Charles Sturt University

Revision 1.0

Infrastructure Design Standards

Module S03: Acoustics

Division of Finance (Strategic Infrastructure)
Charles Sturt University

Document Control

Document Name	**Infrastructure Design Standards**
Sub-Section Name	**Module S03: Acoustics**
Document Status	Current
Revision Number	1.0
Effective Date	11/11/2024
Review Date	10/11/2025
Unit Head	Director, Strategic Infrastructure
Author(s)	The Standards have been developed by Strategic Infrastructure, Facilities Management, external consultants, contractors, and colleagues.
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Contents

1. Introduction

1.1. Overview

The Charles Sturt University Infrastructure Design Standards (the Standards) outline the University's expectations for its built forms to achieve consistency in the quality of the design and construction of those built forms.

The Standards have been developed to provide guidance to the design team and to assist Facilities Management to drive a consistent approach to the design, construction, commissioning, handover, and operation of new capital projects to ensure the new asset is fully integrated into campus life and conforms to the University's standards and policies.

The successful integration of any new project into the day-to-day operation of campus life cannot be underestimated and is vital to ensuring the new asset provides a fully functional platform for Facilities Management clients and the University. The Standards will ensure Facilities Management is successful in supporting the University's strategic objectives now and into the future. The pitfall of viewing any new project as a standalone entity must be avoided as any new project is an extension of the existing campus.

The Standards are aligned with Charles Sturt's requisites for aesthetic appeal, life cycle maintenance and environmental sustainability, while ensuring that there is sufficient scope for innovation and technological advancements to be explored within each project.

1.2. The University

The history of Charles Sturt University dates to 1895, with the establishment of the Bathurst Experiment Farm. Formed progressively through the merge of regional institutions in south-western and western NSW, Charles Sturt was formally incorporated on 19 July 1989 under the Charles Sturt University Act 1989. As one of Australia's newer universities, Charles Sturt has been built on a tradition of excellence in teaching and research spanning more than 100 years.

With over 40,000 current students studying both on-campus and online, Charles Sturt University is the largest tertiary education institution in regional Australia. The University operates six main campuses across New South Wales in Albury-Wodonga, Bathurst, Dubbo, Orange, Port Macquarie, and Wagga Wagga, alongside specialist campuses in Canberra, Parramatta, and Goulburn. Charles Sturt University is structured around three Faculties: Arts and Education; Business, Justice and Behavioural Sciences; and Science and Health.

1.3. University Vision and Values

Charles Sturt University is committed to building skills and knowledge in its regions by offering choice and flexibility to students, while collaborating closely with industries and communities in teaching, research, and engagement. As a significant regional export industry, the University brings both strength and learning back to its regions, positioning itself as a market-oriented institution. Its goals are to remain the dominant provider of higher education in its regions and a sector leader in flexible learning.

Charles Sturt University believes that wisdom has the power to transform communities. With perseverance and dedication, the University contributes to shaping resilient and sustainable regions for the future. Acknowledging the deep culture and insight of First Nations Australians, the University's ethos is encapsulated by the Wiradjuri phrase *yindyamarra winhanganha,* which translates to "the wisdom of respectfully knowing how to live well in a world worth living in." Through its values, Charles Sturt University fosters a welcoming community and learning environment that supports innovation, drives societal advancement, and gives back to the regions it serves.

1.4. Using the Infrastructure Design Standards

The Infrastructure Design Standards are written to advise Charles Sturt University performance requirements and expectations that exist above and beyond existing industry codes and standards.

The Infrastructure Design Standards do not repeat codes and standards.

Performance to Codes and Standards are a non-negotiable regulatory minimum of any design solution, to be determined for each project by the design team.

The Standards are to be used by all parties who are engaged in the planning, design, and construction of Charles Sturt's facilities. This includes external consultants and contractors, Charles Sturt's planners, designers, and project managers as well as faculty and office staff who may be involved in the planning, design, maintenance, or refurbishment of facilities. All projects must comply with all relevant Australian Standards, NCC, EEO as well as Local Government and Crown Land Legislation.

1.5. Modules

The Standards are divided into the following modules for ease of use, but must be considered in its entirety, regardless of specific discipline or responsibilities:

- S01 Overview and Universal Requirements
- S02 Active Transport
- **S03 Acoustics**
- S04 Building Management System
- S05 Electrical and Lighting
- S06 Energy Management
- S07 Ergonomics
- S08 Fire and Safety Systems
- S09 Floor and Window Coverings
- S10 Furniture
- S11 Heritage and Culture
- S12 Hydraulic

- S13 Information Technology
- S14 Irrigation
- S15 Mechanical Services
- S16 Roof Access
- S17 Termite Protection, Vermin Proofing and Pest Management
- S18 Security Systems
- S19 Signage
- S20 Sustainable Building Guidelines
- S21 Waste Management
- S22 Project Digital Asset and Data Requirements
- S23 Commissioning, Handover and Training

1.6. Related Documents

1.6.1. University Documents

The Standards are to be read in conjunction with the following relevant University documents, including but not limited to:

- Facilities and Premises Policy along with supporting procedures and guidelines
- Charles Sturt University Accessibility Action Plan 2020 - 2023
- Relevant operational and maintenance manuals
- Charles Sturt University Asbestos Management Plan
- Charles Sturt University Signage Guidelines
- Charles Sturt University Modern Slavery Statement
- Charles Sturt University Sustainability Statement
- Charles Sturt University Work Health and Safety Policy
- Charles Sturt University Risk Management Policy
- Charles Sturt University Resilience Policy
- Charles Sturt University Health, Safety and Wellbeing Policy

1.6.2. Federal Legislation

The planning, design and construction of each Charles Sturt University facility must fully comply with current relevant Federal legislation, including but not limited to:

- National Construction Code (NCC)
- Disability Discrimination Act 1992 (DDA)
- Environment Protection and Biodiversity Conservation Act 1999 (EPBC)
- Work Health and Safety Act 2011

1.6.3. NSW State Legislation

The planning, design and construction of each Charles Sturt University facility must fully comply with current relevant Federal legislation, including but not limited to:

- Work Health and Safety Act 2011
- Environmental Planning and Assessment Act 1979 (EP&A Act)
- Building and Development Certifiers Act 2018
- Heritage Act 1977
- Protection of the Environment Operations Act 1997 (POEO Act)
- Design and Building Practitioners Act 2020
- State Environmental Planning Policies (SEPPs)
- Local Government Act 1993

1.6.4. Federal Regulations and Standards

- Relevant Australian or Australian/New Zealand Standards (AS/NZS)
- Safe Work Australia Model Codes of Practice
- Work Health and Safety Regulations 2011
- Disability (Access to Premises – Buildings) Standards 2010
- National Environment Protection Measures (NEPMs)

1.6.5. NSW State Regulations and Standards

- SafeWork NSW Codes of Practice
- Disability (Access to Premises – Buildings) Standards 2010
- Building and Development Certifiers Regulation 2020
- NSW Work Health and Safety Regulation 2017
- Protection of the Environment Operations (General) Regulation 2022
- NSW State Environmental Planning Policies (SEPPs)
- Fire and Rescue NSW Fire Safety Guidelines
- NSW Local Council Development Control Plans (DCPs)

1.6.6. Manufacturer Specifications and Data Sheets

All installation must be carried out in accordance with manufacturer specifications and data sheets to ensure product performance over its intended life and so as not to invalidate any warranties.

