RMIT UNIVERSITY

Property Services

Design Standards Brief

Section 13 – Acoustics

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13.1 INTRODUCTION

This Acoustic Brief details standards that should be obtained with regard to the design building acoustics and vibration levels allowed within RMIT University building new developments, refurbishments and existing structures.

Table 1: Room privacy classification system.

Designation	Usage
Class 1	Lecture theatres, seminar rooms, conference rooms, libraries, nominated senior offices
Class 2	Readers' offices, lecturers' offices, common teaching rooms, laboratories
Class 3	Tutors' rooms, stores, general offices, amenity areas

13.2 NOMENCLATURE

'A'-Weighted	Frequency filter applied to measured noise levels to represent how humans hear sounds
dB	Linear sound pressure level, 20 times the logarithm to the base 10 of the ratio of the r.m.s. sound pressure to the reference sound pressure. The reference sound pressure is 20 μPa in air.
dB(A)	'A'-Weighted overall sound pressure level
L_{10}	Noise level exceeded for 10% of the measurement period. This represents the upper intrusive noise level and is often used to represent infrequent noise sources such as traffic noise and intermittent noise
L_{90}	Noise level exceeded for 90% of the measurement period. This represents the background noise level.
L_{eq}	Equivalent continuous sound level. This measure is commonly used when comparing the criterion noise level under the Victorian Noise Regulations and for comparison with relevant standards for air conditioning noise.
D_w	Weighted level difference. A single number characterization of the reduction in sound pressure level between two adjoining enclosed spaces[1]. This number represents actual noise reduction for installed partition and ceiling systems. It takes into account acoustic flanking paths such as perimeter joins. This term replaces Noise Isolation Class (NIC)
NR	Noise Rating[2]. An internationally agreed set of empirical curves relating acceptable octave band sound pressure levels to octave band centre frequencies. The NR of a given noise equals the highest penetration of any band of that noise into the curves. The sound pressure level in dB(A) is approximately 5 higher than the NR for typical broadband noise without pure tones.
R_w	Weighted sound reduction index[3]. Laboratory test measurement for a partition or single component only. Replaces Sound Transmission Class (STC).

[1] From AS/NZS1276.1:1999
[2] From AS1469-1983
[3] Defined in AS/NZS1276.1:1999

13.3 APPLICABLE STANDARDS

The following current standards apply to noise and vibration:

- AS/NZS1276.1:1999, “Acoustics — Rating of sound insulation in buildings and of building elements. Part 1: Airborne sound insulation”;
- AS 1469—1983, “Acoustics — Methods for the determination of noise rating numbers”;
- AS/NZS1668.1:1998, “The use of ventilation and air conditioning in buildings - Fire and smoke control in multi-compartment buildings”;
- AS/NZS2107:2000, “Acoustics — Recommended design sound levels and reverberation times for building interiors”;
- AS 2253—1979, “Methods for field measurement of the reduction of airborne sound trans mission in buildings”;
- AS/NZS2499:2000, “Acoustics - Measurements of sound insulation in buildings and of buildings elements - Laboratory measurement of room-to-room airborne sound insulation of a suspended ceiling with a plenum above it”;
- AS 2670.2—1990, “Evaluation of human exposure to whole-body vibration — Continuous and shock-induced vibration in buildings (1 to 80 Hz)”;
- AS 2702—1 984, “Acoustics - Methods for the measurement of road traffic noise”;
- ISO 140-4:1998, “Acoustics - Measurement of sound insulation in buildings and of building;
- elements - Part 4: Field measurements of airborne sound insulation between rooms”;
- Noise Control Application Manual No. DA2, Australian Institute of Refrigeration, Air Conditioning and Heating (Inc.), April 1995;
- Environment Protection Authority State Environment Protection Policy (Control of Noise From Commerce, Industry and Trade) No. N—I (SEPP N—I);
- EPA State Environment Protection Policy (Control of Music Noise from Public Premises) No. N—2 (SEPP N—1);
- EPA Interim Guidelines for Control of Noise from Industry in Country Victoria (N3/89);

The latest amendment & publication shall be referenced in applicable standards.

13.4 ARCHITECTURAL ACOUSTICS

13.4.1 INTRUSIVE NOISE CRITERIA

The intrusive noise criterion is the maximum allowable noise level due to intrusive traffic and other intermittent noise. The noise measure used to describe traffic noise is the L_{10} level with higher L_{10} levels indicating higher intrusive noise levels. The levels presented in Table 2 are derived from recommendations in Noise Control Application Manual No. DA2.

