

CURTIN UNIVERSITY
PROJECT DELIVERY GUIDELINES

**ACOUSTIC REQUIREMENTS
GUIDELINES**

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Curtin University

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1 INTRODUCTION

1.1 GENERAL PURPOSE

The purpose of this document is to provide Curtin University's expectations and principles in undertaking works projects on the campus by design consultants and construction contractors for Curtin University projects.

This document is intended for use by all design and technical consultants, architects, engineers and building, trade or supply contractors.

It is expected that consultants will consider the most appropriate contemporary functional/aesthetic design outcomes, coordination of services, coordinated installation and ensure that all selected building materials and services are fit for purpose, provide value for money, are of sound construction, offer local support, integrate with other services and design concepts, and are easily maintained within the University environment.

It is expected that building contractors will engage their building skills, materials knowledge, time and cost-efficient methodologies to deliver a fit-for-purpose facility in compliance with the contract conditions, drawings and specifications. They should implement their management skills to harness the complementary skills of the consultants and client technical users in a cooperative engagement environment.

1.2 INTRODUCTION

The purpose of this document is to provide an overview of planning principles for acoustic design. This document is intended for use by consultants, architects, engineers and other design services. The acoustic consultancy should consider in the design phase of any project the best design outcomes, coordination of services, coordinated installation and ensure that all selected building materials and services are fit for purpose, provide value for money, are of sound construction, offer local support, integrate with other services and design concepts, are easily maintained and can be scaled to within the University environment.

Where Australian and international standards are referenced in this document, the application of the standard shall be, unless specifically stated to the contrary, the latest edition and amendment available on the date 30 calendar days prior to the project starting date for which this guideline is relevant.

Where specifications or standards or any other references referred to in this document refer in turn to other specifications, standards or documents whether whole or in part, those consequential references shall apply to this document as if they were completely contained in their entirety in the original reference.

These guidelines establish the standards and objectives for the planning, design, documentation and construction of facilities for Curtin University. These guidelines cover an array of acoustic requirements that occur across the University, including:

- new development
- refurbishments

- internal fitouts
- services modifications and upgrades
- installation of new plant and/or equipment.

Associated with the above, the acoustical requirements that need to be considered would include:

- acoustic privacy
- internal reverberation times
- service noise levels, including mechanical, electrical, hydraulic and lifts
- ambient noise intrusion
- noise emissions from services
- noise emissions from internal usage e.g. laboratories, sports facilities and performance theatres.

It is noted that while this document covers a wide array of projects undertaken by Curtin University, it does not cover all situations. For developments such as performing arts theatres, music rooms, television studios or similar, specialist acoustic advice should be obtained.

1.3 DELIVERABLES

Continuous communication with the Nominated CU Responsible Officer and the consultant and or the building/trades/supply contractor is required throughout service delivery, throughout the course of the project including:

- design/functional brief development stage
- schematic stage
- design development stage
- tender documentation stage
- tender/procurement stage
- construction stage
- defects stage
- relocation/occupation/operational start-up stage
- post occupancy review.

1.4 CURTIN REQUIREMENTS

1.4.1 DISABILITY AND ACCESS INCLUSION PLAN

Curtin University believes in creating equitable and inclusive access for people with a disability to its facilities, services, events and academic programs on all its Western Australian campuses.

The *Universal Design Guideline* has been developed to reflect a commitment to equity and inclusion for all by embedding Universal Design principles into project planning, design and delivery guidelines. Consultant architects, designers and engineers should make themselves familiar with the particular requirements of the *Universal Design Guideline* before responding to a project brief.

1.4.2 HEALTH AND SAFETY

Curtin University is committed to providing and maintaining high standards of health and safety in the workplace and will:

- ensure compliance with relevant legislation and the University's Health and Safety Management System
- promote an organisational culture that adopts health and safety as an integral component of its management philosophy
- ensure that health and safety is part of the business planning processes and that it is adequately resourced by all areas
- maintain an effective mechanism for consultation and communication of health and safety matters
- maintain an effective process for resolving health and safety issues and managing health and safety risks
- provide appropriate health and safety training
- regularly review health and safety performance to monitor the effectiveness of health and safety actions and ensure health and safety targets and objectives are met.