1.6.7. Project-Specific Documents

Requirements specific to a particular project, campus, or other variable, will be covered by project specific documentation, such as client briefs, specifications, and drawings. These Standards will supplement any such project specific documentation. The Standards do not take precedence over any contract document, although they will typically be cross-referenced in such documentation.

Extracts from the Standards may be incorporated in specifications; however, it must remain the consultant's and contractor's responsibility to fully investigate the needs of the University and produce designs and documents that are entirely 'fit for purpose' and which meet the 'intent' of the project brief.

1.7. Discrepancies

The Standards outline the University's generic requirements above and beyond the above-mentioned legislation. Where the Standards outline a higher standard than within the relevant legislation, the Standards will take precedence. If any discrepancies are found between any relevant legislation, the Standards and project specific documentation, these discrepancies should be highlighted in writing to the Manager, Capital Works.

1.8. Departures

The intent of the Standards is to achieve consistency in the quality of the design and construction of the University's built forms. However, consultants and contractors are expected to propose 'best practice / state of the art' construction techniques, and introduce technological changes that support pragmatic, innovative design. In recognition of this, any departures from relevant legislation, or the Standards, if allowed, must be confirmed in writing by the Manager, Capital Works. Any departures made without such written confirmation shall be rectified at no cost to the University.

1.9. Professional Services

All projects at Charles Sturt University require the involvement of adequately skilled and experienced professionals to interpret and implement the Standards. Consultants or contractors lacking proper qualifications and licenses are not permitted to conduct any work.

1.10. Structure of Document

This document is structured into 4 sections:

Section 1 Introduction (this Section).

Section 2 General Requirements – outlines the general requirements or design philosophies adopted at Charles Sturt University.

Section 3 Supporting Documentation – Legislation, Standards, Codes of Practice, University Policies, and other applicable technical references.

Section 4 Specifications (if applicable) – materials specifications and/or preferred lists for materials, processes or equipment used by Charles Sturt University.

2. General Requirements

2.1. Overview

This module of the Facility Design Standards outlines the essential acoustic criteria for both new constructions and renovations within the university. This document is adapted from the Charles Sturt University Technical Acoustic Guideline V01 prepared by WSP in October 2019.

Project Officers must facilitate the development of specifications that meet these standards and other guidelines set forth in the Facility Design Standards. Prior to commencing any on-site work, all designs must undergo review and approval by the university, in compliance with relevant statutory regulations. The design of building and associated spaces at the University should address the following acoustic parameters:

- Internal noise levels
- Noise emission (to the environment)
- Room to room noise control
- Room acoustics (principally reverberation time)
- Vibration control for sensitive equipment

The investment in acoustic treatment must be considered as part of design and must not be value engineered to align with budgetary constraints. Departures from the Facility Design Standards requires approval from the Manager, Capital Works with justification from a qualified Acoustic Consultant is necessary for any proposed modifications. Consultants must be members of the Association of Australasian Acoustical Consultants (AAAC). Their involvement is especially critical in areas requiring high acoustic performance, such as spaces affected by high noise levels (e.g., roads, plant rooms), noise-sensitive environments (e.g., performance spaces, libraries), vibration-sensitive areas (e.g., laboratories), and spaces needing speech privacy (e.g., private offices, counselling rooms).

Examples of spaces demanding exceptional acoustic standards include auditoriums, lecture halls, conference rooms, enclosed workspace, libraries, study areas, theatres, drama, dance, and music rooms, as well as student residences. Separate acoustic requirements are specified for laboratories housing sensitive equipment like electron microscopes and bio-resources.

This document contains numerous terms used when defining and measuring acoustics. Definitions can be found in Section 4.5.

2.2. Sound Insulation

This section outlines performance requirements with respect to sound insulation including:

- Airborne sound and insulation of walls and floors
- Impact noise control of walls
- Impact sound insulation of floors

Example constructions to meet these performance requirements are provided within Sections 4.6 to 4.8.

2.2.1. Refurbishment Projects

For a refurbishment project, the first objective shall be to achieve the onsite sound insulation ratings for new-build projects as outlined in Section 2.2.1.

In a refurbishment project where the building fabric (walls and floors) are not intended to be altered, the Engineer shall liaise with Charles Sturt University to establish if the existing partitions and / or floors are meeting the users' expectations. If existing construction details are not documented or the acoustic performance of the existing partitions is predicted to be below the applicable new-build criteria, benchmark testing may be necessary to establish the actual onsite performance. Depending on cost constraints, potential performance increases should be considered for critical areas.

2.2.1. New Build Projects

2.2.1.1. Airborne Noise Walls and Floors

As sound insulation performance requirements rely on an adjacency of uses (not just the use of one room), the targeted performance will be reliant on the predicted activity noise in one space and the likely acceptable noise tolerance of the adjacent space.

The following matrix (Table 1) details out the Charles Sturt University room types and the required on-site sound insulation (dB $D_{nT,w}$) between these spaces. Note that the acoustic design criteria are provided on-field performance $D_{nT,w}$ ratings. Typically, $D_{nT,w}$ ratings relate approximately to the R_w laboratory rating of an element, minus 5-10 dB, i.e.:

$D_{nT,w}$ rating = R_w rating – 5-10dB

Note that recording facilities or other specialist spaces have not been included within this table. Specialist services should be sought from an appropriately qualified acoustic engineer for the sound insulation design of such spaces.

2.2.1.2. Airborne Noise - Operable Walls

Movable partitions seldom perform acoustically as expected on-site and generally fall below the level of sound insulation of drywall constructions with similar laboratory ratings due to the number of compression seals, etc. Where movable partitions are employed, these will require careful specification, detailing and installation.

However, there should also be an expectation and knowledge from the users that where movable partitions are to be utilised, this may be at the loss of ideal acoustic performance.

Single operable walls are available as standard products up to a performance of 53-55dB R_w. When installed correctly with flanking control would be expected to achieve a maximum on-site rating ($D_{nT,w}$) of approximately 10dB less than the laboratory rating (R_w). Where Table 1 requires the adjacency to achieve 50 dB $D_{nT,w}$ or greater, double operable walls or a relaxation in the acoustic performance targeted will be required. Where a relaxation is applied, this is to be discussed and agreed with Charles Sturt University stakeholders / user groups.

