letter box drop regarding out of hours construction work to be undertaken and a 24 hour contact phone number for residents to call should they have any complaints or questions.

The *ICNG* defines what is considered to be feasible and reasonable as follows:

Feasible

A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.

Reasonable

Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure."

The *ICNG* recommends that a quantitative assessment is carried out for all 'major construction projects that are typically subject to the EIA process'. A quantitative assessment, based on a likely 'worst case' construction scenario, has been carried out for the Multi Use Entertainment Facility.

Predicted noise levels at nearby sensitive receivers (residential, commercial and industrial premises) are compared to the levels provided in Section 4 of the *ICNG*. Where an exceedance of the noise management levels (NML) is predicted the *ICNG* advises that the proponent should apply all feasible and reasonable work practises to minimise the noise impact.

2.3 Construction noise management levels

2.3.1 Proposed construction hours

It is understood that construction activities will generally be undertake during DECCW's recommended standard construction hours:

DECCW's recommended standard hours:

- Monday to Friday 7 am to 6 pm
- Saturday 8 am to 1 pm
- No work on Sundays or public holidays

A summary of construction noise management levels (NMLs) are presented below in Table 2.

Table 2 Construction noise emission management levels

Location		Measured RBL, dB(A)	Noise Management Level, $L_{Aeq,15min}$, dB(A)
Residential receivers to the north	Monday – Friday 7:00 am to 6:00 pm	49	59
	Saturday 8:00 am to 1:00 pm		
	Saturday 1:00 pm to 6:00 pm	49	54
	Sunday 8:00 am to 6:00 pm	48	53
	Monday – Sunday 6:00 pm to 10:00 pm		
Residential receivers to the west	Monday – Friday 10:00 pm to 7:00 am	44	49
	Saturday – Sunday 10:00 pm to 8:00 am	55	65
	Monday – Friday 7:00 am to 6:00 pm		
	Saturday 8:00 am to 1:00 pm	55	60
	Sunday 8:00 am to 6:00 pm		
Residential receivers to the east	Monday – Sunday 6:00 pm to 10:00 pm	53	58
	Monday – Friday 10:00 pm to 7:00 am	49	54
	Saturday – Sunday 10:00 pm to 8:00 am	56	66
	Monday – Friday 7:00 am to 6:00 pm		
	Saturday 8:00 am to 1:00 pm	56	61
Residential receivers to the south	Saturday 1:00 pm to 6:00 pm		
	Sunday 8:00 am to 6:00 pm	55	60
	Monday – Sunday 6:00 pm to 10:00 pm	55	60
	Monday – Friday 10:00 pm to 7:00 am	53	57
	Saturday – Sunday 10:00 pm to 8:00 am	56	66
Classrooms at schools and other educational institutions – Internal when in use	Monday – Friday 7:00 am to 6:00 pm		
	Saturday 8:00 am to 1:00 pm	56	61
	Saturday 1:00 pm to 6:00 pm		
	Sunday 8:00 am to 6:00 pm	55	60
	Monday – Sunday 6:00 pm to 10:00 pm	55	60
Hospital wards and operating theatres – Internal when in use		N/A	45
Places of worship – Internal when in use		N/A	45
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion) – When in use		N/A	65
Passive recreation areas (characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation) – When in use		N/A	60
Community centres – When in use		N/A	Refer AS/NZS 2107:2000
Industrial premises – When in use		N/A	75
Commercial and Retail premises – When in use		N/A	70

Notes:

- 1) Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

2.4 Construction vibration criteria

Unlike the criteria applicable to noise emissions, vibration criteria are the same for both the construction and operational phases of this project. DECCW's '*Assessing Vibration: a technical guideline*', (DECCW, 2006) has been designed to be used in evaluating and assessing the effects on amenity of vibration emissions from industry, transportation and machinery. The guideline is used in the assessments of vibration impacts caused by the construction and operation of new developments.

Vibration criteria are set primarily according to whether the particular activities of interest are continuous in nature or intermittent, whether they occur during the daytime or night-time and the type of receiver to be assessed e.g. residential, commercial or other sensitive receivers.

The effects of vibration in buildings can be divided into three main categories:

- Those in which the occupants or users of the building are inconvenienced or possibly disturbed, i.e. human disturbance or discomfort;
- Those in which the integrity of the building or the structure itself may be prejudiced; and
- Those where the building contents may be affected.

Therefore, vibration levels at sensitive receiver locations must be controlled so as to prevent discomfort and regenerated noise, and in some extreme cases, structural damage.

3.0 Operational Noise and Vibration Criteria

3.1 Summary of acoustic performance requirements

This section will establish criteria in order to address the following acoustical issues:

- Internal mechanical services noise levels;
- Vibration intrusion criteria with respect to human comfort and regenerated noise;
- Road traffic noise intrusion;
- External environmental noise emission levels for mechanical service;
- Office of Liquor, Gaming and Racing criteria; and
- Additional traffic generated by the proposed development.

A full presentation and explanation of acoustic performance requirements is set out in Appendix A. This section presents a summary only.

3.2 Internal noise levels and reverberation times

The internal noise level in the Multi Use Entertainment Facility will be generated by the air conditioning and mechanical ventilation plant servicing the Venue and traffic noise intrusion. To a lesser extent, internal levels could also be influenced by regenerated noise from light rail traffic.

Internal noise levels due to mechanical services noise must comply with Australian Standard AS/NZS 2107:2000 "Acoustics – Recommended design sound levels and reverberation times for building interiors".

Table 1 of AS/NZS 2107:2000 recommends satisfactory and maximum internal noise levels for building interiors based on room designation and location of the development with respect to external noise sources. Internal noise levels due to air conditioning and mechanical ventilation plant should not exceed the maximum levels recommended in this Standard. The levels for areas relevant to this development are given below in [Table 3](#). The midpoint of the internal noise level range should be adopted as the internal design noise criterion for mechanical plant noise.

The internal noise levels and reverberation times presented in [Table 3](#) below represent the design goals for areas relevant to the proposed MUEF.

Table 3 AS 2107:2000 Internal noise criteria for different areas of occupancy in buildings

Type of Occupancy/Activity	Recommended Design Sound Level, L _{Aeq} , dB(A)		Mid Frequency Reverberation Time (s)
	Satisfactory	Maximum	
Auditoriums – Cabarets and theatre restaurants	35	40	Note 1
Auditoriums – Concert and recital halls	Note 2	Note 2	Note 2
Conference and convention centres – Without sound reinforcement up to 50 persons	35	40	Note 3
Conference and convention centres – Without speech reinforcement from 50 to 250 persons	30	35	Note 3
Conference and convention centres – With speech reinforcement	35	45	Note 3
Cafeterias and food courts	45	55	Note 4
Coffee bars	45	50	<1.0
Restaurants	45	50	<1.0

Notes:

- 1) AS/NZS 2107:2000 recommends that the reverberation time in these spaces follows Curve 3 presented in Appendix A of the Standard. The recommended reverberation time is dependent on the room volume.

- 2) Specialist advice should be sought for these spaces. This should occur during the detailed design phase of the project when the internal design has progressed.
- 3) AS/NZS 2107:2000 recommends that the reverberation time in these spaces follows Curve 1 presented in Appendix A of the Standard. The recommended reverberation time is dependent on the room volume.
- 4) AS/NZS 2107:200 recommends that reverberation time should be minimised as far as practicable for noise control.

3.2.1 Emergency equipment internal noise levels

In order to facilitate the safe egress of building occupants under an emergency evacuation situation, internal noise levels due to the operation of smoke exhaust fans and stair pressurisation fans shall not exceed the following noise levels:

- Occupied Spaces: **65 dB(A)**
- Fire Isolated Passages: **80 dB(A)**

3.3 Environmental noise emission

The proposed development has the potential to contribute to the existing external noise environment. Noise will be generated by patrons, activities within the Multi Use Entertainment Facility and mechanical services associated with the Multi Use Entertainment Facility. In order to ensure nearby sensitive receivers are not adversely affected by noise emission, as described above, environmental noise criteria are established and must be applied at the most affected residential boundary.

3.3.1 Normal operational mechanical noise emission

The mechanical noise emission contribution due to the operation of 'normal mode' mechanical plant at the Star City Multi Use Entertainment Facility shall be controlled to comply with the octave band noise levels presented in Table 4, Table 7, Table 5 and Table 6 at the nearest sensitive receivers.

Table 4 Receivers to the south

Measurement	Sound Pressure Level, L_{eq} , dB									L_{Aeq} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
Daytime	67	65	62	58	55	55	53	48	41	60
Night-time	62	61	58	55	52	52	50	45	38	57

Table 5 Receivers to the west (Pyrmont Street)

Measurement	Sound Pressure Level, L_{eq} , dB									L_{Aeq} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
Daytime	66	64	66	56	53	53	49	41	37	58
Night-time	62	60	62	52	49	49	45	37	33	54

Table 6 Receivers to the east (Lyric Theatre Terrace)

Measurement	Sound Pressure Level, L_{eq} , dB									L_{Aeq} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
Daytime	70	68	66	60	56	56	51	50	24	60
Night-time	67	65	63	57	53	53	48	47	31	57

Table 7 Receivers to the north (Jones Bay Road)

Measurement	Sound Pressure Level, L_{eq} , dB									L_{Aeq} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
Daytime	63	61	59	53	49	49	44	43	17	53
Night-time	61	57	55	49	45	45	40	39	23	49

3.3.2 Entertainment noise emission (including patron noise)

Environmental noise emission due to the combination of noise emission from the MUEF and the outdoor area at Project Star shall be controlled to comply with the following octave band noise levels at the nearest sensitive receivers. These noise level criteria satisfy the requirements of the Office of Liquor, Gaming and Racing (OLGR).

The OLGR criterion states that the L_{10} noise level emitted by licensed premises is not to exceed the background noise level by more than 5 dB between 7 am and 12 midnight in any octave band (between 31.5 Hz and 8000 Hz). Between 12 midnight and 7 am, the L_{10} level of noise from the licensed premises shall not exceed the background in any octave band (between 31.5 and 8000 Hz).