Table 2: Criteria for traffic and other intermittent noise.

Designation	Recommended Average Maximum Levels (L_{101} Db (A))	Typical Room Usage
Class T1	40	Lecture theatres, conference/seminar rooms, libraries, nominated senior offices
Class T2	45	Readers' offices, lecturers' offices, common teaching rooms, laboratories
Class T3	50	Tutors rooms, stores, general offices, amenity areas

Expert advice should be sought for specialist spaces not listed above or where specific requirements exist.

13.4.2 REVERBERATION CONTROL

The control of reverberation in spaces is generally carried out either for noise control purposes or to create a specific acoustic environment. In areas such as libraries and offices, reverberation time should be minimized to control ambient noise levels. In teaching areas speech intelligibility is the most important criterion, for which an optimum reverberation time should be selected depending on the usage and volume of the space. It is advised that an acoustic consultant be used for the appropriate selection of reverberation time for teaching areas and specialist spaces such as music and television studios, auditoria or concert halls. In spaces such as these, speech projection and music quality may be dependent not only upon the amount of absorption, but also upon its appropriate location and room geometry.

Table 3 presents typical reverberation times for a variety of spaces, but should be used in conjunction with expert advice.

Table 3: Typical reverberation times[4]

Space	Recommended reverberation time(s)
Private offices	0.4 to 0.6
Computer rooms	0.4 to 0.6
Conference, seminar, tutorial rooms	0.6 to 0.7
Laboratories	0.5 to 0.7
Libraries	0.4 to 0.6
Corridors, lobbies	0.6 to 0.8
Drama studios	Seek specialist advice
Lecture theatres	Seek specialist advice

[4] From AS/NZS2107:2000.

AS/NZS2107:2000 should be used for any other spaces not listed above or where specific requirements may exist.

13.4.3 RAIN NOISE

Rain noise within noise-sensitive spaces (those with an intrusive noise classification of Class TI or better) should not exceed the criterion level of Class TI, i.e. L_{10} = 40 dB(A). Predicted rain noise levels should be based upon rainfall intensity levels of 30 mm/hour.

13.4.4 PRIVACY AND NOISE TRANSMISSION

The most relevant rating for noise separation or speech privacy between offices is the Weighted Level Difference[5] (D_w) referred to in AS/NZS1276.1:1999. The Weighted Level Difference is a single number rating system that relates to the difference in noise levels (noise reduction) between adjacent spaces. The D_w should not be confused with the laboratory- tested Weighted Sound Reduction Index[6] (R_w) that is often quoted in product literature. The R_w relates to the performance of the partition system under laboratory conditions, whereas D_w relates to the real sound reduction performance of the total installation in the field, taking into account variables such as partition area, room size and furnishings, and most importantly, acoustic weaknesses due to sound transmission via flanking paths.

13.4.4.1 Partitions

It should be noted that selection of constructions based on R_w (as is generally provided in product literature) would need to be higher than the D_w values specified in Table 4 to allow for actual in-field installations.

Table 4: Minimum Weighted Level Differences (D_w) for partitions.

Designation	Minimum D_w Value	Description Of Acoustic Privacy Rating (For Raised Voice)7	Typical Room Usage	Ceiling Baffle Details
Class P1	45	Good privacy where raised voice levels are expected or background noise is low. Good isolation of medium noise level activity. Normal voice not audible.	Lecture theatres, conference/seminar rooms, libraries, nominated senior offices	Two sheets of plasterboard to cut ceiling grid and extend to slab or roof above. Other sheets to extend past ceiling by 100 mm.
Class P2	40	Medium to good privacy where raised voice levels are expected or background noise is low. Medium acoustic isolation of medium noise levels. Normal voice muffled.	Readers' offices, lecturers' offices, common teaching rooms, laboratories, toilets	One sheet of plasterboard to cut ceiling grid and extend to slab or roof above.

[5] Formerly NIC rating.

[6] 8 Formerly STC rating.

[7] Background noise levels in rooms are expected to comply with AS/NZS 2107:2000.