A copy of our Health and Safety Management Standards can be found at:

<https://healthandsafety.curtin.edu.au/local/docs/HManagementStandards.pdf>

1.4.3 SUSTAINABILITY AT CURTIN

It is Curtin University policy that all new or refurbishment projects on site should support its status as Australia's first university to achieve a 5-star Green Star – Communities rating from the Green Building Council of Australia (GBCA). Designers should understand and incorporate the Green Star criteria into designs and specifications in order to maintain and enhance Curtin's Green Star status. Information on the criteria can be found in the *PDG Green Star – Communities Design Guidelines*.

2 TERMINOLOGY

R_W WEIGHTED SOUND REDUCTION INDEX

R_W has been used as the design rating of various elements (i.e. wall, floor, doors) to achieve the required airborne noise transmission loss from one space to another. An R_W is a laboratory-tested acoustic performance, with tests undertaken in accordance with the appropriate Australian standard.

D_{n,TW} WEIGHTED STANDARDISED LEVEL DIFFERENCE

This is the field-tested performance achieved by various building elements.

It is noted that, due to flanking paths and construction tolerances, the field acoustic rating (D_{n,TW}) is generally around three units less for partition walls and floors; and around five units less for operable walls and doors than the laboratory test rating (R_W).

L_{EQ} EQUIVALENT CONTINUOUS SOUND LEVEL

The L_{eq} measurement integrates these fluctuations to give the equivalent continuous level containing an equal amount of energy over the time of measurement.

REVERBERATION TIME

The Reverberation Time is, for a given frequency or frequency band, the time that would be required for the reverberantly decaying sound pressure level in the enclosure to decrease by 60 decibels.

BACKGROUND NOISE LEVEL

Silence does not exist in the natural or built environments, only varying degrees of noise. The Background Noise Level is the minimum repeatable dB(A) level of noise measured in the absence of the noise under investigation and by the L_{A90} or the dB(A) noise level that is exceeded for 90 per cent of the measurement period.

3 ACOUSTIC PRIVACY

The acoustic privacy required by various spaces is dependent upon:

- the noise level generated within the source room
- the degree to which legibility is acceptable within the receiving room or space.

Additional to the above, the degree to which noise received from the source room is legible within the receiver room/space is partially dependent on the ambient noise level within the receiving room/space.

For information, the following outlines the subjective acoustic privacy that would be achieved from various levels of noise reduction or R_w ratings between spaces.

R_w 59	Cannot Hear Very Loud Noise
R_w 53	Cannot Hear Very Loud Talking
R_w 50	Cannot Hear Loud Talking
R_w 48	Can Barely Hear Some Loud Talking
R_w 45	Strain to Hear Loud Talking
R_w 42	Can Hear Loud Talking as a Murmur
R_w 35	Can Hear Loud Talking, But Not Understand
R_w 30	Can Hear Loud Speech Plainly
R_w 25	Can Hear Normal Conversation Easily.

Note: These Wall System Ratings must be considered in conjunction with Background Noise Levels. For example, if the Background Noise Level source is a highway with heavy traffic or a noisy street with a Sound Pressure Level of 75 dB, a wall with R_w 30 would take care of loud hi-fi. However, in a quiet residential neighbourhood, the R_w 30 wall would not block out average conversation.

To simplify and reduce the number of different constructions, acoustic privacy has been divided into the following four levels of privacy:

Low	R_w of 35
Medium	R_w of 42
High	R_w of 48
Very High	R_w of 55.

Based on the above, the following acoustic separations for various spaces are outlined in Table 1.

Table 1 – Acoustic Privacy Requirements

Source Room/Space	Acoustic Privacy RW Rating
Educational Areas	
Tutorial Rooms	48
Laboratories	42
Lecture rooms	55
Study rooms	35
Libraries	55
Seminar Rooms	48
Gymnasiums	42
Office/Support Areas	
General office	35
Board/Conference Rooms	48
Senior Private Offices	42
Audiovisual Areas	55
Computer Rooms	48
Interview / Student support	48
Facilities Areas	
Cafeteria	48
Kitchens	48 ⁽¹⁾
Toilets	55 ⁽²⁾
Music Areas	
Drama Studios	55
Music Studio	55
Dance Studio	55
Recording Studios	Specialist Advice Required
Small Practice/Tutorial Room	55
Ensemble Room	55
Performance/Recital Space	Specialist Advice Required
Plantrooms	
Main Plantroom	55
Air Handling Rooms	48

Note: 1 - Control of potential impact noise sources requires special consideration.