Table 8 Receivers to the south

Criterion	Sound Pressure Level, dB									L _{A10} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
7:00 am to 12 midnight	67	65	62	58	55	55	53	48	41	60
12 midnight to 7:00 am	57	56	53	50	47	47	45	40	33	52

Table 9 Receivers to the west (Pyrmont Street)

Criterion	Sound Pressure Level, dB									L _{A10} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
7:00 am to 12 midnight	66	64	66	56	53	53	49	41	37	58
12 midnight to 7:00 am	57	55	57	47	44	44	40	32	28	49

Table 10 Receivers to the east (Lyric Theatre terrace)

Criterion	Sound Pressure Level, dB									L _{A10} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
7:00 am to 12 midnight	70	68	66	60	56	56	51	50	34	60
12 midnight to 7:00 am	62	60	58	52	48	48	43	42	26	52

Table 11 Receivers to the north (Jones Bay Road)

Criterion	Sound Pressure Level, dB									L _{A10} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
7:00 am to 12 midnight	63	61	59	53	49	49	44	43	17	53
12 midnight to 7:00 am	56	52	50	44	40	40	35	34	18	44

Notwithstanding compliance with the values tabulated above, the noise from the use must not be audible within and habitable room in any residential property between the hours of 12:00 midnight and 7:00 am.

3.3.3 Emergency equipment noise emission

The mechanical noise *contribution* due to the operation of emergency equipment at Star City Multi Use Entertainment Facility shall be controlled to comply with the following noise levels at nearby residential receivers:

- From 7 am to 10 pm, the L_{A10} sound pressure level should not exceed: **55 dB(A)**
- From 10 pm to 7 am, the L_{A10} sound pressure level should not exceed: **45 dB(A)**

3.4 Vibration criteria

Project specific vibration and regenerated noise criteria at nearby affected receivers (inclusive the Multi Use Entertainment Facility Star City complex) will drive vibration isolation requirements. The vibration and regenerated noise criteria are based on national and international guidelines.

It is expected that regenerated noise will be driving the design of the vibration mitigation options.

3.4.1 Tactile vibration criteria

In general it has been found that the human response to vibration is a complex phenomenon. There are wide variations in vibration tolerance in humans and accordingly acceptance goals for human comfort are hard to define and quantify. Acceptable values of human exposure to vibration are primarily dependent on the activity taking place in the occupied space (e.g. workshop, office, or residence) and the character of vibration (e.g. continuous or intermittent). In addition, specific values are dependent upon social and cultural factors, psychological attitudes, expected interference with privacy, and ultimately the individual's perceptibility.

The impact assessment of tactile vibration is based on BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting". BS 6472-1:2008 assesses the probability of adverse comment from vibration by means of Vibration Dose Values (VDVs). Project VDV goals are presented in Table 12 below.

Table 12 Tactile vibration criteria summary

Receiver space	Criterion	Comments
MUEF Star City complex	VDV over any 8 hour period not to exceed 0.2 m/s ^{1.75}	Applicable for light rail movement, footfalls inside the MUEF complex; Not applicable for rhythmic crowd movement;
Star City Gaming Floor	VDV over any 8 hour period not to exceed 0.2 m/s ^{1.75}	Assessed for all activities within the MUEF complex
Star City Hotel	VDV over any 8 hour period not to exceed 0.1 m/s ^{1.75}	Assessed for all activities within the MUEF complex
Lyric Theatre	VDV over any 8 hour period not to exceed 0.1 m/s ^{1.75}	Assessed for all activities within the MUEF complex

3.4.2 Regenerated noise criteria

Background noise level in most spaces is controlled by internal building services such as air conditioning, ventilation plant, electrical services, or lift pass-bys. These noise sources are typically continuous even though they may vary from time to time. In this report L_{Aeq} is used to describe continuous background noise levels. Because structure borne noise is often of an intermittent nature, in this report the corresponding noise levels are expressed in terms of L_{Amax} noise levels.

Criteria for regenerated noise cannot be stipulated separately from the specifications for background noise levels. The maximum allowable noise levels must sensibly relate to the recommended background noise levels.

The criteria for regenerated noise are given in terms of L_{Amax} levels for slow response (i.e. duration of 1 second). Maximum allowable sound pressure levels, L_{Amax} are not to exceed the background L_{Aeq} criterion + 5 dB in noise sensitive areas and background L_{Aeq} criterion + 10 dB in general areas. The adopted background noise level criteria are based on information provided in AS/NZS 2107–2000 "Acoustics – Recommended design sound levels and reverberation times for building interiors."

Regenerated noise project goals are presented in Table 13.

Table 13 Regenerated noise criteria summary

Receiver space	Criterion	Comments
MUEF Star City complex	35 dB(A) L_{Amax} (based on L_{Aeq} 30 dBA)	Applicable for light rail movement
Star City Gaming Floor	55 dB(A) L_{Amax} (based on L_{Aeq} 45 dBA)	Assessed for all activities within the MUEF complex
Star City Hotel	35 dBA L_{Amax} (based on L_{Aeq} 30 dBA)	Assessed for all activities within the MUEF complex
Lyric Theatre	35 dBA L_{Amax} (based on L_{Aeq} 30 dBA)	Assessed for all activities within the MUEF complex

Notes:

- 1) Star City Gaming Floor is classified as a retail area.
- 2) A detailed one-third octave analysis is required for sensitive spaces such as the Lyric Theatre and the MUEF Star City complex. Calculated octave band results will be compared against maximum recommended octave band sound pressure levels as outlined in AS/NZS 2107–2000.

3.5 Road traffic noise criteria

DECCW's Environmental Criteria for Road Traffic Noise (ECRTN) has been used to assess the noise arising from traffic generated by the proposed development. The ECRTN guidelines are applicable for traffic movements generated during the construction phase of the project as well as additional traffic generated during the operational phase.

Table 14 presents the road traffic noise criteria from the DECCW for land use developments with a potential to create additional traffic on existing freeways/ arterial roads. The external noise criteria are applied 1 m from the external facade of the affected building.

Table 14 Road traffic noise criteria

Road Classification	Period	Parameter	Criterion, dB(A)
Collector Road	Day 7:00 am to 10:00 pm	$L_{Aeq,1hr}$	60
	Night 10:00 pm to 7:00 am	$L_{Aeq,1hr}$	55
Local Road	Day 7:00 am to 10:00 pm	$L_{Aeq,1hr}$	55
	Night 10:00 pm to 7:00 am	$L_{Aeq,1hr}$	50

Note that where the criteria have already been exceeded the DECCW recommends that:

"Where feasible and reasonable, existing noise levels should be mitigated to meet the noise criteria. Examples of applicable strategies include appropriate location of private access roads; regulating times of use; using clustering; using quiet vehicles; and using barriers and acoustic treatments.

In all cases traffic arising from the development should not lead to an increase in existing noise levels of more than 2 dB."

4.0 Operational Acoustic Assessment

4.1 Multi Use Entertainment Facility

The MUEF will host a range of noisy activities including amplified music when the space is used as a function facility, and both amplified and live music from performers who will occasionally play in the new MUEF.

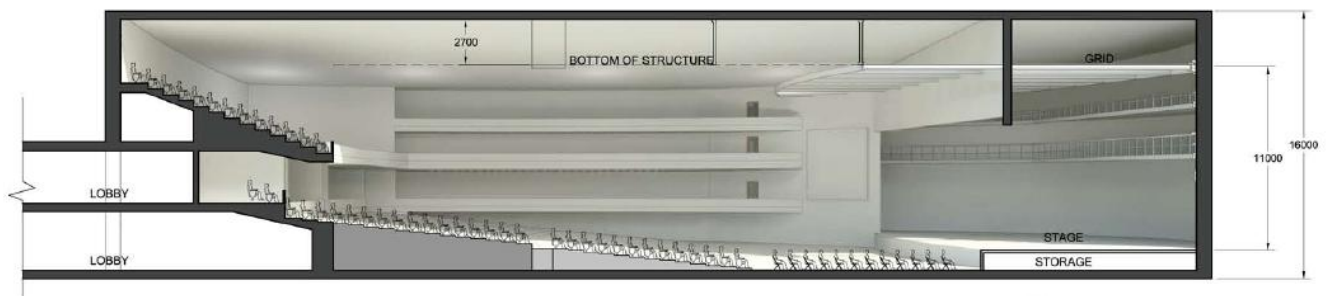
We have nominated an expected average maximum internal noise levels of 110 dB(A) for the assessment of noise emission from the MUEF. The octave band levels associated with this expected maximum internal noise level is given in Table 13 below.

Table 15 Average maximum internal noise levels (L_{A10})

Noise	Sound Pressure Level, dB							Overall dB(A)
	Octave Band Centre Frequency, Hz							
	63	125	250	500	1K	2K	4K	
Amplified music in MUEF	84	87	91	100	108	101	97	110

A cross-section through the MUEF is shown Figure 3 below.

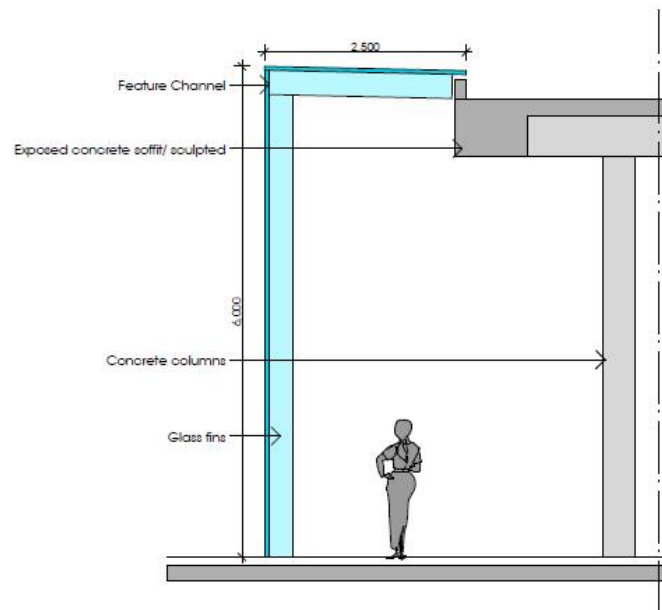
Figure 3 MUEF Cross-section



4.2 Pre-Function Area

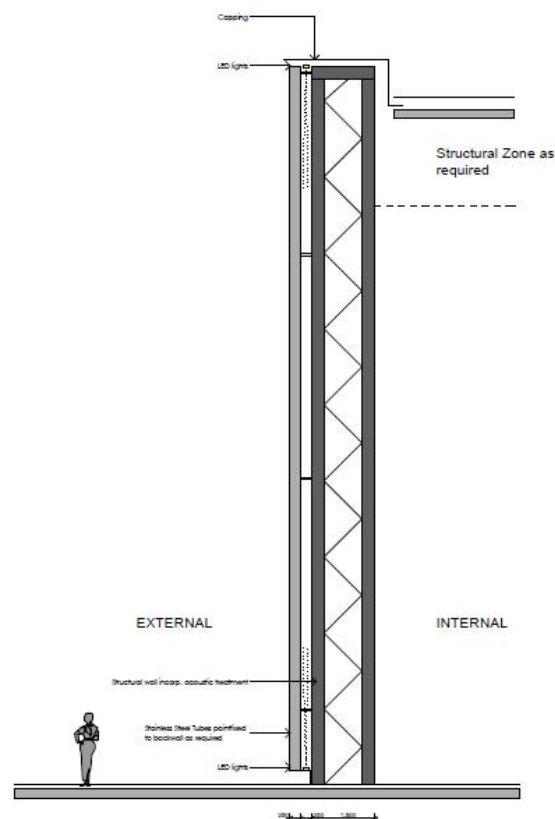
The assessment of the pre-function areas is based upon maximum internal noise levels of approximately 90 dB(A). It has been assumed that these areas will also have noise levels that are dominated by music and the spectrum of the overall noise level will be similar to that given in Table 13 above. The height of the pre-function area is approximately 6m. A cross-section through the MUEF is shown Figure 4 below.