Table 1 - Acoustic design criteria – Airborne sound insulation (onsite performance)

			Activity noise in source room			
			Low	**Average**	**High**	**Very High**
			Counselling / interview, first aid, library-reading, Study rooms, open plan workspace, enclosed workspace, meeting rooms	Atria, art studio, teaching space (<50 people), teaching space (with and without speech reinforcement), library-general, tutorial, computer rooms-teaching and laboratory, corridors/lobbies, laboratory-teaching and working, staff room, toilets	Drama studio, engineering workshops, meeting rooms (video conferencing) teaching space (with speech reinforcement)	Dance studio, music practice, music studio
Noise tolerance in receiving room	High	Atria, corridors/lobbies, engineering workshops, toilets	30 dB $D_{nT,w}$	35 dB $D_{nT,w}$	45 dB $D_{nT,w}$	45 dB $D_{nT,w}$
	Medium	Art studio, computer room-laboratory and teaching, Counselling/interview, dance studio, first aid, laboratory-teaching and working, library-general, professional, and administrative workspace, staff room	35 dB $D_{nT,w}$	40 dB $D_{nT,w}$	45 dB $D_{nT,w}$	50 dB $D_{nT,w}$
	Low	Drama studio, library-reading, music practice, teaching space (<50 people), teaching space (with or without speech reinforcement), study rooms, open plan workspace, meeting rooms	40 dB $D_{nT,w}$	45 dB $D_{nT,w}$	50 dB $D_{nT,w}$	55 dB $D_{nT,w}$
	Very Low	Meeting rooms (video conferencing), music studio	45 dB $D_{nT,w}$	50 dB $D_{nT,w}$	55 dB $D_{nT,w}$	60 dB $D_{nT,w}$

2.2.1.3. Airborne Noise - Room Front Walls and Doors

Partitions for room access (with doors) are rated lower as doors are limited in their sound insulating ability. In general, this is acceptable for rooms where a corridor is located outside a room, due to the transient nature of the corridor. Table 2 outlines the laboratory rating requirements for sound insulation (dB R_w) of the individual wall elements. The on-site performance of the overall partition is generally expected to be driven by the lowest performing wall element.

Table 2 – Recommendation for sound insulation - Room fronts (laboratory ratings)

Wall element	**Low**	**Medium**	**High**
	Computer rooms, laboratories, art studio, staff room, teaching spaces, computer rooms, enclosed workspace, counselling / interview, meeting rooms	Music practice, teaching space (with IVT capabilities), drama / dance studio, meeting rooms (VC)	Music studio, engineering workshop
Doors	30 dB R_w	34 dB R_w	40 dB R_w or lobbied 30 dB R_w doors
Solid walls	40 dB R_w	45 dB R_w	50 dB R_w
Vision panels (Note 1)	33 dB R_w	35 dB R_w	39 dB R_w
Fully glazed walls	39 dB R_w	44 dB R_w	Fully glazed partitions not recommended (specialist advice to be sought if required)

(1) Vision panels may have reduced performance in comparison to fully glazed walls due to the limited area of glazing (maximum 20%). If panels are bigger, an acoustic assessment should be undertaken to ensure the composite value is not detrimentally affected or glazing compliant with the requirement for fully glazed walls can be selected.

2.2.1.4. Impact Noise - Walls

Where pipes service a bathroom, kitchen, etc run through a wall adjacent an enclosed room which is typically occupied for longer durations; teaching, workspace, etc, the wall shall be of discontinuous construction (e.g., twin stud dry wall) the pipes within the wall shall be resiliently tied to the side of the wall of which they service.

2.2.1.5. Impact Noise - Lift Shaft Walls

Enclosed spaces which are typically occupied for longer durations (e.g., teaching, workspace, etc) adjacent to lifts shall be provided with an additional lining spaced off the lift shaft wall to prevent structure-born noise from the lift being readily audible in the adjacent space. Typical construction as follows:

- 2 layers of 13mm standard plasterboard (8.5 mg/m^2)
- Minimum of 64mm steel studs independent of the lift shaft wall by a minimum of 200 clear
- 50mm acoustic insulation (minimum of 11 kg/m^3) in cavity
- Lift shaft wall (to be confirmed on a case-by-case basis)

2.2.1.6. Impact Noise - Floors

Vertical impact noise shall be controlled to the following onsite performance based of the use of the space below. The required maximum onsite impact sound insulation ratings (dB $L_{nT,w}$) are listed in Table 3 below.

Table 3 - Acoustic design criteria - impact sound insulation

Room Use of Space Below	Maximum Onsite Impact Insulation Rating dB $L_{nT,w}$
Art Studio	60
Atria	65
Computer Room - Teaching	60
Computer Room - Laboratory	60
Corridors and Lobbies	65
Counselling / Interview Room	55
Drama / Dance Studio	55
Engineering Workshop	65
First Aid	60
Laboratory - Teaching	60
Laboratory - Working	65
Library - General Areas	55
Library - Reading Areas	55
Meeting Room	60
Meeting Room - Video Conferencing	60
Music Practice	55
Music Studio	55
Open Plan Workspace	60
Professional and Administrative Offices	60
Staff Common Room	65
Study Room	60
Teaching Space - <50 people	60
Teaching Space - without speech reinforcement	55
Teaching Space - with speech reinforcement	55
Toilets	-

2.3. Internal Ambient Noise

The objective of the criteria within the following sections is to provide suitable indoor ambient noise levels and to ensure speech is clear between staff and students.

Internal ambient sound levels should be controlled to provide good conditions for communication and ensure audibility of public address systems.

Internal ambient noise levels are contributed by various noise sources:

- Building services equipment (e.g., ventilation systems, exhaust fans, etc.)
- Noise from external sources (e.g., traffic, industry, etc.)
- Rain of roof noise

2.3.1. Ambient Noise Criteria

The following ambient noise criteria as listed in Table 4 shall be met considering both building services and noise ingress paths to each space.

Where a space is naturally ventilated, the ventilators or windows should be assumed to be open for the design.

Table 4 - Acoustic design criteria - Ambient noise

Room Use	Indoor Ambient Noise Level L_{EQ} (dBA)	Relaxed Criteria for Naturally Ventilated Spaces L_{EQ} (dBA)
	Design sound level range	Maximum with windows open
Art Studio	40 – 45	50
Atria	40 – 50	50
Computer Room - Teaching	40 – 45	50
Computer Room - Laboratory	45 – 50	55
Corridors and Lobbies	< 50	55
Counselling / Interview Room	40 – 45	50
Drama / Dance Studio	35 – 40	45
Engineering Workshop - Teaching	< 45	50
Engineering Workshop - Non-teaching	< 60	65
First Aid	40 – 45	50
Laboratory - Teaching	35 – 45	45
Laboratory - Working	40 – 50	50
Library - General Areas	40 – 50	50
Library - Reading Areas	40 – 45	50
Meeting Room	40 – 45	50
Meeting Room - Video Conferencing	30 – 40	40
Music Practice	40 – 45	50
Music Studio	30 – 35	40
Open Plan Workspace	40 – 45	50

Room Use	Indoor Ambient Noise Level LEQ (dBA)	Relaxed Criteria for Naturally Ventilated Spaces LEQ (dBA)
	Design sound level range	Maximum with windows open
Professional and Administrative Offices	35 – 40	45
Staff Common Room	40 – 45	50
Study Room	40 – 45	50
Teaching Space - <50 people	30 – 35	40
Teaching Space - without speech reinforcement	30 – 35	40
Teaching Space - with speech reinforcement	30 – 40	40
Toilets	45 – 55	55

2.3.1. Rain on Roof Noise Criteria

The noise generated by rain on the roof should be designed to be controlled to the maximum levels outlined in Table 5 based on typical design conditions for non-tropical Australia with rainfall intensity of 10mm/hour.