Note: 2 - Control of potential impact and hydraulic noise needs to be considered.

The rating used to separate spaces is to be the higher of the R_w ratings listed above. For example, the partition separating a counselling room from a standard office is to have an R_w rating of 48. Some adjustment to the above ratings for various spaces may be considered on a project-by-project basis.

The acoustic performances of corridors (or other transitional spaces) that contain entry doors can be reduced by one level of acoustic performance. For example, the partitions of a counselling room are to have an R_w rating of 48; however, the partition to the corridor that contains the entry door only requires an R_w rating of 42.

With partitioning, it is noted that if the partitions stop at the ceiling line, without a plasterboard margin or without penetrating the ceiling, the acoustic performance of a standard partition is limited by the junction between the partition and the ceiling to around an R_w of 36. This increases marginally with the addition of extra sheets. However, once the partition passes through the ceiling line the acoustic performance of the partition increases significantly.

3.1 DEEMED TO SATISFY CONSTRUCTIONS

3.1.1 R_w RATING OF 35

PLASTERBOARD PARTITIONS

To achieve the required acoustic rating, these partitions should comprise one sheet of 13 mm plasterboard to both sides of a 64 mm steel stud, with 70 mm polyester insulation within the cavity.

For this acoustic rating, partitions only need to be floor-to-ceiling. However, R2 insulation is to be laid over the ceiling for 600 mm both sides of the partition.

GLAZING

For the glazed sections, to achieve the required rating, 10.38 mm laminated glass is recommended. Additionally, the glazed partitions should be able to be sealed at the ceiling line, thus achieving a satisfactory acoustic performance.

DOORS

To maintain the acoustic performance, solid core doors, with door seals, are required. For these rooms, Raven RP99Si (drop seal) and RP87Si (frame) or similar door seals are required.

Note: Door grilles are not to be used.

3.1.2 R_w RATING OF 42

PLASTERBOARD PARTITIONS

To achieve the required acoustic rating, these partitions should comprise two sheets of 13 mm plasterboard to one side and one sheet of 13 mm plasterboard to the other side of a 64 mm steel stud, with insulation within the cavity.

To achieve the required acoustic rating, either of the following is required:

- a) Partitions are to pass through the ceiling by approximately 150 mm and R2 insulation is to be laid over the ceiling for 600 mm both sides of the partition.
- b) The ceiling is to contain a plasterboard margin (minimum of 600 mm wide) and R2 insulation is to be laid over the ceiling for 600 mm both sides of the partition.

GLAZING

For the glazed sections, to achieve the required rating, we believe that there are the following two options:

1. Use double glazing, with 10.38 mm and 6.38 mm laminated glass, with a minimum air gap of 50 mm.
2. Single glazed 12.5 mm laminated glass (Viridian 12.5 mm Vlam Hush glass or similar).

Glazed partitions are allowed to corridors or other transitional spaces. Glazed partitions or part partitions to other normally occupied spaces are not acceptable.

DOORS

Doors are to be solid core and, to maintain the acoustic performance. We suggest that the doors are closed into recessed frames with Raven RP99Si (drop seal) and RP87Si (frame) seals.

3.1.3 R_w RATING OF 48

PLASTERBOARD PARTITIONS

To achieve the required acoustic rating, these partitions should comprise two sheets of 13 mm fire-rated plasterboard to both sides of a 76 mm steel stud, with insulation within the cavity.

To achieve the required acoustic rating, either of the following is required:

- a) Partitions are to pass through the ceiling by approximately 150 mm, with 'baffle block' installed within the ceiling space.
- b) The ceiling is to contain a plasterboard margin (minimum of 600 mm wide), with 'baffle block' installed within the ceiling space.