Figure 4 Pre-function area cross-section



4.3 Operational Noise Control Recommendations

The MUEF is located approximately 38m from the nearest residential neighbours to the north-east and approximately 8m from the residential component of the hotel. The MUEF is approximately 16m high and the wall has an overall thickness of approximately 1500mm, including the internal structure.



To comply with the noise emission criteria given in Section 3.3.2, the wall to the MUEF must have a transmission loss of approximately R_w 70 with adequate attenuation in each relevant octave band.

An indicative cavity construction wall that will achieve the required noise emission criteria consists of 2x75mm Hebel Power Panel separated from resiliently mounted 2x25mm plasterboard shaft liner by a 1000mm cavity containing 100mm thick partition insulation. This can be accommodated within the proposed wall structure.

The roof / ceiling construction to the MUEF will need to provide a transmission loss of approximately R_w 65 to achieve noise emission criteria.

An indicative cavity ceiling construction that will achieve the required noise emission criteria consists of 2x25mm plasterboard shaft liner separated from resiliently mounted 2x25mm plasterboard shaft liner by a 150mm cavity containing 100mm thick partition insulation. This can be accommodated within the proposed roof structure.

Adequate noise control from the pre-function area can be achieved using a minimum of 10.38mm laminated glazing for the facade construction.

To mitigate noise transfer to the gaming floor below and potentially being transmitted structurally to other noise sensitive spaces such as the Lyric Theatre, a vibration isolated floor should be provide to the MUEF. The detailed design of this floor construction will need to be developed as part of the detailed design for the development.

The acoustic requirements for the design of the MUEF facade and roof structure will need to be verified during the detailed design stage of the development.

The recommended wall and roof / ceiling constructions are summarised in Table 16 below.

Table 16 Summary of wall and roof / ceiling construction acoustic requirements ~~indicative constructions~~

Component	Required R_w	Indicative construction
Wall	R_w 70	- Two layers of 75 mm Hebel Power Panel - Steel wall frame including resilient connections for wall panels and 1000mm airgap between wall panels 100 mm 24 kg/m³ glasswool insulation - Two layers of 25 mm shaft liner plasterboard
Ceiling / roof	R_w 65	- Two layers of 25 mm shaft liner plasterboard - Steel roof frame including resilient connections for shaft liner panels and minimum 150mm airgap between the panels 100 mm 24 kg/m³ glasswool insulation - Two layers of 25 mm shaft liner plasterboard

4.4 Operational Traffic Noise

The current traffic flows and expected increase in traffic flows have been provided by Arup Pty Ltd in their reports "Project Star – Transport – Transport Impact of Star City Redevelopment revision A" dated September 2008 and "Project Star – Transport for Multi-use Entertainment Facility – Addendum to Transport Report Draft" dated August 2010. AECOM has analysed this data and it has been concluded that if the proposed development were to go ahead, traffic on surrounding roads would increase as detailed in Table 17.

Table 17 summary of traffic flow increase for peak periods

Location		Existing	Nett Increase	% Increase	Increase in Noise Levels, dB(A)
AM					
No increase in traffic flows					
PM					
Pymont Street	North of Union Street	564	7	1	0
	South of Union Street	694	7	1	0
	North of Pymont Bridge Road	767	7	1	0
	South of Pymont Bridge Road	503	0	0	0
Edward Street	North of Union Street	385	0	0	0
	South of Union Street	226	36	16	1
Murray Street	North of Union Street	1044	72	7	0
	South of Union Street	684	9	1	0
Union Street	West of Pymont Street	8	0	0	0
	East of Pymont Street	278	14	5	0
	West of Edward Street	268	14	5	0
	East of Edward Street	121	2	2	0
	West of Pymont Bridge Road	112	2	2	0
	East of Pymont Bridge Road	1168	30	3	0
	West of Murray Street	1320	30	2	0
Darling Drive	East of Murray Street	1354	33	2	0
Pymont Bridge Road	West of Pymont Street	1686	5	0	0
	East of Pymont Street	1312	2	0	0
	West of Union Street	1120	32	3	0
LATE¹					
Pymont Street	North of Union Street	591	25	4	0
	South of Union Street	492	22	4	0
	North of Pymont Bridge Road	716	22	3	0
	South of Pymont Bridge Road	380	0	0	0
Edward Street	North of Union Street	323	177	55	2
	South of Union Street	141	122	87	3
Murray Street	North of Union Street	1158	251	22	1
	South of Union Street	582	33	6	0
Union Street	West of Pymont Street	10	2	20	1

Location		Existing	Nett Increase	% Increase	Increase in Noise Levels, dB(A)
	East of Pymont Street	193	49	25	1
	West of Edward Street	203	49	24	1
	East of Edward Street	93	6	6	0
	West of Pymont Bridge Road	91	6	7	0
	East of Pymont Bridge Road	868	96	11	0
	West of Murray Street	1089	96	9	0
Darling Drive	East of Murray Street	1043	122	12	0
Pymont Bridge Road	West of Pymont Street	1329	19	1	0
	East of Pymont Street	925	3	0	0
	West of Union Street	811	90	11	0

Notes:

- 1) As defined by the ARUP traffic reports

The traffic noise increase on Edward Street south of Union street due to the development of the MUEF is 3 dB(A) during the "late" night peak flow. This would exceed the traffic noise criteria by 1 dB(A). However, it is noted that this would occur only during the peak late night traffic flow. Traffic noise emission would comply with traffic noise criteria at other times.

The increased traffic flows do not result in an increase in traffic noise by more than 2 dB(A) on any other roads and therefore complies with the relevant traffic noise criteria established in Section 3.5.

5.0 Operational Vibration Assessment

Vibration can represent a problem over a large range of different magnitude scales. On the high end of the scale, seismic vibration and vibration associated with some construction/excavation activities can cause structural damage to a building. Humans can detect vibration at much lower levels and their response to vibration can range from annoyance to discomfort for low level vibration to activity interference to impairment in health for high level vibration and extended exposure durations. Vibration below the threshold of human perception can cause the floors, walls and ceilings of a building to vibrate and to re-radiate noise. This noise is commonly referred to as structure- or ground-borne noise or regenerated noise. Ground-borne noise is low frequency and if audible is perceived as a 'rumble'.

5.1 Vibration issues

The critical vibration issues identified with the Star City Multi Use Entertainment Facility can broadly be grouped into three groups:

1. Vibration generated within the complex can propagate to nearby noise and vibration sensitive receivers and can adversely impact on these receivers (such as the Star City hotel);
2. Excessive vibration can be generated in large structures when crowds synchronise their movements with music. Rhythmic crowd movements can excite one of the low-frequency modes which in turn can cause resonant behaviour. In addition to line item 1, this may also cause adverse response within the crowd; and
3. Vibration generated outside the complex (such as light rail pass-bys) can cause regenerated noise inside the complex and can interfere with some of the planned uses of the complex such as concerts or conferences.

5.2 Mitigation measures

Post-construction fixes which address regenerated noise and vibration issues are known to be very costly and often only a limited number of options can be retrofitted. Accordingly, mitigation solutions need to be implemented in the early design phase.

Mitigation options typically rely on breaking up the vibration transmission path between source and receivers. In practice this is very often achieved by joining structural systems with resilient elements such as rubber pads or springs. For the Star City Multi Use Entertainment Facility project this could result in the use of vibration isolation bearings under supporting structural elements.

Excessive vibratory response of the Star City Multi Use Entertainment Facility building in response to dynamic crowd excitation will require careful investigation. Mitigation options typically involve tuning of the dynamic response of structural elements so their natural frequencies are well separated from footfall vibration spectra. We recommend that the floor of the MUEF be structurally separated from the overall building structure. A resilient jack-up system is recommended.

6.0 Construction Noise and Vibration Assessment

A construction noise assessment management plan will need to be compiled by the building contractor after the construction methodology for the development is more fully understood.

Traffic generated by construction vehicles and indicative equipment will need to be identified and a construction noise and management plan prepared to ensure that the criteria identified in this report are satisfied.

A preliminary assessment of the impacts caused by construction activity is given below and is based upon reasonable assumptions of the operations that will be carried out.

6.1 Plant and equipment noise level assessment

Table 18 presents the typical sound power levels of the construction equipment that is likely to be used. These sound pressure levels are typical values from projects similar to this project and assume equipment is modern and in good working order.

Table 18 Description of construction equipment and associated L_{Aeq} sound power levels, dB(A)

Plant & equipment	$L_{Aeq}(15min)$ Sound Power Level (dBA)
Bobcat	104
Crane	104
Dumper	95
Excavator	99
Franner Crane	93
Hand Tools	94
Hi-Ab	92
Hydraulic Crane	101
Jackhammer	108
Piling Rig	108
Portable Generator	92
Semi-trailer	108
Services Truck	98
Concrete Mixer	103
Idling Truck	84

AECOM's experience in similar projects indicates that $L_{A1(1 min)}$ noise levels are typically 10 dB(A) higher than L_{Aeq} noise levels.

6.1.1 Modifying factors

A noise source may exhibit a range of particular characteristics that increase annoyance, such as tones, impulses, low frequency noise and intermittent noise. Where this is the case, an adjustment is applied to the source noise level received at the assessment point to account for the additional annoyance caused by the particular characteristics.