Table 5 - Acoustic design criteria - Rain noise

Room Use	Maximum LEQ (dBA) Due to Rain on Roof
Art Studio	50
Atria	55
Computer Room - Teaching	50
Computer Room - Laboratory	55
Corridors and Lobbies	55
Counselling / Interview Room	50
Drama / Dance Studio	45
Engineering Workshop - Teaching	50
Engineering Workshop - Non-teaching	65
First Aid	50
Laboratory - Teaching	60
Laboratory - Working	55
Library - General Areas	55
Library - Reading Areas	50
Meeting Room	50
Meeting Room - Video Conferencing	45
Music Practice	50
Music Studio	40

Room Use	Maximum LEQ (dBA) Due to Rain on Roof
Open Plan Workspace	50
Professional and Administrative Offices	45
Staff Common Room	50
Study Room	50
Teaching Space - <50 people	40
Teaching Space - without speech reinforcement	40
Teaching Space - with speech reinforcement	45
Toilets	60

2.3.2. Aircraft Noise Intrusion Criteria

The assessment of potential aircraft noise exposure at a given site is to be based on the appropriate Australian Noise Exposure Forecast (ANEF) chart outlining the noise exposure contours. The assessment is to be based on the highest value ANEF contour which crosses the building and all the following guidance:

- **Acceptable (<20 ANEF zone):** There is usually no need for the building construction to provide protection specifically against aircraft. This should be confirmed by an acoustic engineer.
- **Conditionally Acceptable (20-25 ANEF Zone):** The maximum aircraft noise levels for the relevant aircraft and the required noise reduction required based on the indoor sound levels provided in Table 6 should be determined as per AS2021.
- **Unacceptable (>25 ANEF Zone):** Construction of the building should generally not be considered.

The indoor design sound levels for determinisation of aircraft noise reduction are provided in Table 6.

Table 6 - Acoustic design criteria - Aircraft noise intrusion

Room Use	Indoor Design Sound Level LEQ (dBA) for Aircraft Noise
Libraries and Study Areas	50
Open Plan Workspace	65
Enclosed Workspace and Conference Rooms	55
Teaching and Assembly Areas	55
Workshops and Gymnasia	**75**

2.4. Control of Reverberation

Reverberation refers to the behaviour of sound within a room. In a highly reverberation environment, sound takes longer to decay and effectively:

- Speech becomes more difficult to hear as the long delay blurs successive syllables into each other.
- A build-up of noise occurs as the sound takes longer to be absorbed. When this build-up occurs:
    - This may increase the noise levels in adjacent noise sensitive spaces.

- o There is a ‘snowball’ effect as voices are raised to be heard over the noise.

Reverberation time should be controlled as per Table 7.

Table 7 - Acoustic design criteria - Reverberation time

Room Use	Reverberation Time T_{MF} Maximum(s)
Art Studio	≤ 0.8
Atria	Note 2
Computer Room - Teaching	≤ 0.6
Computer Room - Laboratory	≤ 0.6
Corridors and Lobbies	≤ 0.8
Counselling / Interview Room	≤ 0.6
Drama / Dance Studio	Note 1
Engineering Workshop - Teaching	Note 2
Engineering Workshop - Non-teaching	Note 2
First Aid	≤ 0.8
Laboratory - Teaching	≤ 0.8
Laboratory - Working	≤ 0.8
Library - General Areas	≤ 0.6
Library - Reading Areas	≤ 0.6
Meeting Room	≤ 0.6
Meeting Room - Video Conferencing	≤ 0.4
Music Practice	≤ 0.9
Music Studio	Note 1
Open Plan Workspace	≤ 0.7
Professional and Administrative Offices	≤ 0.8
Staff Common Room	≤ 0.6
Study Room	≤ 0.8
Teaching Space - <50 people	Note 1
Teaching Space - without speech reinforcement	Note 1
Teaching Space - with speech reinforcement	Note 1 and 3
Toilets	-

(1) The appropriate reverberation time shall be influenced by the use, volume, and geometry of the space.

(2) Reverberation time should be minimised for noise control.

(3) Guidance from an acoustic engineer should be sought, and the design developed in conjunction with any sound reinforcement systems to meet the overall Speech Transmission Index for the space (see Section 2.5).

2.4.1. Design Guidance for Reverberation Control

2.4.1.1. Video Conferencing Meeting Rooms

Within a video conferencing (VC) room, reflections between parallel hard surfaces can cause unclear transmission of sound to the far end of the call.

To control this, the acoustic treatment within a VC room should be located such as to minimise this effect. The following general guidance applies:

- Hard surface finish above the project / meeting table with sound absorptive treatment applied to the ceiling along the perimeter of the room.
- Wall treatment to a minimum of two walls:
  - The wall facing parallel to the VC system should have a sound absorptive finish.
  - Treatment should be applied to perpendicular walls.
  - The wall treatment should, at a minimum, be a 1m high band located at seat height with a minimum performance of NRC ≥ 0.7. Where larger areas of treatment are provided, the acoustic performance may be reduced, and the spatial acoustic design of the room should be reviewed by an acoustic engineer.
- Carpet floors are highly recommended.

2.4.1.2. Teaching Spaces

Teaching spaces should be designed to enhance early reflections and control late reflections to improve intelligibility and clarity of speech.

The following general guidance applies:

- Hard surface finishes in the area above and behind the lecturer.
- Absorptive treatment to the ceiling towards the back of the room, the back wall and, if required, to the side walls towards the back of the space.

2.4.1.3. Laboratories

Laboratories, by their nature, contain hard surfaces and are therefore usually very reverberant. To control the reverberation within any teaching laboratories, including Physical Containment (PC) rated laboratories, these spaces must be provided with absorptive treatment to the ceiling. This may be provided using hygienic ceiling tiles in a grid or direct fixed to a set plasterboard ceiling / wall.

2.4.1. Refurbishment Projects

Refurbishments of existing spaces shall avoid the acoustic absorptivity of existing materials unless additional treatment is inserted into the room as part of the refurbishment works. Common issues that sould be avoided at any cost include:

- Painting over ceiling tiles

- Removing pinboards or soft wall finishes
- Removing carpet flooring
- Painting over rough brickwork

In a refurbishment project where the surface finishes are not intended to be altered or finishes are intended to be replaced with like for like material, the acoustic engineer shall liaise with Charles Sturt University to establish conditions that meet the users' needs and expectations. If information about the absorptive properties for the existing finishes is not available, benchmark testing may be necessary to establish actual on-site performance.

2.5. Speech Intelligibility

The ability for students to be able to understand speech is key to the success of the learning experience. The Speech Transmission Index (STI) is a measure of speech transmission quality and expresses the ability of a communication path to relay the information contained in speech, where the communication path is the path the sound takes between the speaker and the listener.

The speech intelligibility is influenced by the room acoustics, ambient noise and where applicable audio systems are situated within a space.

Speech transmission is represented by a number between 0 and 1, where 1 is perfect speech intelligibility. Criteria for various Charles Sturt University teaching spaces are provided in Table 8 below.