For these rooms, with the installation of baffle block, we recommend that return air be ducted, using grilles located in the ceiling, with cushion heads and acoustic type

flexible ductwork. To penetrate the baffle block and to ensure that the flexible duct does not become crushed, we suggest that the flexible duct be pulled (thus protected) spiral duct. However, it should be noted that to maintain the acoustic performance, the spiral duct should be a tight fit around the flexible duct.

GLAZING

For the glazed sections, to achieve the required rating, we believe that there are the following two options:

- a) Use double glazing, with 10.38 mm and 6.38 mm laminated glass, with a minimum air gap of 50 mm.
- b) Single-glazed 12.5 mm laminated glass (Viridian 12.5 mm Vlam Hush glass or similar).

Glazed partitions are to be less than 50 per cent of the partition area and to be located adjacent to entry doors only. Viewing windows are acceptable.

DOORS

Doors are to be 50 mm thick solid core and, to maintain the acoustic performance, we suggest that the doors close into recessed frames with Raven RP38 (drop seal) and RP24 (frame) seals.

3.1.4 R_w RATING OF 55

PLASTERBOARD PARTITIONS

To achieve the required acoustic rating, these partitions should comprise two sheets of 13 mm fire-rated plasterboard to both sides of a staggered steel stud, with insulation within the cavity.

To achieve the required acoustic rating, partitions are to be floor-to-slab or floor-to-underside of roof. In locations with large ceiling spaces, after one metre above the ceiling, only one sheet of plasterboard each side of the studs needs to be carried up to the underside of slabs or roof.

Return air is to be sealed via attenuated paths.

GLAZING

Glazed partitioning for these areas is not allowed. Glazing is to be limited to viewing windows in the entry doors.

DOORS

Doors are to be 50 mm solid core and, to maintain the acoustic performance, we suggest that the doors close into recessed frames with Raven RP38 (drop seal) and RP24 (frame) seals. For these areas, double sets of doors are required, to provide an acoustic lobby.

3.2 OTHER PARTITIONING REQUIREMENTS

3.2.1 IMPACT ISOLATION

Walls to kitchens, mechanical services air handling plant rooms and toilets are to comply with the following impact isolation requirements:

- a) Stud walls are to be either of staggered or double stud construction, comprising two layers of 13 mm thick fire-rated plasterboard and 75 mm thick 9–11 kg/m³ insulation in the cavity.

or

- b) masonry construction.

3.2.2 RATINGS TO CORRIDORS

Doors are an acoustical weakness in any partitioning system. To minimise this weakness, door from spaces requiring any degree of acoustic privacy should be solid core doors with acoustic seals, as outlined in the above sections.

As corridors are a transient space, experience indicates that the glazed sections provide a visual deterrent to people 'loitering' around the spaces where acoustic privacy is required.

Similar issues can also occur for the separation of teaching spaces from corridors. However, in this case it can be the noise transfer into the teaching space from the corridor that can be intrusive. Therefore, any glazed section should be limited to viewing windows.

Where it cannot be clearly determined that single glazing will provide adequate acoustic isolation to meet user expectations, the glazing system should be detailed in a manner that allows easy retro-fitting of a second pane of glass to form acoustic double glazing. This requires at least a 50 mm air gap between the layers of glass.

3.2.3 OPERABLE WALLS

It is noted that the installed acoustic rating for operable walls is generally lower than that of fixed walls. Therefore, if operable walls are to be used, their acoustic R_w rating is to be two points higher than for a fixed wall or those listed in Table 1.

3.3 FLOORS

To prevent the transfer of noise vertically between floors, the minimum R_w rating of floors shall be 48.

Typically, a 150 mm thick concrete slab will provide an R_w rating of 54. Thus, the critical area for the transfer of noise between floors is at the facade (i.e. the gap between edge of slab and facade) that needs to be considered.

3.4 DOORS (GENERAL REQUIREMENTS)

In planning the location of doorways, recognition must be given to the resultant unavoidable acoustic weakness. Wherever possible, the distance between doors to neighbouring spaces should be maximised, rather than the doors be directly side by side.