Designation	Minimum D_w Value	Description Of Acoustic Privacy Rating (For Raised Voice)7	Typical Room Usage	Ceiling Baffle Details
Class P3	35	Medium to good speech privacy for conversational voice. Raised voice intelligible (most words). Non-intelligible noise is medium-intrusive. Normal voice audible.	Tutors' rooms, stores, general offices, amenity areas	Partition does not need to cut ceiling grid.
Other Areas	30	Poor privacy.	Waiting areas, store rooms, etc.	

Constructions higher than Class P1 may be required for specialist acoustic spaces. Partitions should also consider noise produced by equipment within adjacent rooms and provide sufficient sound attenuation to comply with the ambient noise criteria.

13.4.4.2 Doors

The noise separation criteria used for selection of door types is provided in Table 5. Doors should be selected to match the designation of the partition into which they will be installed, but doors will always weaken the partition into which they are installed. A representative sample of doors should have their acoustic performance tested to guarantee door and seal acoustic performance.

Table 5: Minimum Weighted Level Differences (D_w) for doors.

Designation	Door Construction	Acoustic Seals
Class Dl	45 mm solid core *or* 43 mm insulated cavity door$_1$	Raven RP24 to frame, RP38 door bottom seal, RP16 Astragal x 2 or equivalent.
Class D2	42 mm solid core *or* 10 mm laminated glass *or* 44 mm insulated cavity door$_2$	Raven RP10 to frame, RP8 door bottom seal, RP16 or RP71 Astragal x 2 or equivalent
Class D3	38 mm solid core *or*	Contact seal to head and jamb, eg. RP48 or brush seal
Other Areas	6 mm laminated glass *or* 37 mm hollow core door$_3$	No specific sealing requirements.

Notes:

(1) 9 mm MDF, 25 mm insulated cavity, 9 mm MDF

(2) 6 mm MDF, 32 mm insulated cavity, 6 mm MDF

(3) 6 mm MDF, 25 mm cavity, 6 mm MDF

Door grilles should not be used for Class DI or Class D2 doors. In these cases, the relief air path is to be as described under clause **13.5.2.3**, Relief Air Paths. Conventional double doors hinged at the edge can be more effectively sealed acoustically and are therefore preferred to double-acting centre-pivot doors, which are not acceptable for Class DI or D2 doors. Constructions higher than Class DI may be required for specialist acoustic spaces.

13.4.4.3 Detailing

Partition details are important to help achieve the required D_w ratings, particularly for Class P1 and Class P2 partitions. The following details should be carefully attended to:

- Plasterboard at partition junctions and “T”’-junctions;
- Recesses above and below services ducts and at wall angles;
- Blinds;
- Mullions.

13.4.4.4 Toilets

Where internal walls supporting basins and cisterns are adjacent to occupied areas they should be isolated from other walls to minimize structural noise transmission. Doors to the cubicles and toilet areas should have rubber stops to minimize impact noise. Toilet seats should also have rubber stops to minimize impact noise.

Partitions between toilets and adjacent spaces should be Class P2 (see **Clause 13.4.4.1**, Partitions).

Ensuites should have isolated walls supporting showers, fittings and toilets. Doors to ensuites should be a Class D2 rating where airlocks are not used.

13.4.4.5 Operable Walls

Operable walls or bifold doors should have a D_w rating that at least matches the D_w rating of the partition that they are replacing or in which they are installed. Operable walls should have retractable mechanical seals along the top and bottom that are adjustable, and an adjustable jamb to maintain acoustic performance.

13.4.4.6 Plant Rooms

Noise from plant rooms should be assessed to ensure that adjacent spaces comply with the requirements of **Clause 13.5.1.1**, *Ambient Noise Criteria.*

13.4.4.7 Ceiling Space Plant

Radiated noise from ceiling space-mounted plant should be assessed to ensure that spaces below comply with the requirements of **Clause 13.5.1.1**, *Ambient Noise Criteria.*

13.5 MECHANICAL SERVICES ACOUSTICS

13.5.1 NOISE AND VIBRATION CRITERIA

13.5.1.1 Ambient Noise Criteria

Ambient noise criteria should be based on AS/NZS2107:2000, “Acoustics — Recommended design sound levels and reverberation times for building interiors” and Noise Control Manual No. DA2.

Table 6: Criteria for continuous noise intrusion.

