SECTION 12: ACOUSTICS, VIBRATION AND EMI

CONTENTS

12.1 INTRODUCTION

This section of the Design Standards provides details of the minimum requirements for the acoustic design of new and refurbished University spaces.

The project designer is required to produce their own specification which satisfies the requirements of this and other sections of the Design Standards. All designs are to be submitted to the University for review prior to tendering or any works commencing on-site. The Design Standards are to be considered in conjunction with all relevant statutory regulations.

The designer must use the Modification Request Form to obtain approval from the University for any departure from any clause in the Design Standards. No design work is to proceed on the basis of the proposed modification until the modification request has been approved in writing. Any proposed departures would generally be required to be accompanied by justification from a suitably qualified Acoustic Consultant.

An appropriately qualified Acoustic Consultant shall be engaged as part of the project team; especially in areas where high acoustic performance is required due to:

- high noise levels (roads/rail, plant rooms, etc.),
- noise sensitive spaces (performance spaces, libraries, accommodation, etc.)
- vibration sensitive spaces (laboratories)
- speech privacy requirements (private offices, counselling rooms, etc.)

Acoustic Consultants must be a member firm of the Association of Australasian Acoustical Consultants (AAAC). Member firms are listed on the AAAC website.

Examples of rooms/spaces where high acoustic performance is required include but are not limited to:

- auditoriums,
- lecture theatres,
- meeting, board and conference rooms,
- private offices,
- libraries,
- study areas,
- theatres,
- drama, dance & music rooms,
- student accommodation.

Requirements for laboratories housing sensitive equipment (e.g. electron microscopes) and bio-resources are provided separately.

12.1.1 Standards, Policies, Regulations & Guidance

All work shall meet the latest requirements of the national and local authorities, and shall be in accordance with the following as relevant to the project:

- Australian/New Zealand Standard AS/NZS 2107 *Acoustics - Recommended design sound levels and reverberation times for building interiors*.
- Australian Standard AS2021 *Acoustics - Aircraft noise intrusion - Building siting and construction*
- Environment Protection Regulations
- EPA publication 1826 *Noise limit and assessment protocol for the control of noise from commercial, industrial and trade premises and entertainment venues*, May 2021
- National Construction Code (NCC) / Building Code of Australia (BCA)
- Assessing Vibration: A Technical Guideline, NSW Department of Environment and Conservation, February 2006.

- AS 2670.2-1990 - Evaluation of human exposure to whole-body vibration - Continuous and shock-induced vibration in buildings (1 to 80 Hz)

Other guidance documents which may assist the designer in relation to the acoustics include:

- *Building Quality Standards Handbook* published by the Department of Education and Early Childhood Development
- *Sound Transmission and Insulation in Buildings* published by the Australian Building Codes Board.

Acoustic criteria and recommendations within these guidance documents do not supersede the information provided within these Design Standards. Guidance Documents should be used for information only.

12.2 INTERNAL NOISE LEVELS

The total internal noise level within a space from steady and quasi-steady noise sources should not exceed the levels stated in AS/NZS 2107 "*Acoustics — Recommended design sound levels and reverberation times for building interiors*". This should include:

- noise generated by building services serving the space itself
- noise intrusion from mechanical plant serving other buildings and spaces
- noise intrusion from external sources such as road traffic, tram and rail noise
- any other noise subject to the AS/NZS 2107 design criteria.

Transient noise sources, such as that may arise from adjoining spaces, rain or aircraft noise, should also be considered in the design but are not subject to the AS/NZS 2107 design criteria.

12.2.1 Building Services Noise

Noise from building services (including mechanical services and hydraulics services) shall be free of tonal and spectral content and not exceed the levels stated in AS/NZS 2107 "*Acoustics — Recommended design sound levels and reverberation times for building interiors*". Where a design sound range is provided, the lower level is to be used as a design goal and the upper level indicates the maximum permissible level on-site. Additional guidance for internal noise levels for education spaces can be found in the AAAC *Guidance for Educational Facilities*.