Table 8 - Acoustic design criteria - Speech intelligibility

Room Use	Speech Transmission Index (STI)
Teaching spaces	> 0.60 – 0.75
Collaborative teaching / open plan teaching	> 0.70

2.6. Vibration

Vibration from services equipment and equipment / machines used for teaching and research (e.g., within engineering workshops, materials laboratories, medical imagery, etc.) shall be controlled such that the user comfort and ambient noise levels are not affected.

2.6.1. Vibration Sensitive Equipment

Vibration sensitivities of medical imaging equipment (Avci et al., 2018), biomechanical force plates (Werkle et al., 2015), or any other vibration sensitive equipment will need to be taken into account in the design of supportive structure and selected anti-vibration mounts. The design of the spaces housing vibration sensitive equipment will be dependent on the operating specifications of the equipment type and the selected units.

2.6.2. Vibration Generating Equipment

2.6.2.1. Human Comfort

Equipment / machinery generating vibration within the development shall be designed such that the resultant vibration does not exceed the criteria detailed in Assessing Vibration: A technical Guideline (February 2006).

Acceptable values for continuous and impulsive vibration from 1 Hz - 80 Hz for spaces applicable to Charles Sturt University developments are presented in Table 9.

Table 9 - Vibration criteria

Location	Preferred Values – RMS 1-80HZ (M/S^2)		Maximum Values – RMS 1-80HZ (M/S^2)	
	Z- axis	X- and Y- axes	Z- axis	X- and Y- axes
Continuous vibration				
Educational institutions	0.020	0.014	0.040	0.028
Offices	0.020	0.041	0.040	0.028
Workshop	0.040	0.029	0.080	0.058
Impulsive vibration				
Educational institutions	0.64	0.46	1.28	0.92
Offices	0.64	0.46	1.28	0.92
Workshop	0.64	0.46	1.28	0.92

2.6.2.2. Reradiated Noise

Noise generated by vibration entering the structure and causing reradiated noise shall be controlled to 10dB below the internal ambient noise levels given in Section 2.3.1.

This may be achieved through locating equipment appropriately and provision of suitable anti-vibration mounts and inertia bases.

2.7. Environmental Noise Emissions

2.7.1.1. Planning and Statutory Requirements

Charles Sturt University campuses that are located on crown land are not subject to standard regulatory and planning requirements. Nonetheless, noise emissions to other university buildings and encroaching external developments should be designed with consideration to local planning requirements as a matter of due diligence.

2.7.1.2. Construction Noise Emissions

Environmental noise emissions from equipment associated with the development should be mitigated to minimise the impact to the external areas of the development. Noise emissions should be designed to not exceed 55dBA Leq at any occupied outdoor area and at the building façade to noise sensitive spaces.

University campuses continue to function throughout the year and all projects are to be undertaken in a way to maintain continuing building operation and limit impact on the continuing functions, with respect to both noise and services. Any construction works to existing buildings shall be designed and undertaken to limit the impact on the existing and continuing functions of adjacent areas of the building or site, particularly with respect to noise and services interruption.

Project Officers shall engage with local Campus Facilities Manages to identify sensitive land and building uses that may influence construction hours. More sensitive periods are during exam periods, and on some campuses, graduations. Sensitive land uses that could potentially be affected by construction noise include:

- Residential areas (on campus and external housing).
- Schools and childcare centres.
- Medical centres, dental clinics, and hospitals.
- Places of worship.
- Passive recreation areas, such as outdoor grounds used for teaching.
- Active recreation areas, including parks and sports grounds.

Other land uses that might occasionally be sensitive to construction noise encompass:

- Sensitive premises like film, television, and radio studios.
- Research facilities.
- Entertainment venues, restaurants, office buildings, and retail spaces.
- Temporary accommodation such as hotels.
- Certain industrial facilities housing noise-sensitive processes.

Residences and other sensitive land uses should be clearly identified and documented in the acoustic engineer's assessment. Construction noise levels can vary based on the distance from each sensitive land use, as well as intervening topography or buildings. Therefore, it is important to identify and consider sensitive land uses located farther from the construction site that could also experience adverse effects.

Further information regarding construction noise planning and management ca be found in the NSW Environmental Protection Authority (EPA) publication Draft Construction Noise Guideline (see Section 4.3)

2.8. Mechanical Services Acoustic Controls

Mechanical services noise within spaces must adhere to the noise rating (NR) curve, maintaining a level 3 dB(A) lower than the maximum recommended design sound level as per Australian Standard AS/NZS2107. For instance, a lecture room for up to 50 seats should have a maximum noise level of 35 dB(A), thus requiring an NR of 33.

All buildings must comply with Green Star requirements. Specific acoustic paths must be addressed, including:

- Fan noise through supply and return air ducts
- Breakout noise from plant rooms and ductwork
- Regenerated noise and structurally borne noise

Mechanical designs must incorporate acoustic attenuators or other sound attenuation measures where necessary to meet these criteria. Additionally, the design should ensure acoustic privacy between spaces is not compromised by mechanical services, particularly concerning noise transmission via return air paths.

Plant rooms housing high-noise equipment (e.g., chillers, generators, exhaust fans, pumps) must be constructed from masonry. Access doors should be strategically located in service areas and may require configurations such as back-to-back doors or acoustic lobbies achieving a dB R_W 40 design performance, especially when accessed from main corridors or circulation areas.

2.9. Provision for People Having Special Hearing or Communication Needs

Students, staff, partners, and visitors to the University with special hearing or communication needs may include, but are not limited to, individuals with permanent hearing impairment, or complex needs including:

- Speech, language, and communication difficulties
- Visual impairments
- Fluctuating hearing impairments caused by conductive hearing loss
- Attention deficit hyperactivity disorders (ADHD)
- An auditory processing disorder or difficulty
- Being on the autistic spectrum

The NSW Department of Education has made significant inroads towards improving outcomes for students with disability with considerable investment in school learning environments to ensure equitable access to facilities and learning opportunities. With students experiencing these environments during primary and high school, it is an expectation that universities will have similar strategies to improve the physical environment to drive equitable and inclusive participation in higher education.

Students with special educational needs typically exhibit heightened sensitivity to their acoustic surroundings compared to their peers. Therefore, the design specifications may necessitate shorter reverberation times, increased sound insulation between adjoining spaces, and reduced indoor ambient noise levels to minimise potential distractions.

Individuals with conditions such as hearing impairment and autism often demonstrate heightened sensitivity to specific types of noise, especially those characterised by strong tones, impulsiveness, or intermittent patterns. It is imperative to incorporate these considerations into the design of areas that may be utilised by individuals with such needs.

In some circumstances Alternative Performance Standards (APS) may be appropriate for specific areas within individual buildings for educational, environmental or health and safety reasons. In these cases, the following information should be provided as part of Gates 1 and 2 developments:

- A written report by a specialist acoustic consultant clearly identifying (a) all areas of non-compliance with the performance standards (b) the proposed alternative performance standards and (c) the technical basis upon which these alternative performance standards have been chosen.
- Written confirmation from the stakeholder client body of areas of non-compliance, together with the justification for the need and suitability of the APS in each space.