6.1.2 Noise Modelling Scenarios

A description of each of the scenarios that have been modelled is provided in Table 19 below.

Table 19 Noise Modelling Scenarios

Description of Works	Description	Hours of Operation	Plant
General construction activity	Installing Plant and Building Site Offices	Daytime	1 x Crane 3 x Hand tools 1 x Portable generator 1 x Concrete mixer 1 x Idling truck

6.1.3 Modelling

Noise levels due to the construction activities shown in Table 19 have been predicted at potentially affected residences located approximately 40m from the construction activities, assuming no shielding. It can be expected that there may be differences between predicted and measured noise levels due to variations in instantaneous operating conditions, plant in operation during the measurement and also the location of the plant equipment.

6.1.4 Predicted construction noise levels and recommendations

Predicted construction noise levels

Calculated construction $L_{Aeq(15 \text{ min})}$ levels at the noise sensitive receivers are presented in Table 20.

Table 20 Construction Predicted Maximum Noise Levels

Noise Sensitive Area	$L_{Aeq(15 \text{ min})}$ (dBA)		
	Predicted Noise Level	Day NML	Exceedance
General construction activity			
Jones Bay Road	67	56	11

Note1: These works are scheduled to occur during the daytime period only

The results in Table 20 indicate that noise levels are predicted to exceed the noise management levels at a number of locations for most construction scenarios. Predicted noise levels exceed the daytime noise management levels by 11 dB(A).

The noise levels presented in Table 20 indicate that mitigation measures should be considered during construction. A solid hoarding that breaks the line of site of the construction activity and the nearest residences will provide at least 5 dB of noise attenuation. If the construction activities are significantly shielded by a solid hoarding of say 3m in height, a typical level of noise reduction that could be expected is about 10 dB, depending upon the individual locations of the noise sources and the receivers. This level of reduction is likely to generally limit the noise of construction to around the criterion at the nearest residences.

Recommended Additional Noise Mitigation

All reasonable and feasible mitigation measures should be utilised to minimise the noise impact on nearby sensitive receivers. A Construction Noise and Vibration Management Plan (CNVMP) should be produced to define how these impacts will be managed. Project mitigation measures may include:

- Hoardings should be provided where practicable,
- Noise intensive construction works should be carried out during normal construction hours wherever practicable.
- Appropriate plant should be selected for each task, minimising the noise impact,
- Deliveries should be carried out during normal construction hours,
- Non-tonal reversing alarms should be fitted on all construction equipment where possible,
- Trucks should travel via major roads and routes where possible and not be allowed to queue near residential dwellings.

It is also recommended that letterbox drops for all residents within the vicinity of the project be considered.

Where potential $L_{A1(1 \text{ min})}$ exceedances are identified, all possible reasonable and feasible measures will be investigated to minimise the risk of adverse impacts on these receivers, including the recommendations presented in the DECCW's ICNG.

6.2 Plant and equipment vibration level assessment

Vibration from the construction activities have the potential to disturb people located in the Star Casino site. There is very little chance that vibration from construction will disturb people in nearby residences.

In particular, activities such as any demotion works, concrete pours with the associated use of vibrators and percussive fixing tools (including hammer action drills) will need to be carefully managed.

The CNVMP will provide recommendations that minimise the risk of disturbance due to construction activities.

7.0 Conclusion and Summary of Recommendations

This report provides a summary of the noise criteria relevant to the proposed MUEF to be constructed at Star City Casino.

The operational noise levels from the MUEF can be controlled to the established criteria by constructing the facade of the centre to provide a weighted sound transmission loss of approximately R_w 70 and the roof / ceiling to approximately R_w 65. Indicative constructions that will meet these acoustic performances have been provided in this report.

Careful attention to the Construction Noise and Vibration Management Plan (CNVMP) will need to be made during the building process to ensure that impact to the nearest residences and the Casino itself are minimised. Traffic from the delivery of construction material also has the potential to disturb the nearby residences. This noise impacts will be addressed in the CNVP.

Appendix A

Acoustic Design Requirements

Appendix A Acoustic Design Requirements

This section specifies the acoustic requirements of the building to control the intrusion of environmental noise; control the transmission of noise between the various spaces within the building structure and control the emission of environmental noise.

The requirements applicable to the development have been established and derived from:

- Part 3A Instrument of Approval conditions
- Director General's Environmental Assessment Requirements, 30 June 2008;
- City of Sydney Standard Conditions of Consent 18 September 2006;
- Australian/New Zealand Standard AS/NZS 2107: 2000 '*Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors*';
- Australian/New Zealand Standard AS/NZS 1668.1: 1998 *The use of ventilation and air conditioning in buildings - Fire and smoke control in multi-compartment buildings*
- EPA Environmental Noise Control Manual Chapter 151 *Noise Control Guideline, Generators - Emergency*

The following Sections detail the criteria contained within the aforementioned documents. Many of the criteria presented overlap, in that for some spaces, constructions or noise sources, there is more than one relevant criterion.

Following the presentation of acoustical requirements in Appendix A; and the presentation of a detailed noise survey in Appendix B, the derivation of numerical noise criteria are summarised in Appendix C.

Review and coordination of the information provided in Appendix A, B and C has been used to determine the specified constructions and treatments in this Specification.

If alternative constructions and treatments are adopted during the Detailed Design and Construction phases, they must be acoustically equivalent to those proposed in this document and as such will require rigorous assessment by a suitably qualified acoustical engineer. The information provided in Appendix A, B and C will permit such an assessment.

Part 3A Approval Conditions for Major Project No. 08-0098

The Part 3A approval conditions made under Section 75J of the Environmental Planning & Assessment Act, dated 27th January, 2009 and modified on 1 December, 2009 are very similar to the City of Sydney Council Standard Conditions of Consent, states the following:

Part E – Prior to Occupation or Commencement of Use

E1 Noise Control – Plant and Machinery

Noise associated with the operation of any plant, machinery or other equipment on the site, shall not give rise to any one or more of the following:

- 1) *Transmission of "offensive noise" as defined in the Protection of the Environment Operations Act 1997 to any place of different occupancy.*
- 2) *A sound pressure level at any affected residential property that exceeds the background (LA90, 15minute) noise level by more than 5 dB(A). The background noise level must be measured in the absence of noise emitted from the premises. The source noise level must be assessed as a LAeq, 15 minute.*
- 3) *Notwithstanding compliance with (1) and (2) above, the noise from mechanical plant associated with the premises must not be audible in any habitable room in any residential property between the hours of 12:00 midnight and 7:00am.*

Prior to issue of any Occupation Certificate a report is to be prepared and submitted by a qualified acoustic engineer confirming that the development has been constructed in accordance with the recommendations in the Acoustic Assessment Report prepared by ARUP, September 2008 and addendum provided by Acoustic Logic Consultancy, 14 August, 2009.

Part F – Post Occupancy & Ongoing Operational Conditions

F4 Mechanical Plant and Equipment

Noise associated with mechanical plant and equipment associated with the approved works must not give rise to any one or more of the following:

- 1) Transmission of “offensive noise” as defined in the Protection of the Environment Operations Act 1997 to any affected receiver.
- 2) A sound pressure level at any affected receiver that exceeds the background (LA90, 15 minute) noise level by more than 5 dB(A). The background noise level must be measured in the absence of noise emitted from the use in accordance with Australian Standard AS 1055.

Note: The method of measurement of vibration being carried out in accordance with “Assessing Vibration: Technical Guidelines” - DEC (EPA). AS1055 for sound level measurements.

F5 Noise

Noise caused by the approved use including music and other activities must comply with the following criteria:

- 1) The use must not result in the transmission of “offensive noise” as defined in the Protection of the Environment Operations Act 1997 to any place of different occupancy.
- 2) The L_{10} noise level emitted from the use must not exceed 5 dB above the background (L_{90}) noise level in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) between the hours of 7.00am and 12.00 midnight when assessed at the boundary of the nearest affected property. The background noise level must be measured in the absence of noise emitted from the use.
- 3) The L_{10} noise level emitted from the use must not exceed the background (L_{90}) noise level in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) between the hours of 12.00 midnight and 7.00am when assessed at the boundary of the nearest affected property. The background noise level must be measured in the absence of noise emitted from the use.
- 4) Notwithstanding compliance with (a) and (b) above, the noise from the use must not be audible within any habitable room in any residential property between the hours of 12.00 midnight and 7.00am.
- 5) The L_{10} noise level emitted from the use must not exceed the background noise level (L_{90}) in any Octave Band Centre Frequency (31.5 Hz to 8kHz inclusive) by more than 3 dB when assessed indoors at any affected commercial premises.

Schedule 3 – Proponent’s Statement of Commitments

Star City made the following commitments in relation to the proposed development:

Preparation of a Noise and Vibration Management Plan – Construction

This plan will be prepared by an accredited acoustic consultant and will involve a process of consultation with affected stakeholders. It will detail administrative or engineering measures proposed to assist in reducing construction noise and vibration impacts in accordance with AS 2346 and BS 5228.

The following control measures will be considered:

- Providing acoustic screens and/or enclosures for stationary equipment, such as compressors; or constructing a solid hoarding (of at least 15 kg/m² surface density construction) on the site boundary to act as a noise barrier.
- Providing mobile acoustic screens at noise sensitive receivers, where possible.
- Selecting low noise plant and equipment. Noise levels of plant used on site should not exceed those given in “Schedule 1” of the City of Sydney Code of Practice for Construction Hours/Noise within the Central Business District.

- *Regular maintenance of plant and equipment.*
- *Keeping engine covers and access hatches to equipment closed, e.g. compressors, etc.*
- *Use of alternative construction methods to minimise noise and vibration.*
- *Development of a construction works methodology to minimise the effect of direct line of sight (for noise) to affected receivers.*
- *Position access ways for major plant and trucks at the lowest grade practicable.*
- *Scheduling noisy construction activities during times when noise impact on residents of sensitive receivers is likely to be lowest.*
- *Introducing respite periods during the day or at weekends where no noisy construction work can take place. These periods are to be determined through consultation and negotiation with affected stakeholders.*

Regular community communication to advise residents of impending noisy activities.

Vibration levels will be measured at sensitive internal and external receivers at the beginning of each stage of construction /demolition, and work practices modified accordingly to minimise the vibration impact from the works. Consultation with affected receivers should be followed, and if necessary vibration monitoring could be conducted to assist in controlling the vibration and / or structureborne impact of the works.