AS/NZS 2107:2016 notes that when the sound level is below the lower level of the range, the inadequacy of background sound to provide masking sound can become problematic, by allowing other intermittent noise sources to cause distraction, annoyance, or lack of privacy. In spaces where acoustic isolation and speech privacy are important, and the sound levels are below the lower level of the recommended design range, acoustic masking may be required to be introduced into the space to raise the sound level to within the recommended design sound range level.

For noise sensitive spaces such as auditoriums, lecture theatres and other enclosed rooms, Appendix C of AS/NZS 2107:2016 provides maximum recommended octave band sound pressure levels which can be scaled appropriately to achieve the a suitable overall L_{eq} recommended design level for the space.

12.2.2 Rain Noise

In line with the advice provided with the AAAC *Guideline for Educational Facilities*, the internal noise level with a rainfall rate of 25 mm/hr should not exceed the upper extent of the AS/NSZ 2107 noise level range by more than 5 dB(A).

12.2.3 External Noise Intrusion

External noise intrusion into University facilities shall be limited so that the total internal noise level (including building services) within spaces does not exceed the levels stated in AS/NZS 2107 "*Acoustics — Recommended design sound levels and reverberation times for building interiors*". Where a design sound range is provided, the lower level is to be used as a design goal and the upper level indicates the maximum permissible level on-site.

Where University facilities (especially student accommodation) are close to highways, freeways, busy arterial roads and rail corridors, the Acoustic Consultant shall design the building envelope or provide noise mitigation advice to suitably reduce the internal noise levels.

Where University facilities are under flight paths for aircraft or helicopters, external noise intrusion from these sources should also be considered. In these cases, facilities should be designed to achieve compliance with AS 2021 *Acoustics - Aircraft noise intrusion - Building siting and construction*.

12.3 EXTERNAL NOISE LEVELS

In addition to any of the requirements listed below, external noise emissions from University facilities must be minimised so far as reasonably practicable in accordance with the general environmental duty as set out in the Environment Protection Act 2017.

12.3.1 Mechanical Services

The Environment Protection Regulations regulate environmental noise emissions to neighbouring noise sensitive areas (residential, hotels, hospitals, etc.). To comply with this legislation, noise at adjacent noise sensitive areas due to the operation of mechanical plant must not exceed noise limits determined in accordance with the legislation.

Additionally, operation of mechanical plant shall not cause internal noise levels in adjacent land uses not covered by the Environment Protection Regulations to exceed those contained in AS/NZS 2107 "Acoustics – Recommended Design Sound Levels and Reverberation Times for Building Interiors".

12.3.2 Music Noise

The Environment Protection Regulations regulate music noise emissions to neighbouring noise sensitive areas (residential, hotels, hospitals, etc.). To comply with this legislation, music noise at adjacent noise sensitive areas must not exceed noise limits determined in accordance with the legislation.

In some instances, music noise from University facilities would not strictly need to comply with this policy as they would not be defined as an 'Indoor Venue' or 'Outdoor Venue' under EPA publication 1826. However, music performances or events should comply with the requirements of this policy as part of a best practice approach.

12.4 SOUND INSULATION

In order to achieve the appropriate level of sound insulation between spaces, partitions must be designed to achieve a minimum measured acoustic performance on site.

Weighted Sound Reduction (R_w) values are used for design and procurement purposes of individual building elements. Weighted Level Difference (D_w, $D_{n,w}$ and $D_{nT,w}$) values are used for in-situ verification of construction performance, because they provide a

measure of the 'as-experienced' condition including the level of degradation from any unwanted flanking paths which can arise from poor design and/or construction.

The advice below is based on D_w values. For the purposes of design, it is sufficient for the assessment to be carried out on the basis of R_w values for different elements. The R_w value of a large element (e.g. wall or floor) should be selected such that it is at least 5 dB above the desired D_w value, and specific consideration should be given to the design of smaller elements and detailing such that the desired D_w value between the two spaces is achieved.