2.10. Acoustic Commissioning

During the commissioning phase of building projects, it is crucial to conduct three types of acoustic tests to ensure optimal acoustic performance. Firstly, ambient noise levels, including those originating from mechanical systems, must be measured across a representative sample of rooms. This assessment helps verify compliance with environmental noise regulations and ensures occupant comfort. Secondly, intrusive noise levels, such as those from traffic and aircraft, are evaluated to gauge their impact on indoor environments and to implement necessary mitigation strategies. Lastly, testing for noise isolation between different spaces is essential to maintain privacy and minimise disturbances.

Mechanical Services

- Ensure ambient noise levels meet design criteria during commissioning.
- Use independent acoustic consultants for testing and share results with contractors.
- Contractors must rectify any excessive noise levels caused by faulty equipment or installation.

Architectural Acoustics

- Follow current standards (e.g., AS/NZS 2107 for road traffic noise, AS/NZS 2021 for aircraft noise).
- Assess vibration levels according to AS 2670 guidelines.
- Measure Partition Weighted Level Differences (dB D_W) for privacy-sensitive spaces (AS/NZS 2253 and AS/NZS 1276).

Ambient Noise Adjacent to Mechanical Plant

- Monitor noise levels during normal operation.
- Install acoustic treatments if noise levels are excessive to meet criteria before project completion.

Intrusive Noise

- Evaluate traffic and aircraft noise levels as needed.
- Ensure compliance with acoustic comfort standards under the direction of project stakeholders.

2.11. Acoustic Post-Occupancy Evaluation

One of the most common points of client feedback for both new builds and refurbishments relates to acoustic issues. If directed by the project team or acoustic engineer, a post-occupancy evaluation will be conducted to assess specific acoustic parameters. The evaluation will adhere to ISO 1996-1:2016 and focus on selected aspects as outlined below:

Internal Noise Levels

- Post-occupancy evaluation of noise levels typically involves short-term attended measurements (approximately one hour) of steady-state LAeq noise levels in unoccupied yet prepared rooms.
- Longer or more detailed measurements may be necessary for specific sources (e.g., plant and equipment) if identified as issues post-occupancy.

Room Acoustics

- Evaluation of room acoustics post-occupancy will occur in spaces with specified reverberation time requirements. Reverberation time will be reported as the arithmetic average at 500 Hz and 1000 Hz, rounded to the nearest 0.1 second.
- More comprehensive measurements across octave bands (63 Hz to 8000 Hz) will be conducted if issues arise post-occupancy or if required for teaching spaces accommodating hearing-impaired students or recording studios.

Noise Emission

- Post-occupancy evaluation of noise emission will be undertaken if issues arise after occupancy or as mandated by development consent. This evaluation will assess noise emissions from stationary sources or transient activities within specific space elements within the facility.

Room-to-Room Acoustic Performance

- Evaluation of room-to-room acoustic performance may focus on airborne noise between:
  - Occupied teaching spaces and adjacent areas with noise-producing activities.
  - Workspace where acoustic leakage is reported.
- Tests will be conducted bidirectionally when applicable, with results reported as the lower value for compliance assessment.

3. Supporting Documentation

These below lists are not all-inclusive and those associated with the project are responsible for identifying and complying with all standards relevant to the scope of works.

3.1. Supporting Legislation

National Construction Code of Australia (NCC) 2022 (Cth)

Work Health and Safety Act 2011 (NSW)

Work Health and Safety Regulation 2017 (NSW)

Work Health and Safety Act 2011(ACT)

Work Health and Safety Regulation 2011(ACT)

Protection of the Environment Operations Act 1997 (NSW)

Environmental Planning and Assessment Act 1979 (NSW)

Environment Protection Act 1997 (ACT)

3.2. Supporting Standards

Standard Number	Standard Title
AS ISO 717.1:2024	Acoustics - Rating of sound insulation in buildings and of building elements, Part 1: Airborne sound insulation
AS ISO 717.2:2024	Acoustics - Rating of sound insulation in buildings and of building elements, Part 2: Impact sound insulation
AS 1055:2018	Acoustics - Description and measurement of environmental noise
AS 1191:2002	Acoustics - Method for laboratory measurement of airborne sound transmission insulation of building elements
AS/NZS 1269.0:2005	Occupational noise management, Part 0: Overview and general requirements
AS/NZS 1269.1:2005	Occupational noise management, Part 1: Measurement and assessment of noise immission and exposure
AS/NZS 1269.2:2005	Occupational noise management, Part 2: Noise control management
AS/NZS 1269.3:2005	Occupational noise management, Part 3: Hearing protector program
AS/NZS 1276.1:1999	Acoustics - Rating of sound insulation in buildings and of building elements Part 1: Airborne sound insulation
ISO 1996-1:2016	Acoustics - Description, measurement and assessment of environmental noise - Part 1: Basic quantities and assessment procedures
ISO 1996-2:2017	Acoustics - Description, measurement and assessment of environmental noise - Part 2: Determination of sound pressure levels
AS 2021:2015	Acoustics - Aircraft noise intrusion - Building siting and construction
AS/NZS 2107:2016	Acoustics - Recommended design sound levels and reverberation times for building interiors
ISO 9613-1:1993	Acoustics - Attenuation of sound during propagation outdoors - Part 1: Calculation of the absorption of sound by the atmosphere
ISO 9613-2:2024	Acoustics - Attenuation of sound during propagation outdoors - Part 2: Engineering method for the prediction of sound pressure levels outdoors
ISO 10140-1:2021	Acoustics - Laboratory measurement of sound insulation of building elements - Part 1: Application rules for specific products
ISO 10140-5:2021	Acoustics - Laboratory measurement of sound insulation of building elements - Part 5: Requirements for test facilities and equipment

Standard Number	Standard Title
ISO 26101-1:2021	Acoustics - Test methods for the qualification of the acoustic environment - Part 1: Qualification of free-field environments
ISO 26101-2:2024	Acoustics - Test methods for the qualification of the acoustic environment - Part 2: Determination of the environmental correction
ISO 12999-1:2020	Acoustics - Determination and application of measurement uncertainties in building acoustics - Part 1: Sound insulation
ISO 16032:2024	Acoustics - Measurement of sound pressure level from service equipment or activities in buildings - Engineering method
AS/NZS 60118.4:2017	Hearing loop systems - Methods of measuring and specifying the performance of systems

3.3. Industry Codes of Practice

NSW Environmental Protection Authority Noise Policy for Industry (2017)

https://www.epa.nsw.gov.au/your-environment/noise/industrial-noise/noise-policy-for-industry-(2017)

NSW Environmental Protection Authority Draft Construction Noise Guideline (2020)

https://hdp-au-prod-app-nswepa-yoursay-files.s3.ap-southeast-2.amazonaws.com/9416/0506/9710/DRAFT-construction-noise-guideline.pdf

National Occupational Health and Safety Commission Control Guide Management of Noise at Work

https://www.safeworkaustralia.gov.au/system/files/documents/1702/nationalstandardforoccupationalnoise_nohsc1007-2000_pdf.pdf