Control of vibration and structure borne noise from construction and demolition activities will include the following measures:

- *Conduct a site dilapidation survey to determine the vibration sensitivity of the nearest receivers, particularly heritage buildings on Union and Pyrmont Street.*
- *Use of trenches to block the propagation path of surface vibration.*
- *To mitigate the effects of structure borne noise and vibration, any sections of the existing structure to be demolished should be separated from the remainder of the complex by cutting slots in slabs etc, subject to the confirmation of the temporary stability of the structure to be demolished.*
- *Vibration levels at the nearest receivers should be measured by a qualified acoustic consultant when works commence. Site specific vibration limits should be established based on vibration measurements and the findings of the site dilapidation surveys.*
- *Smaller or hand-driven equipment, such as jackhammer, should be used where possible when working in vibration sensitive areas (such as the Lyric Theatre or heritage buildings).*

The principals of 'Best Management Practice' (BMP) and 'Best Available Technology Economically Achievable' (BATEA) will be applied at all times.

Implementation: No construction works will be commenced until a Noise and Vibration Management Plan for the relevant stage of works has been submitted to the satisfaction of the Department of Planning.

Preparation of a Noise and Vibration Management Plan - Operation

This Plan will be prepared by an accredited acoustic consultant and will involve a process of consultation with affected stakeholders. It will detail administrative and engineering measures proposed to assist in reducing operational noise impacts upon surrounding properties. The following control measures will be considered:

Noise control treatments will be incorporated into the design of the mechanical systems so that the industrial noise control criteria are met at all noise sensitive receivers. Detailed design of these systems, noise control measures, such as acoustic enclosures or louvers and attenuation will be incorporated where necessary to ensure that the industrial noise criteria for noise from these systems are met.

- *Engineering and administrative noise control measures to reduce the noise generation on the new hotel porte-cochere including:*
 - *Encouraging drivers and hotel staff to minimise noise by not slamming doors or boots*
 - *Incorporating a road surface in the porte-cochere with sufficient roughness to provide additional slip resistance (which reduces the incidence of wheel squeal noise)*

- *Measures to mitigate noise from entertainment venues operating after midnight including:*
 - *Incorporating acoustic separation to restaurants*
 - *Restaurants opening onto the arcade, not directly onto Jones Bay Road*
 - *Operable windows or doors of the night venue and conference centre being kept closed when amplified music is played in these venues.*

Given the presence of the noise-sensitive receivers in the Star City locality, all venues will be managed so that noise emission from the venue is controlled. Management measures that may be considered to control entertainment venue noise levels include:

- *Restricting the hours of operation of venues*
- *Keeping operable doors or windows closed when noisy activities are underway within the venue (especially night venue and conference centre, and particularly after midnight); this might include closing or restricting access to outdoor areas of the venues.*
- *Designing venues to control noise emission, including construction of external partitions, internal acoustic treatments, and physical separation between noisy areas and sensitive receivers.*

Implementation: *Plan to be submitted to the Department of Planning for approval prior to occupation of the proposed building.*

Director General's Environmental Assessment Requirements

The DGR's provided by the NSW Government Department of Planning, dated 30 September 2010 set out non-objective acoustical requirements for the project as follows:

4. Noise Impacts

Noise impact assessment is required to be undertaken. It should be demonstrate that the proposed modifications will be designed, constructed, operated and maintained so that there is no unacceptable level of noise impacts on amenity in the locality and should include:

- *The identification of noise receivers potentially affected by the proposal;*
- *The selection of a suitable assessment criteria from an appropriate Australian Standard, DECCW Guideline or similar document recognised by the acoustic consultants' profession;*
- *Assessment of the existing acoustic environment at the receiver locations in accordance with AS1055-1997 'Acoustic – Description and measurement of environmental noise' and current DECCW Guidelines;*
- *The identification of future and/or existing operations from the proposed use giving rise to the emission of noise and prediction of resultant noise at the identified receiver location. The method of noise prediction shall be justified and include an evaluation of prevailing atmospheric or other conditions that may promote noise propagation; and*
- *A statement that the proposed use is capable of complying with the design criteria together with details of any necessary acoustic control measures that will be incorporated into the development or use.*

City of Sydney Council Standard Conditions of Consent – Noise

Sydney City Council provides relevant noise criteria in their Standard Conditions of Development Consent, revised 23 November 2009, as follows:

(57) Noise – Licensed premises

- a) *The LA10 noise level emitted from the use must not exceed the background noise level (LA90) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) by more than 5dB between the hours of 7.00am and 12.00 midnight when assessed at the boundary of any affected residence.*

- b) *The LA10 noise level emitted from the use must not exceed the background noise level (LA90) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) between the hours of 12.00 midnight and 7.00am when assessed at the boundary of any affected residence.*
- c) *Notwithstanding compliance with (a) and (b) above, the noise from the use must not be audible within any habitable room in any residential property between the hours of 12.00 midnight and 7.00am.*
- d) *The L10 noise level emitted from the use must not exceed the background noise level (L90) in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) by more than 3dB when assessed indoors at any affected commercial premises.*
- e) *The use of the premise must be controlled so that any emitted noise is at a level so as not to create an "offensive noise" as defined in the Protection of the Environment Operations Act 1997 to any affected receiver.*

(58) Noise - General

- a) *The $L_{Aeq\ 15minutes}$ noise level emitted from the use must not exceed 5dB above the background (L_{A90}) noise level in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) between the hours of 7.00am and 12.00 midnight when assessed at the boundary of any affected receiver. The background noise level must be measured in the absence of noise emitted from the use in accordance with Australian Standard AS 1055.*
- b) *The $L_{Aeq\ 15minutes}$ noise level emitted from the use must not exceed the background (L_{A90}) noise level in any Octave Band Centre Frequency (31.5 Hz to 8 kHz inclusive) between the hours of 12.00 midnight and 7.00 am when assessed at the boundary of any affected receiver. The background noise level must be measured in the absence of noise emitted from the use in accordance with Australian Standard AS 1055.*
- c) *The use of the premise must be controlled so that any emitted noise is at a level so as not to create and "offensive noise" as defined in the Protection of the Environment Operations Act 1997 to any affected receiver.*

(62) Noise – Mechanical plant and equipment

Noise associated with the use of mechanical plant and equipment must not give rise to any one or more of the following:

- a) *Transmission of "offensive noise" as defined in the Protection of the Environment Operations Act 1997 to any affected receiver.*
- b) *A sound pressure level at the boundary of any affected receiver that exceeds the background ($L_{A90,15minutes}$) noise level by more than 5dB. The background noise level must be measured in the absence of noise emitted from the use in accordance with Australian Standard AS1055.*

Note: The method of measurement of vibration being carried out in accordance with "assessing Vibration; Technical Guidelines" – DEC (EPA) AS1055 for sound level measurements.

Office of Liquor Gaming and Racing

The Office of Liquor Gaming and Racing (OGLR) provide relevant noise criteria for the operation of licensed premises as follows:

The L_{A10} noise level emitted from the licensed premises shall not exceed the background noise level in any Octave Band Centre Frequency (31.5 Hz – 8kHz inclusive) by more than 5 dB between 7:00 am and 12:00 midnight at the boundary of any affected residence.

The L_{A10} noise level emitted from the licensed premises shall not exceed the background noise level in any Octave Band Centre Frequency (31.5 Hz – 8 kHz inclusive) between 12:00 midnight and 7:00 am at the boundary of any affected residence.

Notwithstanding compliance with the above, the noise from the licensed premises shall not be audible within any habitable room in any residential premises between the hours of 12:00 midnight and 7:00 am.

Australian/New Zealand Standard AS/NZS 2107:2000

Combined internal noise levels due to external noise intrusion and internal mechanical services such as air conditioning and mechanical ventilation plant should not exceed the maximum levels recommended in Australian/New Zealand Standard AS/NZS 2107:2000 'Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors'.

The Standard recommends a range of internal noise levels for building interiors, the lower and upper bounds of which are 'satisfactory' and 'maximum' respectively. The recommended noise levels are based on room designation and location of the development relative to external noise sources.

The Standard is applicable only to 'steady-state' or 'quasi-steady-state' sounds such as mechanical plant and road traffic noise and the recommended design sound levels are for a fully fitted-out and completed building ready for occupation.

Table 21 gives the relevant internal noise levels recommended in AS/NZS 2107:2000.

Table 21 AS 2107:2000 Internal noise criteria for different areas of occupancy in buildings

Type of Occupancy/Activity	Recommended Design Sound Level, L _{Aeq} , dB(A)		Mid Frequency Reverberation Time (s)
	Satisfactory	Maximum	
Auditoriums – Cabarets and theatre restaurants	35	40	Note 1
Auditoriums – Concert and recital halls	Note 2	Note 2	Note 2
Conference and convention centres – Without sound reinforcement up to 50 persons	35	40	Note 3
Conference and convention centres – Without speech reinforcement from 50 to 250 persons	30	35	Note 3
Conference and convention centres – With speech reinforcement	35	45	Note 3
Cafeterias and food courts	45	55	Note 4
Coffee bars	45	50	<1.0
Restaurants	45	50	<1.0

Notes:

- 4) AS/NZS 2107:2000 recommends that the reverberation time in these spaces follows Curve 3 presented in Appendix A of the Standard. The recommended reverberation time is dependent on the room volume.
- 5) Specialist advice should be sought for these spaces. This should occur during the detailed design phase of the project when the internal design has progressed.
- 6) AS/NZS 2107:2000 recommends that the reverberation time in these spaces follows Curve 1 presented in Appendix A of the Standard. The recommended reverberation time is dependent on the room volume.
- 7) AS/NZS 2107:200 recommends that reverberation time should be minimised as far as practicable for noise control.

Appendix B

Environmental Noise Survey

Appendix B Environmental Noise Survey

Environmental Noise Measurements

In order to quantify the existing noise environment at (and near to) the Star City Multi Use Entertainment Facility development site, a noise survey by way of unattended and attended noise measurements was undertaken during September 2008. The methodology and processed results of this noise survey are presented in the following sections. In brief, the noise survey results are used to:

- Determine energy-average noise levels at the proposed facade locations to establish facade glazing requirements to control external noise intrusion to internal spaces;
- Determine existing background noise levels at nearby most-potentially affected noise receivers due to the operation of Project Star, to later design noise emission from patron activity and mechanical plant to compliant levels.