Similarly, doors along corridors should be offset, to avoid situations where one door is directly opposite another. Also, planning arrangements must be such that doors to spaces requiring confidential speech privacy do not open directly onto waiting areas or to workstations in close proximity to the door.

3.4.1 DOORS TO SPACES REQUIRING R_w RATINGS OF 55

For these spaces, the acoustic ratings required cannot be achieved using a single door. Therefore, planning must allow for incorporation of acoustic lobbies or corridors to act as acoustic buffers. For example:

- lecture theatres must incorporate acoustic lobbies.
- spaces designed for music/performance should also be accessed via an acoustic lobby or acoustically isolated corridor.

3.5 PLANT ROOM

Plant rooms containing high noise level equipment, such as chillers, generators, exhaust fans and pumps are to be of masonry construction.

Doors to these spaces should only be located in services areas and may require back-to-back doors or acoustic lobbies with an R_w 40 design performance where access is required from main corridor/circulation areas.

3.6 CRECHE/DAYCARE

For these spaces, walls are to be either:

- single 90 mm thick concrete block walls with 15 mm render both sides; or
- staggered stud partition comprising two layers of 13 mm plasterboard on both sides of a 64 mm staggered stud (i.e. in 92 mm track) with an insulation infill.

To reduce noise generated within the outdoor play area, a soft fall floor covering is recommended.

3.7 GYMNASIUM

For these spaces, walls are to be either:

- single 90 mm thick concrete block walls with 15 mm render both sides; or
- staggered stud partition comprising two layers of 13 mm plasterboard on both sides of a 64 mm staggered stud (i.e. in 92 mm track) with an insulation infill.

Any proposed concrete slabs should provide adequate acoustic separation between floors. However, if the gym contains a weights area or equipment where weights can be dropped, then these areas should incorporate a special floor underlay designed to absorb the impact of falling weights or incorporate the installation of a floating floor.

The need for further protection is to be determined when more details are known about the gym's location (compared to the surrounding spaces) and the equipment to be installed.

3.8 FLANKING PATHS

3.8.1 MECHANICAL SERVICES SUPPLY AIR

A common flanking path between spaces is via continual perimeter linear diffusers.

For new projects, continual linear diffuser should not be used and care should be taken to ensure that linear diffusers do not occur over the top of any partitioning.

For refits or in locations where linear diffusers do cross over the top of partitions, the linear diffuser is to be sealed.

3.8.2 MECHANICAL RETURN AIR

For spaces requiring a low or medium degree of acoustic privacy, the required acoustic privacy can be achieved with air registers located within the ceiling.

For other spaces, ceiling-mounted air registers, internally lined cushion heads with one length of 3 m flexible ductwork is acceptable.

Door grilles are not to be used.

3.8.3 WALL TO BUILDING FACADE

Where a partition meets the external wall (i.e. masonry), then the partition can be constructed and sealed to the wall.

In cases where the facade is glazing, partitioning requiring an R_w rating up to 42 are to be designed such that the partition meets the facade at a mullion and the partition should be sealed using a single sheet of 12.5 mm thick VLam Hush glass or similar.

Where an R_w rating of 48 is required, a double-glazed infill panel is to be used, comprising of 6.38 mm and 10.38 mm thick laminated glass with a minimum air gap of 50 mm.

For R_w 55 rated walls, glazed infill panels are not acceptable.

Detailing of the connection between internal partition walls and the external walls/glazing is critical to maintain the required acoustic separation between spaces. The connection must not downgrade the performance of the dividing wall by allowing flanking sound transmission through acoustically weak materials/infill.

3.8.4 ELECTRICAL FITTINGS

In partitions dividing spaces requiring any degree of acoustic privacy, electrical switches should not be located back to back, unless acoustically rated switch boxes are used.

4 REVERBERATION

4.1 GENERAL OBJECTIVE

The general objective is to ensure general reverberation is adequately controlled to suit the required use of the space.

The control of reverberation in spaces is normally carried out either for noise reduction within a room, or to create a specific acoustic environment. Reverberation Time (RT) within specified rooms shall not exceed the RTs recommended in the Australian standard AS/NZS2107 Acoustics - Recommended Design Sound Levels and Reverberation Times for Building Interiors.