Further information can be found in the Appendix of AAAC *Guideline for Educational Facilities.*

12.4.1 Airborne Sound Insulation

For walls without doors, the AAAC *Guideline for Educational Facilities* provides recommended D_w sound insulation ratings for various room types based on the noise generated within room types and the noise tolerance of the room adjacent (Table 3 and Table 5 of AAAC *Guidance for Educational Facilities*). Sound insulation of walls for University facilities shall be designed so that the D_w ratings are met upon completion of the project.

The sound insulation requirements within the AAAC *Guideline for Educational Facilities* are based on a typical ambient noise levels of L_{eq} 35 – 40 dB(A). For lower internal noise levels, the sound insulation rating needs to be increased to achieve a similar subjective performance. For every 5 dB(A) reduction in the background noise level, the D_w requirement shall be increased by 5 dB to achieve the same subjective performance.

12.4.2 Doors

Where doors are proposed between spaces, consideration must be given to the placement and performance requirements of the door since ratings for doors with no acoustic treatment are not likely to exceed D_w 20 dB while standard solid core doors with full perimeter acoustic seals could achieve a rating of up to D_w 30 dB.

Proprietary acoustic door systems can achieve a sound insulation greater than D_w 30 dB if manufacturer installation instructions are followed. However, these doors are heavier than standard doors and can be more difficult to operate. This should be considered (especially in relation to DDA door force limits) where proprietary acoustic doors are proposed.

The D_w for walls containing doors should only be reduced by a maximum of 10 dB compared to the D_w of the wall only (i.e. does not contain a door). If a wall containing a door is required to achieve a D_w greater than 35, then a proprietary acoustic door, back-to-back doors, or airlock design will likely be required.

It is acoustically preferable to use hinged doors rather than sliding doors as it is more practical to achieve an airtight seal around the door. Hinged doors shall be used for all spaces requiring high acoustic performance. Sliding doors shall only be used in D_w 40 walls or lower where speech privacy is not important.

For adjacent spaces, all doors should not be located adjacent to each other. Wherever possible, doors to adjacent spaces should be separated by 2 metres or more.

12.4.3 Operable Walls

Acoustically rated operable walls may pose operational and manual handling constraints, as a heavy mass is required to achieve a high level of sound attenuation. Lighter, more easily operated walls may be used where walls are opened and closed frequently, but only where a lower level of acoustic separation has been accepted.

Operable walls shall:

- be rated to a minimum R_W 50
- have mechanically adjustable ends, and it is also preferable for the doors to have mechanically adjustable top and bottom seals, however, contact seals are acceptable if manufacturer warrants their performance
- have a baffle above the operable wall constructed from 1 x 13 mm plasterboard on one side of the structural member
- have adjacent ceilings with a Ceiling Attenuation Class (CAC) of 35 or higher. Adjacent ceilings with a CAC lower than 35 will require an upgrade to the operable wall or the ceiling baffle or both. Advice shall be sought from an appropriately-qualified Acoustic Consultant.

12.4.4 Impact Isolation

For floor impact noise, the of AAAC *Guideline for Educational Facilities* provides recommended L_{nTw} impact isolation ratings for various room types based on the noise generated within room types and the tolerance of the room adjacent (Table 3 and Table 4 of AAAC *Guidance for Educational Facilities*). Impact isolation ratings of floors for University facilities shall be designed so that the L_{nTw} ratings are met upon completion of the project.

12.4.5 Student Accommodation

For University student accommodation, the acoustic requirements within Part F5 of the National Construction Code (NCC) / Building Code of Australia (BCA) shall be achieved as a minimum standard. In particular, impact noise isolation of floors shall be designed to achieve a higher standard than the nominated rating in the NCC / BCA. The impact noise isolation of new developments shall aim to achieve $L_{nTw} \leq 50$, and the impact noise isolation of refurbished accommodation shall aim to achieve $L_{nTw} \leq 55$.

12.5 INTERNAL ACOUSTICS

12.5.1 Reverberation Time

Reverberation Time (T_{60}) is measured in seconds and indicates how quickly sound decays within a space. The higher the T_{60}, the more reverberant or acoustically “live” is the space. A low T_{60} indicates an acoustically “dead” space. A higher T_{60} generally promotes higher noise levels during activity which results in worsening conditions for communication.