Unattended Noise Logging

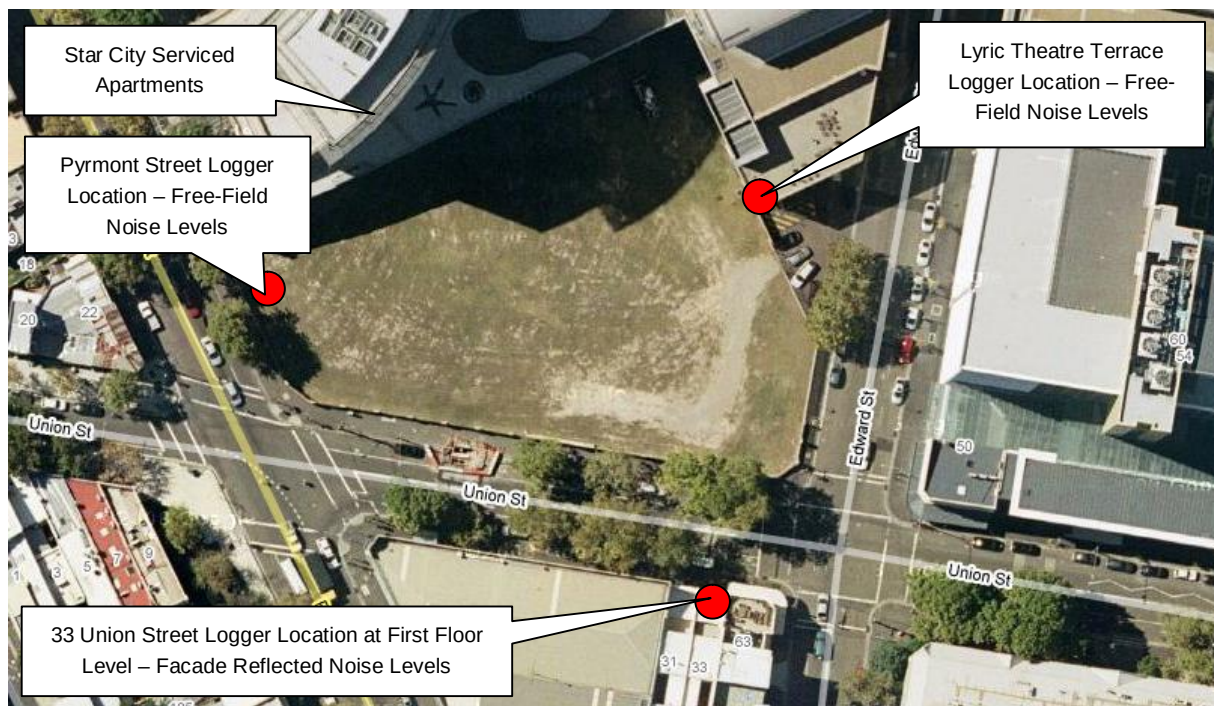
Unattended noise logging has been conducted at three (3) locations at the Project Star site to measure broadband noise levels. The locations, equipment and dates are summarised in Table 22:

Table 22 Unattended noise logging summary – location, equipment and dates

Logger Location	Equipment	Serial Number	Logging Commenced	Logging Completed
33 Union Street	SVAN 949	8197	02/09/08	09/09/08
Pymont Street	RION NL 21	00765700		
Lyric Theatre Terrace	RION NL 21	00865769		

The three unattended noise logging locations are shown in Figure 5:

Figure 5 Unattended noise logging locations



33 Union Street

Unattended noise logging was carried out at first floor balcony (overlooking Union Street) of this mixed-use residential/commercial receiver as this location is considered representative of the road traffic noise-exposed Union Street facade of the Project Star podium. The background noise levels at this location are used to derive mechanical and patron noise emission criteria for the Star City Multi Use Entertainment Facility.

33 Union Street – Rating Background Noise Levels

In order to set noise criteria for noise emission from mechanical plant serving Project Star in accordance with City of Sydney requirements, the data obtained from the 33 Union Street logger has been processed to determine a typical daytime (7:00 am until 12:00 Midnight) and Night-time (12:00 Midnight until 7:00 am) background noise level, rounded to the nearest 1 dB(A).

The means of doing this involves:

- For each daytime and night-time period of each 24 hour period, determine the lowest 10th percentile value of all the 15-minute L_{A90} background noise levels measured by the noise logger.
- Take the median value of the above values for daytime and for night-time – this is the background noise level which is used for assessment purposes at, and near to that location.

The calculated values for the 33 Union Street logging location are presented in Table 23.

Table 23 Daytime and night-time noise levels – 33 Union Street

Date	L _{A90} Background Noise Levels, dB(A)	
	Day (7:00 am to 12:00 Midnight)	Night (12:00 Midnight to 7:00 am)
Tuesday 2 September, 2008	54	52
Wednesday 3 September, 2008	55	52
Thursday 4 September, 2008	55	52
Friday 5 September, 2008	Rain affected data	
Saturday 6 September, 2008		
Sunday 7 September, 2008	54	53
Monday 8 September, 2008	55	52
Tuesday 9 September, 2008	56	-
Median Background	55	52

Pymont Street

Unattended noise logging was carried out at the Pymont Street frontage of the vacant Project Star site. This location is considered representative of receivers within the Project Star development facing west. Furthermore, this location is considered representative of the nearest potentially affected noise sensitive receiver to the west at the serviced apartments in the existing Star City development. The background noise levels at this location are used to derive mechanical and patron noise emission criteria for the Star City Multi Use Entertainment Facility.

The noise levels measured at Pymont street are representative of those at residences to the north of the site. These levels correlate well with previous noise logging performed adjacent to the residences by Arup Acoustics.

Pymont Street – Rating Background Noise Levels

In order to set noise criteria for noise emission from mechanical plant serving Project Star in accordance with City of Sydney requirements, the data obtained from the Pymont Street logger has been processed to determine a typical daytime (7.00 am until 12 Midnight) and Night-time (12 Midnight until 7.00 am) background noise level, rounded to the nearest 1 dB(A).

The means of doing this involves:

- For each daytime and night-time period of each 24 hour period, determine the lowest 10th percentile value of all the 15-minute L₉₀ background noise levels measured by the noise logger.
- Take the median value of the above values for daytime and for night-time – this is the background noise level which is used for assessment purposes at, and near to that location.

The calculated values for the Pymont Street logging location are presented in Table 24.

Table 24 Daytime and night-time noise levels – Pymont Street

Date	L _{A90} Background Noise Levels, dB(A)	
	Day (7:00 am to 12:00 Midnight)	Night (12:00 Midnight to 7:00 am)
Tuesday 2 September, 2008	52	49
Wednesday 3 September, 2008	53	51
Thursday 4 September, 2008	55	50
Friday 5 September, 2008	Rain affected data	
Saturday 6 September, 2008		
Sunday 7 September, 2008	52	49
Monday 8 September, 2008	54	59
Tuesday 9 September, 2008	54	-
Median Background	53	49

Lyric Theatre Terrace

Unattended noise logging was carried out at elevated level (equivalent to Level 3 of Project Star) at the southern corner of the Lyric Theatre Terrace. This location is considered representative of nearby receivers to the east of the development site. The background noise levels at this location are used to derive mechanical and patron noise emission criteria for the Star City Multi Use Entertainment Facility.

Lyric Theatre – Rating Background Noise Levels

In order to set noise criteria for noise emission from mechanical plant serving Project Star in accordance with City of Sydney requirements, the data obtained from the Lyric Theatre Terrace logger has been processed to determine a typical daytime (7.00 am until 12 Midnight) and Night-time (12 Midnight until 7.00 am) background noise level, rounded to the nearest 1 dB(A).

The means of doing this involves:

- For each daytime and night-time period of each 24 hour period, determine the lowest 10th percentile value of all the 15-minute L_{A90} background noise levels measured by the noise logger.
- Take the median value of the above values for daytime and for night-time – this is the background noise level which is used for assessment purposes at, and near to that location.

The calculated values for the 33 Union Street logging location are presented in Table 25.

Table 25 Daytime and night-time noise levels – Lyric Theatre

Date	L _{A90} Background Noise Levels, dB(A)	
	Day (7:00 am to 12:00 Midnight)	Night (12:00 Midnight to 7:00 am)
Tuesday 2 September, 2008	54	52
Wednesday 3 September, 2008	55	52
Thursday 4 September, 2008	55	52
Friday 5 September, 2008	Rain affected data	
Saturday 6 September, 2008		
Sunday 7 September, 2008	54	52
Monday 8 September, 2008	55	52
Tuesday 9 September, 2008	55	-
Median Background	55	52

Supplementary Environmental Noise Measurements

In order to quantify the existing noise environment to the north of the site closer to the location of the Star City MUEF development site, an additional noise survey was undertaken during September 2010. The methodology and processed results of this noise survey are presented in the following sections. In brief, the noise survey results are used to:

- Determine existing background noise levels at nearby most-potentially affected noise receivers due to the operation of MUEF and mechanical plant to compliant levels;
- Compare the results with the previous monitoring to determine whether the ambient noise level has changed over the two year interval between the noise logging and to see whether the noise level to the north of the Star Casino site differs substantially to that at the south of the site.