Designation	Recommended Maximum Levels		Typical Room Usage
	L_{qds} dB(A)	NR	
Class Al	35	30	Lecture theatres, conference/seminar rooms, libraries, nominated senior offices
Class A2	40	35	Readers’ offices, lecturers’ offices, common teaching rooms, laboratories
Class A3	45	40	Tutors’ rooms, stores, general offices, amenity areas
Class A4	50	45	Service areas, corridors, etc.

The steady noise level in an occupied room generated by all components of the air conditioning and ventilation plant should not exceed the maximum levels outlined in Table 6. The noise levels apply to all plant and air distribution systems, thermal plant, air-handling units, duct systems, plant rooms and externally located plant.

13.5.1.2 Environmental Noise Criteria

Noise from the operation of buildings near residential premises shall be in accordance with EPA State Environment Protection Policy (Control of Noise from Commerce, Industry and Trade) No. N—I for the Melbourne metropolitan area or ‘Interim Guidelines for Control of Noise from Industry in Country Victoria (N3/89).

While not specifically referring to noise transmission to adjacent commercial premises, the environmental noise criteria can be determined from the maximum allowable noise level within adjacent buildings, as specified in AS/NZS2107:2000. The noise criteria to commercial premises is:

- Day time noise levels (between 7:00 and 22:00) should be less than 65 dB(A) at adjacent properties;
- Night time noise levels (between 22:00 and 7:00) should be less than 55 dB(A) at adjacent properties.

13.5.1.3 Vibration Criteria

Vibration isolation of mechanical plant and equipment is to be supplied and installed to limit vibration levels in the building to comply with recommended vibration levels as set out in AS2670.2—1990, “Evaluation of human exposure to whole-body vibration — continuous and shock induced vibration in buildings (1 to 80 Hz)”.

13.5.2 MECHANICAL PLANT

This section outlines general requirements only. An acoustic consultant may be required to satisfy the noise criteria on a case-by-case basis.

13.5.2.1 Air Handling Units

Air handling units should have sufficient in-duct sound attenuation to comply with the ambient noise criteria as specified in Table 6. Both supply and return air paths will need to be considered.

13.5.2.2 Variable Air Volume Boxes

Variable air volume boxes should be selected to ensure that their self-generated duct and radiated noise, together with noise from the main system, does not cause the required noise criteria to be exceeded under normal conditions of operation.

Excessive noise should not be generated by the VAV on shutdown. The damper should have an airtight seal to prevent hisses or objectionable noise when closed.

13.5.2.3 Relief Air Paths

Where return air paths must cross partitions, the requirements of Table 4 (Privacy Classifications) should be adhered to. In general, relief air paths should be designed and installed such that their acoustic performance exceeds the D_w of the partition being penetrated. The overall D_w rating of the partition should be maintained.

13.5.2.4 Duct Penetrations and Locations

All duct penetrations through acoustically rated partitions, walls, etc. should be sealed airtight. Ducts should not run along the line of full height partitions or partitions with acoustic baffles.

13.5.2.5 Smoke Spill Fans

Emergency smoke and fire systems should comply with the noise requirements specified in Clauses 4.6 and 4.17 of AS/NZS1668.1:1998. Specifically, this states that “The noise level during operation of the smoke control systems (including smoke-spill fans and air pressurization fans) shall not exceed 65 dB(A) in occupied spaces or 5 dB(A) above the ambient noise levels to a maximum level of 80 dB(A). Noise levels in fire-isolated exits shall not exceed 80 dB(A).”

13.5.2.6 Pipework

Pipework and valves should be assessed and clad as appropriate in order to ensure that they comply with the criteria of **Clause 13.4.1**, *Intrusive Noise Criteria*. Pipework should not be routed above or adjacent to spaces of Class TI or better.

13.6 HYDRAULICS

13.6.1 INTRUSIVE NOISE CRITERIA

Noise generated by hydraulics services into occupied spaces should not cause the background noise level to increase by more than 1 dB for typical use.

13.6.2 PIPE ISOLATION

All fluid-carrying pipes should be isolated at the mounting points to minimize structure-borne noise within the building. Pipes should also be lagged to prevent accidental contact with studs, etc. and isolated at both block wall and slab penetration points. Pipes penetrating walls, floors, ceiling etc. should be isolated from the structure and be sealed airtight with a flexible caulking compound.