The reverberation times listed in AS/NZS2107 apply to the mid-frequency RTs, being the 1000 Hz and 2000 Hz octave bands. For larger volume or specific spaces (i.e. lecture theatres, music facilities) reverberation times across all frequency bands between 63 and 8000 Hz need to be considered. It is also noted that for large volume spaces, the reverberation times may be up to 50 per cent higher than those listed in AS/NZS 2107. These requirements are determined on a case-by-case assessment.

5 SERVICES NOISE

The objective of this section is to ensure that the background noise level within occupied spaces within the University is not intrusive and does not interfere with the usage/function of the spaces.

5.1 MECHANICAL SERVICES

The acoustic criterion for noise received within spaces from the mechanical services is to be the noise rating (NR) curve being 3 less than the maximum recommended design sound level listed in Australian Standard AS/NZS2107. For example, the maximum noise level for a lecture room up to 50 seats is 35 dB(A), therefore, the design criterion will be an NR of 33.

It is noted that all buildings are to be designed such that compliance with Green Star requirements is achieved.

As a minimum, the following acoustic paths need to be considered:

- fan noise via supply and return air
- breakout noise from both plant room and supply and return air ductwork
- regenerated noise.

Structurally borne noise should also be considered.

Where required, to achieve compliance with the acoustic criteria, acoustic attenuators or other sound attenuation is to be incorporated into the mechanical services design.

As part of the mechanical services, consideration of the acoustic privacy of various spaces needs to be considered and not compromised by the mechanical services (i.e. noise transmission between spaces via the return air).

6 NOISE INGRESS

The objective of this section is to control the background noise level within spaces from external noise sources. Typical noise sources are:

- vehicle noise, including that associated with vehicles moving on the roads and car parks
- mechanical plant.

6.1 CRITERIA

The acoustic criteria for noise ingress for various spaces is to be the Satisfactory Noise Levels listed in AS/NZS2107.

6.2 NOISE MEASUREMENT

Existing noise levels in the area are to be measured to provide baseline noise level data for the project. As a minimum, 1-hour hand-held noise level measurements should be recorded at an appropriate location or locations. Noise level measurements should be recorded at a time considered to be the peak period.

Note: Depending on the location, the peak period may differ and if this is considered likely, then noise level measurement during various times of the day (including night) should be undertaken.

6.3 NOISE PREDICTION

Based on the noise level measurements recorded, an analysis is to be undertaken to determine the R_w ratings required to achieve the required internal noise level(s).

7 HYDRAULICS

Hydraulic noise can be a source of unacceptable noise within occupied spaces.

All drains (waste pipes and downpipes) are to be located in risers with a minimum R_w rating of 48.

It is noted that the majority of noise generation associated with pipework is at bends. Therefore, pipework running in ceiling spaces is to be wrapped in loaded vinyl (minimum of 4.5 kg/m^3 with 12 mm backing foam).

The hydraulics downpipes located within occupied space needs to be isolated from the structure and should have single wrapping. Waste pipes in risers located in office space should be double wrapped.

Note:

1. HPDE pipework deletes one layer of wrapping/lagging.
2. Downpipes or waste pipes within service cores do not need to be wrapped.

8 RAIN NOISE

Rain noise only needs to be considered in specialist spaces such as a performing arts theatre. In these cases, specialist acoustic advice is required.

9 LIFTS

Walls around lifts are to have a minimum R_w rating of 50 and are to be of discontinuous construction.

10 ENVIRONMENTAL NOISE

10.1 NOISE RECEIVED AT NEIGHBOURING PREMISES

The *Environmental Protection (Noise) Regulations 1997* stipulate the allowable noise levels that can be received at a premise from other premises.

If noise emissions from a University facility are likely to impact on surrounding premises, then an acoustic assessment of environmental noise is to be undertaken. This assessment is to be undertaken by a recognised acoustic consultant.

10.2 NOISE RECEIVED WITHIN CAMPUS

Noise received at normally occupied locations, such as building entrances, courtyards etc., around the University from services is to be a maximum of 45 dB(A).