Unattended Noise Logging

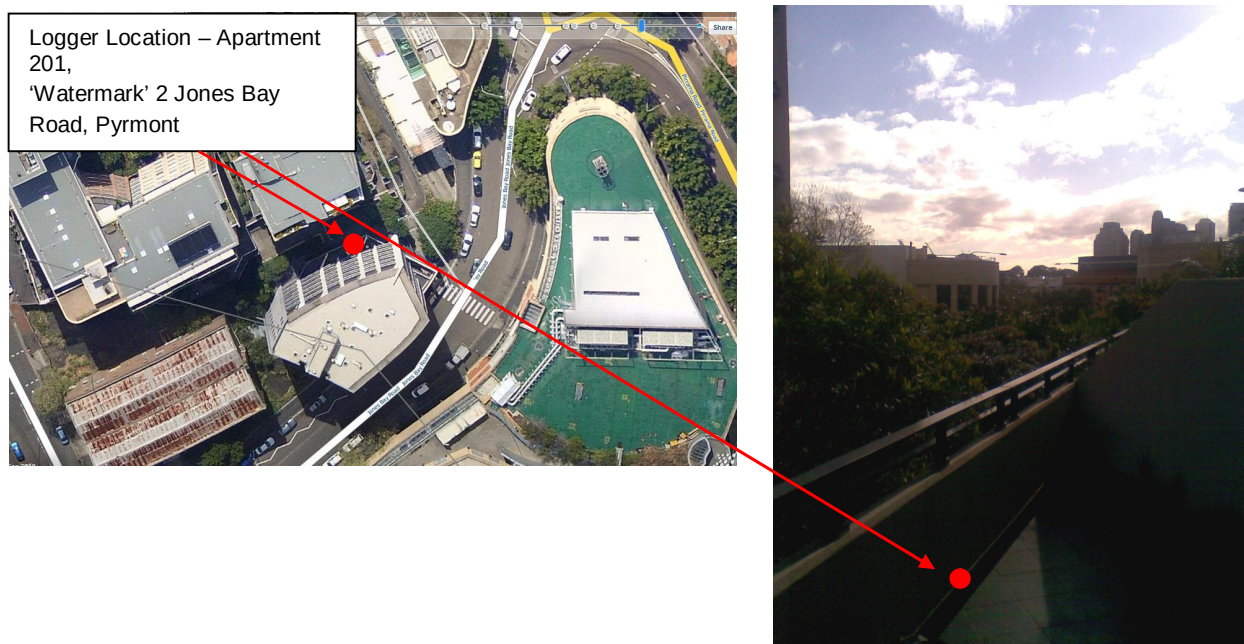
Unattended noise logging was conducted on the balcony of unit 201 of the Watermark Apartments. These apartments are the closest residences to the MUEF other than hotel room at the casino site itself. The noise levels were monitored on the northern face of the apartment block and are likely to be slightly lower than those facing the casino and the busier Jones Bay Road. The locations, equipment and dates are summarised in Table 26:

Table 26 Unattended noise logging summary – location, equipment and dates

Logger Location	Equipment	Serial Number	Logging Commenced	Logging Completed
Apartment 201 "Watermark" 2 Jones Bay Road, Pyrmont	SVAN 949	8135	02/09/08	09/09/08

The unattended noise logging locations is shown in Figure 5:

Figure 6 Unattended noise logging locations



In order to set noise criteria for noise emission from the activities within the MUEF and mechanical plant serving the development in accordance with City of Sydney requirements (which are the most stringent relevant criteria), the data obtained from the logger at the Watermark apartment has been processed to determine a typical daytime

(7.00 am until 12 Midnight) and Night-time (12 Midnight until 7.00 am) background noise level, rounded to the nearest 1 dB(A).

The means of doing this involves:

- For each daytime and night-time period of each 24 hour period, determine the lowest 10th percentile value of all the 15-minute L_{A90} background noise levels measured by the noise logger.
- Take the median value of the above values for daytime and for night-time – this is the background noise level which is used for assessment purposes at, and near to that location.

The calculated values for the logging location are presented in Table 25 below.

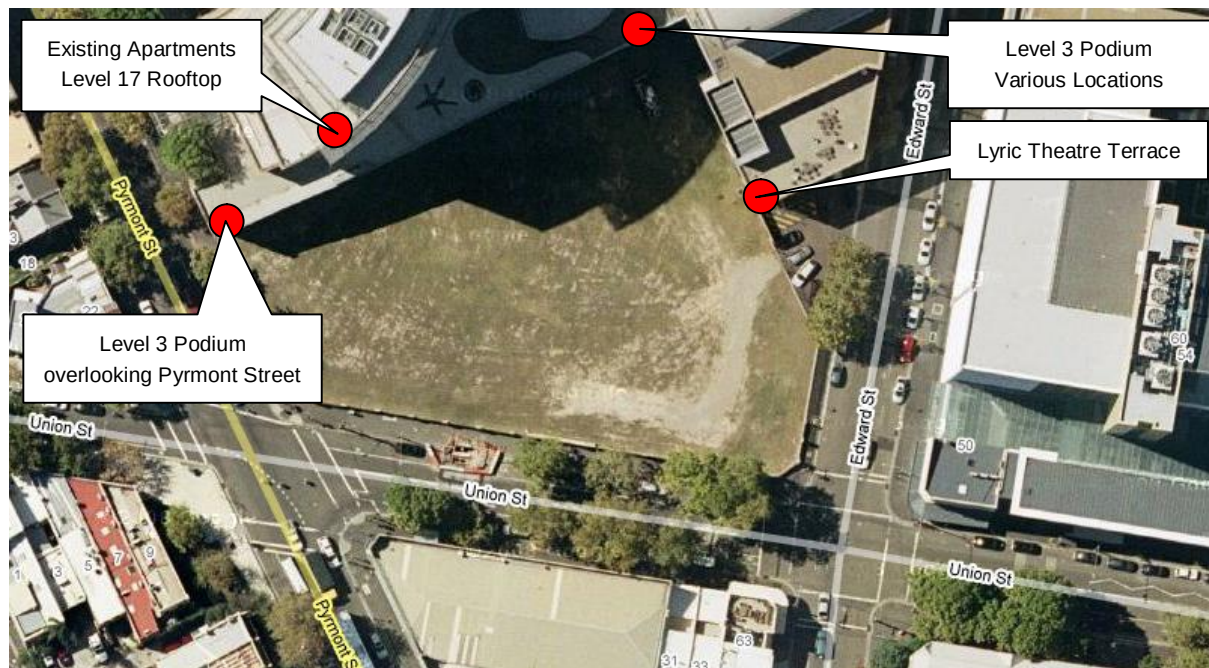
Table 27 Daytime and night-time noise levels – Watermark Apartment, Jones Bay Road

Date	L _{A90} Background Noise Levels, dB(A)	
	Day (7:00 am to 12:00 Midnight)	Night (12:00 Midnight to 7:00 am)
Friday 24 September, 2010	49	45
Saturday 25 September, 2010	49	45
Sunday 26 September, 2010	47	44
Monday 27 September, 2010	47	44
Tuesday 28 September, 2010	48	44
Median Background	48	44

Attended Noise Measurements

The data obtained by the unattended noise loggers has been supplemented by short-term attended noise measurements. Noise measurements were undertaken on the afternoon of 9 September 2008 between 1 pm and 4 pm at the locations shown in Figure 7.

Figure 7 Attended Noise Measurement Locations



The purpose of undertaking these measurements was to obtain octave-band spectral data of the noise environment at various locations, to assist with facade design and establishing compliance with criteria set out in terms of octave band requirements (in accordance with City of Sydney Standard Conditions).

Octave band results and overall A-weighted sound pressure levels during the measurement period are presented in Table 28.

Table 28 Attended noise measurements and existing plant noise audit

Measurement Location	Sound Pressure Level, dB									L _{Aeq} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
Level 3 Podium overlooking Pyrmont Street	71	69	71	61	58	58	54	46	42	63
Level 17 Rooftop	73	69	66	62	58	57	51	43	31	61
Level 3 Podium adjacent to Lyric Theatre	70	69	68	63	56	55	50	41	28	60
Lyric Theatre Terrace	69	67	65	59	55	55	50	49	33	59

Note that the A-weighted values presented above relate to overall broadband noise levels during the particular 15-minute measurement period on 9 September. In order to 'normalise' the above measurements for use in later calculations, the octave band spectra shall later be 'scaled' to:

- Representative L_{Aeq} 1 Hour road traffic noise levels to determine road traffic noise intrusion into various facades of the Multi Use Entertainment Facility, and to
- Long-term background noise levels to establish background noise spectra to determine environmental noise emission compliance, as required by City of Sydney Standard Conditions.

Union Street Octave Band Noise Levels

The equipment used to obtain the broadband noise data at 33 Union Street also measured octave band data continuously during the monitoring period.

The octave band data obtained by the 33 Union Street Logger has been processed to determine representative daytime and night-time L_{Aeq} energy average and L_{90} background noise spectra at receivers in Union Street. Calculated values are presented in Table 29.

Note that:

- The energy average values have been scaled to the calculated L_{Aeq} 1 hour daytime and night-time values free-field (incident) noise levels based on logger data from 33 Union Street.
- The L_{90} values have been scaled to the long-term background noise levels.

Table 29 Representative noise spectra at 33 Union Street

Measurement	Sound Pressure Level, dB									L _{Aeq} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
L _{eq, 1 hour} Daytime	71	69	66	62	60	59	57	52	45	64
L _{eq, 1 hour} Night-time	68	67	64	61	59	58	56	51	44	63
L ₉₀ Daytime	62	60	57	53	50	50	48	43	36	55
L ₉₀ Night-time	57	56	53	50	47	47	45	40	33	52

Pymont Street Octave Band Noise Levels

The noise spectra measured at the Level 3 podium on 9 September 2008 is considered representative of the noise environment at the Pymont Street noise logger and at noise receivers west of the Star City Multi Use Entertainment Facility site.

Accordingly, the octave band noise spectra measured at the Level 3 podium have been scaled to the long term L_{Aeq} road traffic noise levels and L_{90} background noise levels.

Calculated spectra are presented in Table 30.

Table 30 Representative noise spectra at Pymont Street and receivers to the west

Measurement	Sound Pressure Level, dB									L _{Aeq} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
L _{eq, 1 hour} Daytime	72	70	72	62	59	59	55	47	43	64
L _{eq, 1 hour} Night-time	72	70	72	62	59	59	55	47	43	64
L ₉₀ Daytime	61	59	61	51	48	48	44	36	32	53
L ₉₀ Night-time	57	55	57	47	44	44	40	32	28	49

Lyric Theatre Octave Band Noise Levels

The noise spectra measured at the Lyric Theatre Terrace on 9 September 2008 is considered representative of the noise environment at the Lyric Theatre Terrace noise logger and at noise receivers east of the Project Star site.

Accordingly, the octave band noise spectra measured at the Lyric Theatre Terrace (presented in [Table 28](#)) have been scaled to the long term L_{Aeq} road traffic noise levels and L_{90} background noise levels presented in [Table 25](#).

Calculated spectra are presented in [Table 31](#).

Table 31 Representative noise spectra at Lyric Theatre terrace and receivers to the east

Measurement	Sound Pressure Level, dB									L _{Aeq} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
L _{eq, 1 hour} Daytime	71	69	67	61	57	57	52	51	35	61
L _{eq, 1 hour} Night-time	69	67	65	59	55	55	50	49	33	59
L ₉₀ Daytime	65	63	61	55	51	51	46	45	19	55
L ₉₀ Night-time	62	60	58	52	48	48	43	42	26	52

Jones Bay Road Octave Band Noise Levels

The noise spectra measured at the Lyric Theatre Terrace on 9 September 2008 is considered representative of the expected character of noise at Jones Bay Road and the octave band levels can therefore be used to shape the overall background noise levels measured at the Watermark Apartment.