The reverberation times within University spaces are to be designed to comply with the recommended reverberation times within AS/NZS 2107 “*Acoustics — Recommended design sound levels and reverberation times for building interiors* ”. Additional reverberation time guidance for education spaces can be found in the AAAC *Guideline for Educational Facilities*.

For performance spaces and rooms where music/speech quality is important (i.e. auditoriums, lecture theatres, drama & music rooms, etc.) the location and extent of acoustic absorption within the room should be designed by the Acoustic Consultant to achieve the required reverberation time. Note that, for specialist performance spaces, limited guidance on suitable reverberation times is provided in AS/NZS 2107 and additional guidance on an appropriate design standard should be sought from an appropriately-qualified Acoustic Consultant.

12.5.2 Speech Transmission Index

Speech Transmission Index (STI) describes the clarity of speech in a space, and takes account of the space's acoustic characteristics, the background noise level and other noisy activities which may be occurring.

AAAC *Guidance for Educational Facilities* provides STI values for spaces where high quality speech communication is important such as:

- Open plan teaching areas
- Auditoria
- Gymnasia (sole use)
- Multipurpose Hall.

The internal acoustics of these types of spaces shall be designed so that the STI values in Table 6 of the AAAC *Guideline for Educational Facilities* are met upon completion of the project, and include assessments of reverberation, echo, activity and noise ingress.

12.6 VIBRATION

12.6.1 Mechanical Plant

Radiated structure borne noise caused by vibration from building service plant shall be limited to ensure the internal noise limits (refer to Section 12.2) are not exceeded.

12.6.2 Building Isolation

The building structure should be designed so that vibration levels comply with the levels for "Education Institutions" published within *Assessing Vibration: A Technical Guideline, NSW Department of Environment and Conservation, February 2006*.

12.7 COMMISSIONING TESTING

For projects containing spaces where a high acoustic performance is required, the University may require acoustic commissioning testing.

In such cases, a commissioning testing methodology is required to be submitted to the University for approval to ensure that the selection of spaces is appropriate. Generally, it would not be necessary or practical for testing to be carried out on every space, but a sufficient number of spaces should be tested to enable verification of the design. As a minimum, 10% of high acoustic performance spaces should be tested.

The tests should have regards to the acoustic sensitivities of the spaces and the works that were carried out. For example, it may not be necessary to carry out commissioning testing of airborne noise separation for projects where no works were undertaken to walls. Similarly, vibration testing would not generally be required where there has been no change to the structure of a building.

The methodology for the tests should address the requirements of this section of the Design Standards and the requirements outlined below.

12.7.1 Walls and Floors

The airborne rating of building elements is to be carried out and assessed in accordance with

- AS/NZS ISO 717.1:2004 Acoustics—Rating of sound insulation in buildings and of building elements Part 1: Airborne sound insulation, and
- AS ISO 140.4—2006 *Acoustics – Measurement of sound insulation in buildings and of building elements – Part 4: Field measurements of airborne sound insulation between rooms* for airborne sound separation between rooms.

The impact noise rating of floors is to be carried out and assessed in accordance with:

- AS/NZS ISO 717.2 Acoustics—Rating of sound insulation in buildings and of building elements Part 2: Impact sound insulation.
- AS ISO 140.6—2006 Acoustics—Measurement of sound insulation in buildings and of building elements Part 6: Laboratory measurements of impact sound insulation of floors for impact noise separation between floors.

12.7.2 Noise Levels

Noise levels shall be measured in accordance with Section 6 of AS2107:2016. Appendix D of AS/NZS 2107 provides information on identifying spectral imbalance and tonal components of internal noise levels.

12.7.3 Reverberation

Reverberation times shall be measured in accordance with Section 6.2 of AS/NZS 2107:2016.

12.7.4 Vibration

Vibration levels shall be measured to allow comparison with the levels for “Education Institutions” published within *Assessing Vibration: A Technical Guideline, NSW Department of Environment and Conservation, February 2006.*