National Occupational Health and Safety Commission National Standard for Occupational Noise

https://www.safeworkaustralia.gov.au/system/files/documents/1702/control_guide_managementofnoiseatwork_1991_pdf.pdf

Australian Building Codes Board Sound Transmission and Insulation in Buildings

https://www.abcb.gov.au/sites/default/files/resources/2021/Handbook_Sound_Transmission_and_Insulation_in_Buildings.pdf

Association of Australian Acoustical Consultants (AAAC) Guideline for Child Care Centre Acoustic Assessment V3.0

https://aaac.org.au/resources/Documents/Public/AAAC%20Guideline%20for%20Child%20Care%20Centre%20Acoustic%20Assessment%20V3.0.pdf

Association of Australian Acoustical Consultants (AAAC) Guideline for Educational Facilities Acoustics V2.0

https://aaac.org.au/resources/Documents/Public/AAAC%20Guideline%20for%20Educational%20Facilities%20Acoustics%20V2.0.pdf

Association of Australian Acoustical Consultants (AAAC) Guideline for Healthcare Facilities V2.0

https://aaac.org.au/resources/Documents/Public/AAAC%20Guideline%20for%20Healthcare%20Facilities%20V2.0.pdf

Association of Australian Acoustical Consultants (AAAC) Commercial Building Acoustics Guideline V2.0

https://aaac.org.au/resources/Documents/Public/AAAC%20Commercial%20Building%20Acoustics%20Guideline%20V2.0.pdf

Association of Australian Acoustical Consultants (AAAC) Licensed Premises Guideline V3.0

https://aaac.org.au/resources/Documents/Public/AAAC%20Licensed%20Premises%20Guideline%20V3.0.pdf

Association of Australian Acoustical Consultants (AAAC) Guideline for Gyms and Exercise Facilities - Explanatory Notes V2.0

https://aaac.org.au/resources/Documents/Public/AAAC%20Guideline%20for%20Gyms%20and%20Exercise%20Facilities%20-%20Explanatory%20Notes_V2.pdf

Association of Educational Technology Managers (ATEM) Audio Visual Guidelines (account required)

https://www.aetm.org/membership/members-only/aetm-audio-visual-guidelines/

Green Star Buildings v1 (account required)

https://new.gbca.org.au/

NSW Department of Environment and Conservation Assessing Vibration: A Technical Guideline

https://www.environment.nsw.gov.au/resources/noise/vibrationguide0643.pdf

3.4. University Documents

Charles Sturt University Facilities and Premises Policy

https://policy.csu.edu.au/document/view-current.php?id=465

3.5. Other Resources

CSR The Gyprock Red Book

https://www.gyprock.com.au/resources/redbook

SafeWork NSW Noise

https://www.safework.nsw.gov.au/hazards-a-z/noise-at-work

SafeWork NSW Hazardous noise and hearing loss at work: The facts

https://www.safework.nsw.gov.au/resource-library/hazardous-manual-tasks/hazardous-noise-and-hearing-loss-at-work-the-facts

Vibrations Serviceability of a Medical Facility Floor for Sensitive Equipment Replacement: Evaluation with Sparse In Situ Data (Avci et al., 2018)

https://www.researchgate.net/publication/328517272_Vibrations_Serviceability_of_a_Medical_Facility_Floor_for_Sensitive_Equipment_Replacement_Evaluation_with_Sparse_In_Situ_Data

Influence of human induced floor vibrations on the measurement precision of force plates in a biomechanics laboratory (Werkle et al., 2015)

https://files.eccomasproceedia.org/papers/compdyn-2015/779.pdf?mtime=20170329171705

NSW Department of Education Progress Report: Improving Outcomes for Students with Disability 2022

https://education.nsw.gov.au/content/dam/main-education/teaching-and-learning/disability-learning-and-support/our-disability-strategy/Progress_Report_Improving_outcomes_for_students_with_disability_2022.PDF

3.6. Glossary

Term	Definition / Description
Alternative Performance Standards (APS)	Alternative acoustic performance standards focus on occupant satisfaction by setting tailored goals based on the environment's function, rather than relying on rigid metrics like sound pressure levels and reverberation times. Innovative designs, materials, and sustainability objectives are used to achieve these goals, enhancing acoustic quality through flexible and creative approaches
Australian Noise Exposure Forecast (ANEFF)	A tool used to predict and assess aircraft noise exposure around airports in Australia. It provides a standardised method for estimating noise levels in surrounding communities based on aircraft movements, flight paths, and other relevant factors. ANEFF helps authorities and planners in evaluating potential noise impacts, implementing noise mitigation strategies, and informing land-use planning decisions near airports to minimise community exposure to aircraft noise.
Ceiling Attenuation Class (CAC)	Measures how effectively a ceiling system reduces airborne sound transmission between adjacent spaces. It evaluates the ceiling's ability to block sound across different frequencies, with a higher CAC rating indicating better sound isolation. This rating is critical for ensuring acoustic privacy and reducing noise disturbances in environments like offices, healthcare facilities, and educational institutions. Building codes often specify minimum CAC ratings to meet standards for noise reduction and acoustic comfort.
Decibel (dB)	A unit of measurement used to express the intensity of sound or the ratio of one sound intensity to another. It is logarithmic, representing a tenfold increase or decrease in intensity for every 10 dB change. In acoustics, 0 dB typically denotes the threshold of human hearing, with higher values indicating louder sounds
Frequency (Hz)	Frequency, measured in Hertz (Hz), indicates how often something happens within a specific time frame. In acoustics, it refers to the number of cycles or vibrations of a sound wave per second. Higher frequencies correspond to higher-pitched sounds, while lower frequencies correspond to lower-pitched sounds.
Equivalent Continuous Sound Level LEQ (dBA)	LEQ is a measure of the average noise level over a specific period, usually in A-weighted decibels (dBA). It represents a constant sound level that would convey the same total acoustic energy as the varying sound levels experienced during the measurement. LEQ is widely used in noise assessment and environmental monitoring to quantify average noise exposure levels, offering a single value that reflects overall noise energy over time, adjusted for human ear sensitivity to different frequencies.
Equivalent Continuous Sound Pressure Level (LAeq)	Metric used to express the average sound level over a defined period, typically in environmental and occupational noise assessments. Represented in decibels (dB), it incorporates A-weighting to approximate human auditory sensitivity and provides a single value reflecting the cumulative noise exposure during that timeframe. For instance, "LAeq,8h" denotes the A-weighted equivalent continuous sound level over an 8-hour period, crucial for evaluating compliance with noise regulations and assessing potential impacts on human health and well-being.