Accordingly, the octave band noise spectra measured at the Lyric Theatre Terrace (presented in [Table 28](#)) have been scaled to the long term L_{Aeq} road traffic noise levels and L_{90} background noise levels presented in [Table 27](#).

Calculated spectra are presented in [Table 31](#).

Table 32 Representative noise spectra at Lyric Theatre terrace and receivers to the east

Measurement	Sound Pressure Level, dB									L _{Aeq} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
L _{eq, 1 hour} Daytime	71	69	67	61	57	57	52	51	35	61
L _{eq, 1 hour} Night-time	69	67	65	59	55	55	50	49	33	59
L ₉₀ Daytime	58	56	54	48	44	44	39	38	12	48
L ₉₀ Night-time	56	52	50	44	40	40	35	34	18	44

Appendix C

Derivation of Noise Emission Criteria

Appendix C Derivation of Noise Emission Criteria

Based on the information presented in Appendix A and B, City of Sydney noise criteria for use of the premises (i.e.: patron noise emission), and mechanical noise emission are presented below.

Note that:

- For the City of Sydney patron noise criterion, City of Sydney simply refers to *boundary of the nearest affected property* – making no real distinction between residential and non-residential premises. Notwithstanding this, City of Sydney Standard Conditions requires that *the noise from the use must not be audible within any habitable room in any residential property between the hours of 12.00 midnight and 7.00am;*
- For the City of Sydney mechanical noise emission criterion, there is no real distinction between residential and non-residential premises – with the criterion simply referring to *any place of different occupancy;*
- The values tabulated below represent the **contribution** of the source under consideration; and
- Daytime is 7.00 am to Midnight and Night-time is Midnight to 7.00 am.

In this Section, measurements undertaken at 33 Union Street relate to receivers south of the site, those undertaken at Pyrmont Bay Road relate to receivers to the north of the site, Pyrmont Street relate to receivers west of the site and those undertaken at the Lyric Theatre Terrace relate to receivers east of the site.

The Office of Liquor Gaming and Racing (OLGR), through the Liquor Act 1982 and the Registered Clubs Act 1976, is the Regulatory Authority responsible for noise emission from licensed premises. The OLGR criterion states that the L_{10} noise level emitted by licensed premises is not to exceed the background noise level by more than 5 dB between 7 am and 12 midnight in any octave band (between 31.5 Hz and 8000 Hz). Between 12 midnight and 7 am, the L_{10} level of noise from the licensed premises shall not exceed the background in any octave band (between 31.5 and 8000 Hz) and shall not be audible within any habitable room of a residence.

Union Street

The criteria presented below apply to existing receivers within Union Street. Additionally, these criteria have been used to determine required noise controls within the project Star site, for receivers within the hotel tower facing south towards Union Street.

Patron and music noise emission criteria

Compliance shall be assessed at the boundary.

Table 33 Union Street patron noise emission criteria

Period	L ₁₀ Sound Pressure Level, dB									L _{A10} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
Daytime	67	65	62	58	55	55	53	48	41	60
Night-time	57	56	53	50	47	47	45	40	33	52

Notwithstanding compliance with the values tabulated above, noise from the use must not be audible within any habitable room in any residential property between the hours of 12:00 midnight and 7:00 am.

Mechanical noise emission criteria

Table 34 presents the mechanical services noise emission criteria. This is to be assessed at the boundary of any affected residential premises.

Table 34 Union Street mechanical services noise emission criteria

Measurement	Sound Pressure Level, L_{eq} , dB									L_{Aeq} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
Daytime	67	65	62	58	55	55	53	48	41	60
Night-time	62	61	58	55	52	52	50	45	38	57

Pymont Street

The criteria presented below apply to existing receivers within Pymont Street. Additionally, these criteria have been used to determine required noise controls for receivers in the existing Star City Serviced Apartments.

Patron and Music noise emission criteria

Compliance shall be assessed at the boundary.

Table 35 Pymont Street patron noise emission criteria

Period	L ₁₀ Sound Pressure Level, dB									L _{A10} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
Daytime	66	64	66	56	53	53	49	41	37	58
Night-time	57	55	57	47	44	44	40	32	28	49

Notwithstanding compliance with the values tabulated above, noise from the use must not be audible within any habitable room in any residential property between the hours of 12:00 midnight and 7:00 am.

Mechanical noise emission criteria

Table 36 presents the mechanical services noise emission criteria. This is to be assessed at the boundary of any affected residential premises.

Table 36 Pymont Street mechanical services noise emission criteria

Measurement	Sound Pressure Level, L_{eq} , dB									L_{Aeq} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
Daytime	66	64	66	56	53	53	49	41	37	58
Night-time	62	60	62	52	49	49	45	37	33	54

Lyric Theatre terrace

The criteria presented below apply to existing receivers to the east of the Project Star site.

Patron and Music noise emission criteria

Compliance shall be assessed at the boundary.

Table 37 Pymont Street patron noise emission criteria

Period	L ₁₀ Sound Pressure Level, dB									L _{A10} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
Daytime	70	68	66	60	56	56	51	50	34	60
Night-time	62	60	58	52	48	48	43	42	26	52

Notwithstanding compliance with the values tabulated above, noise from the use must not be audible within any habitable room in any residential property between the hours of 12:00 midnight and 7:00 am.

Mechanical noise emission criteria

Table 38 presents the mechanical services noise emission criteria. This is to be assessed at the boundary of any affected residential premises.

Table 38 Pymont Street mechanical services noise emission criteria

Measurement	Sound Pressure Level, L _{eq} , dB									L _{Aeq} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
Daytime	70	68	66	60	56	56	51	50	24	60
Night-time	67	65	63	57	53	53	48	47	31	57

Jones Bay Road

The criteria presented below apply to existing receivers to the north of the Project Star site and the proposed MUEF.

Patron and Music noise emission criteria

Compliance shall be assessed at the boundary.

Table 39 Jones Bay Road music and patron noise emission criteria

Period	L ₁₀ Sound Pressure Level, dB									L _{A10} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
Daytime	63	61	59	53	49	49	44	43	17	53
Night-time	56	52	50	44	40	40	35	34	18	44

Notwithstanding compliance with the values tabulated above, noise from the use must not be audible within any habitable room in any residential property between the hours of 12:00 midnight and 7:00 am.

Mechanical noise emission criteria

Table 40 presents the mechanical services noise emission criteria. This is to be assessed at the boundary of any affected residential premises.

Table 40 Jones Bay Road mechanical services noise emission criteria

Measurement	Sound Pressure Level, L _{eq} , dB									L _{Aeq} Overall, dB(A)
	Octave Band Centre Frequency, Hz									
	31.5	63	125	250	500	1K	2K	4K	8K	
Daytime	63	61	59	53	49	49	44	43	17	53
Night-time	61	57	55	49	45	45	40	39	23	49

Appendix D

Construction Noise and Vibration Criteria

Appendix D Construction Noise and Vibration Criteria

DECCW Interim Construction Noise Guidelines

The NSW Department of Environment, Climate Change and Water (DECCW) *Interim Construction Noise Guidelines (ICNG)* are used for construction noise assessment. This document supersedes their previous publication the *Environmental Noise Control Manual (ENCM)* and is used as the basis for establishing construction noise criteria.

Under the DECCW guidelines a construction noise management plan is required to be compiled by the Contractor, prior to construction commencing. Noise management levels must be set for the daytime and must be complied with where reasonably practicable. Work that is proposed outside of standard working hours, as defined in the *ICNG*, generally requires strong justification.

The noise management plan should detail the “best practice” construction methods to be used, presenting a reasonable and feasible approach. The plan should identify the extent of the residential area affected and assess the impact on residents. The plan should detail any community relation programs that are planned e.g. prior notification for particularly noisy activities, letter box drop regarding out of hours construction work to be undertaken and a 24 hour contact phone number for residents to call should they have any complaints or questions.

The *ICNG* defines what is considered to be feasible and reasonable as follows:

Feasible

A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements.

Reasonable

Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure.

The *ICNG* recommends that a quantitative assessment is carried out for all ‘major construction projects’.

Predicted noise levels at nearby noise sensitive receivers (residential, commercial and industrial premises) are compared to the levels provided in Section 4 of the *ICNG*. Where an exceedance of the criteria is predicted the *ICNG* advises that the proponent should apply all feasible and reasonable work practises to minimise the noise impact.

Criteria for residential receivers are set using the information in Table 41.

Table 41 Noise at residential using quantitative assessment

Time of Day	Management Level, $L_{Aeq,15min}$, dB(A)	How to Apply
Recommended standard hours: Monday to Friday 7 am to 6 pm Saturday 8 am to 1 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise. Where the predicted or measured $L_{Aeq (15 min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level. The proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise. Where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	A strong justification would typically be required for works outside the recommended standard hours. The proponent should apply all feasible and reasonable work practices to meet the noise affected level. Where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community. For guidance on negotiating agreements see section 7.2.2 (ICNG).

Noise Levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 metres above ground level. If the property boundary is more than 30 metres from the residence, the location for measuring or predicting noise levels is at the most affected point within 30 metres of the residence. Noise levels may be higher at upper floors of the noise affected residence.

Criteria for other sensitive land uses, such as schools, hospitals or places of worship are shown in Table 42.

Table 42 Noise at sensitive land uses (other than residences) using quantitative assessment

Land Use	Management Level, $L_{Aeq,15min}$ (applies when properties are being used)
Classrooms at schools and other educational institutions	Internal noise level 45 dB(A)
Hospital wards and operating theatres	Internal noise level 45 dB(A)
Places of worship	Internal noise level 45 dB(A)
Active recreation areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65 dB(A)
Passive recreation areas(characterised by contemplative activities that generate little noise and where benefits are compromised by external noise intrusion, for example, reading, meditation)	External noise level 60 dB(A)
Community centres	Depends on the intended use of the centre. Refer to the recommended 'maximum' internal levels in AS 2107 for specific uses.

Criteria for industrial and commercial premises are shown below:

- Industrial premises: external $L_{Aeq (15min)}$ 75 dB(A)
- Offices, retail outlets: external $L_{Aeq (15min)}$ 70 dB(A)