13.6.3 WASTE AND STORM WATER PIPES

Waste pipes and down pipes located in ceiling spaces or adjacent to occupied spaces above critical spaces should be acoustically insulated and isolated. Pipe insulation should minimize the radiation of audible noise from waste pipes into occupied spaces. Waste and down pipes connected to columns require isolation at clamps.

Down pipes should be preferably located in public or unoccupied spaces and not adjacent to spaces of intrusive noise Class TI or better. Elsewhere they may require acoustic cladding or other forms of acoustic treatment. Flying down pipes should also be located above public or unoccupied spaces.

13.7 ELECTRICAL SERVICES

Noise generated by electrical services into occupied spaces should not cause the background noise level to increase by more than 1 dB for typical use. This includes fluorescent light starters and ballasts, uninterruptible power supplies and other general computer/electronic equipment.

13.8 LIFTS

13.8.1 INTRUSIVE NOISE CRITERIA

Noise generated by lifts into occupied spaces should not cause the background noise level to increase by more than 1 dB for typical use.

13.8.2 VIBRATION ISOLATION

All lift mechanisms should be vibration-isolated so that intrusive noise levels do not exceed the intrusive noise criteria (see **clause 13.5.1.1 Table 6**). Isolated walls are required between the lift core and critical occupied areas.

Lifts should not cause excessive vibration when compared to the vibration criterion summarized in AS 2670.2—1 990.

The lift arrival tone should be non-intrusive in occupied spaces.

13.9 ACOUSTIC CONSULTANTS

It is recommended that acoustic consultants be used for expert advice for the following circum stances:

- For spaces where low ambient noise levels and for good to excellent privacy is required (typically Class 1 and Class 2 spaces or higher);
- For spaces where acoustic performance is critical, including music, drama and TV studios, lecture theatres, auditoria and concert halls;
- Unconventionally finished or unusually shaped spaces, where room finishes and geometry may affect the acoustic environment;
- Unusual situations, such as where design constraints force noisy spaces or high-level noise sources to be located adjacent to occupied areas;
- Where low noise levels are required from air conditioning systems.

13.10 COMMISSIONING AND ACOUSTIC TESTING

Three types of acoustic testing should be carried out during the commissioning stage of buildings. These are:

- Ambient noise levels (including mechanical services);
- Intrusive noise levels;
- Noise isolation between spaces.

Noise levels are to be taken in a representative number of typical rooms. Spaces selected for testing should be selected in conjunction with RMIT University and the head consultant.

13.10.1 MECHANICAL SERVICES

Ambient noise levels within a sample of rooms should be measured during commissioning.

Noise and vibration levels should comply with the design criteria. Levels of noise and/or vibration that impair the efficiency of working or normal standard of comfort in any environment should not be accepted. Testing should be carried out by an independent acoustic consultant and results forwarded to the contractor with copies to RMIT University Project Manager.

In the event of unacceptable noise or vibration levels resulting from faulty plant or negligence during installation, the contractor shall carry out all alterations and additions to the installed plant in order to reduce levels to acceptable levels, as directed by RMIT University or nominated party.

13.10.2 ARCHITECTURAL ACOUSTICS

13.10.2.1 Relevant Standards

Intrusive traffic noise levels (L_{10}) I be measured in accordance with AS 2702—1984, “Acoustics — Methods for the measurement of road traffic noise”. Intrusive aircraft noise levels shall be measured in accordance with AS 2021—2000, “Acoustics — Aircraft noise intrusion — Building siting and construction”. Vibration levels shall be measured in accordance with AS2670.

Partition Weighted Level Differences (D_w) should be measured in accordance with AS2253 and calculated as described in AS1276 for privacy-sensitive spaces.

13.10.2.2 Ambient and Intrusive Noise

Ambient noise levels adjacent to mechanical plant shall be measured at a representative number of locations by a qualified independent acoustic consultant.

Where noise levels are excessive, additional acoustic treatment should be installed to comply with the ambient noise criteria. Approval shall not be granted for completion of associated works until ambient noise testing is completed and noise levels comply with the design criteria.

Intrusive traffic and aircraft noise levels are to be measured at the discretion of the RMIT Project Manager, acoustic consultant or architect.

13.10.2.3 Plant Room Walls

Ambient noise levels should be measured adjacent to operational plant rooms under normal load situations. Where noise levels are excessive due to airborne noise, defects are to be rectified and acoustic treatment installed so that ambient noise criteria are satisfied.