Term	Definition / Description
Noise Rating (NR)	Quantification of the overall reduction in indoor noise levels. It assesses the effectiveness of acoustic measures such as architectural design and sound insulation in creating suitable environments for activities like teaching in lecture rooms or working in offices. Maintaining a specified NR rating ensures spaces minimise distractions from external noise and mechanical systems, promoting comfort and productivity in educational and operational settings.
Noise Reduction Coefficient (NRC)	The average sound absorption capabilities of a material across a range of frequencies. It indicates the effectiveness of a material in reducing sound reverberation within a space. The NRC rating ranges from 0 to 1, where higher values indicate greater sound absorption. NRC is commonly used in acoustics to evaluate and select materials for improving room acoustics by reducing echo and improving speech intelligibility.
Partition Weighted Level Differences (dB D_W)	The evaluation the sound insulation provided by partitions between rooms. Defined by AS/NZS 1276, dB D_W quantifies the difference in sound levels across different frequencies, considering both airborne and structure-borne sound transmission. These measurements are crucial for ensuring privacy and reducing noise disturbance between spaces in buildings. By assessing dB D_W values, architects and engineers can select appropriate partition materials and designs to meet regulatory acoustic standards and enhance overall acoustic comfort within indoor environments.
Reverberation Time (T_{MF})	The duration it takes for sound to decay in a room after the source of the sound stops. It is a measure of the acoustic quality of a space, indicating how long sound persists in the room before becoming inaudible. The subscript "MF" typically denotes the frequency bands used in the measurement, such as mid-frequency bands. Reverberation time is crucial for various applications, including auditoriums, concert halls, classrooms, and recording studios, where appropriate reverberation levels are essential for sound clarity, speech intelligibility, and overall acoustic performance.
Speech Transmission Index (STI)	A numerical measure used to assess speech intelligibility in communication systems by evaluating factors like background noise, reverberation, and equipment characteristics. It ranges from 0 to 1, with higher values indicating better speech clarity. STI is crucial for optimising systems such as public address and conference systems, ensuring effective communication in various environments by measuring how well speech can be understood amidst environmental and equipment-related distortions.
Weighted Sound Reduction Index (dB R_W)	Measures the sound reduction capabilities of materials and structures across different frequencies. It indicates how effective they are in reducing the transmission of sound, with higher values indicating better sound insulation. This metric is crucial for specifying and comparing the acoustic performance of building elements such as walls and windows, ensuring environments meet desired noise control standards.
Weighted Standardised Impact Sound Pressure Level (dB $L_{nT,w}$)	The cumulative noise level over a specific time period, typically in decibels (dB). It is commonly employed in noise assessments and environmental monitoring to quantify the total noise exposure experienced by individuals or sensitive receptors over a specified period, considering both continuous and intermittent noise sources. The "L" represents the equivalent continuous sound level, while the "nT,w" denotes the time-weighted adjustment factor applied to account for variations in noise levels and their duration throughout the measurement period. This measure helps assess noise exposure in a way that aligns with human perception and potential health impacts
Weighted Standardised Level Difference ($D_{nT,w}$)	Standardised single number rating used to express the airborne sound insulation of building elements such as walls, floors, and ceilings. It is often used in building acoustics to quantify the sound insulation performance in a standardised manner. The measurement and reporting of $D_{nT,w}$ values typically adhere to ISO 717 standards, specifically ISO 717-1:2013 Part 1, which provides guidelines for laboratory measurements and calculations of airborne sound insulation.

4. Specifications

4.1. Example Wall Constructions

The following table provides example wall construction to meet the ratings outlined in Section XX. The wall constructions are provided as examples only as actual on-site performances will be heavily dependent on junctions, detailing and materials selections.

Table 10 - Sound Insulation - example with constructions

Onsite Performance	Laboratory Rating	Construction	Details
35 dB $D_{nT,w}$	40 dB $D_{nT,w}$	Single stud drywall	• 1 x 13mm standard plasterboard (8.5kg/m² per layer) • 64mm metal stud frame • 50mm insulation (minimum 11kg/m³) in cavity • 1 x 13mm standard plasterboard (8.5kg/m² per layer)
40 dB $D_{nT,w}$	45 dB $D_{nT,w}$	Single stud drywall	• 2 x 13mm standard plasterboard (8.5kg/m² per layer) • 64mm metal stud frame • 50mm insulation (minimum 11kg/m³) in cavity • 1 x 13mm standard plasterboard (8.5kg/m² per layer)
45 dB $D_{nT,w}$	50 dB $D_{nT,w}$	Single stud drywall	• 1 x 13mm dense plasterboard (8.5kg/m² per layer) • 64mm metal stud at 600mm centres • 50mm insulation (minimum 11kg/m3) in cavity • 2 x 13mm dense plasterboard (13kg/m2 per layer)
50 dB $D_{nT,w}$	55 dB $D_{nT,w}$	Single stud drywall	• 2 x 13mm fire rated plasterboard (8.5kg/m² per layer) • 92mm staggered metal stud frame. 64mm studs within 92mm frame • 50mm insulation (minimum 11kg/m3) in cavity • 2 x 13mm fire rated plasterboard (8.5kg/m² per layer)

(1) For any ceiling type, a full height slab-to-slab partition is required for walls rated 45dB R_w and above. Where ceilings either side of the partition have a minimum CAC35 rating, partitions rated at 40 dB R_w can be built to the ceiling line only with a positive seal and with the following ceiling void protection: 32kg/m³ insulation packed at 30% compression 20 300mm both sides of the partition or mass barrier with minimum 8kg/m².

4.2. Example Glazing Constructions

The following table provides example glazing construction to meet the ratings outlined in Section XX.

Table 11 - Sound insulation - example glazing constructions.

Onsite Performance	Laboratory Rating	Construction	Details
30 dB $D_{nT,w}$	435 dB R_w	Single glazing	• 10.38mm laminate glazing
34 dB $D_{nT,w}$	39 dB R_w	Single glazing	• 12.76mm laminated glazing, or • 10.5mm Vlam Hush glazing (CSR Viridian)
35 dB $D_{nT,w}$	40 dB R_w	Single glazing	• 12.5mm Vlam Hush glazing (CSR Viridian)
40 dB $D_{nT,w}$	45 dB R_w	Single glazing	• 6.38mm laminate glazing / 50mm air gap / 10.38mm laminated glazing • Frame to be packed with 25kg/m3 polyester or glass wool insulation

(1) For any ceiling type, a full height slab-to-slab partition is required for walls rated 45dB R_w and above. Where ceilings either side of the partition have a minimum CAC35 rating, partitions rated 35-40 dB R_w can be built to the ceiling line only with a positive seal and with the following ceiling void protection: 32kg/m^3 insulation packed at 30% compression to 300mm both sides of the partition or mass barrier with a minimum 8kg/m^2.

4.3. Example Floor Constructions

The following table provides example glazing construction to meet the ratings outlined in Section XX.

Table 12 - Sound Insulation - example floor considerations

Airborne Sound Insulation Onsite Performance	Airborne Sound Insulation Laboratory Rating	Details
50 dB $D_{nT,w}$	55 dB R_w	• 200mm concrete
45 dB $D_{nT,w}$	50 dB R_w	• 150mm concrete
40 dB $D_{nT,w}$	45 dB R_w	• 100mm concrete

To meet impact sound insulation requirements, floor finishes should include:

- Carpet
- Timber finish with acoustically rated underlay
- Vinyl finish with acoustically rated underlay

Floors with an impact rating 55 dB $L_{nT,w}$ likely require a ceiling to the space below to achieve nominated rating.