CURTIN UNIVERSITY

PROJECT DELIVERY GUIDELINES

AUDIOVISUAL GUIDELINES

PART 6 – ROOM DESIGN AND CONSTRUCTION

000318

Curtin University

TEACHING, LEARNING AND MEETING SPACES

ABSTRACT

The purpose of this document is to provide room design and construction guidelines for teaching, learning and meeting spaces at Curtin University to design and build professionals such as architects, builders, interior design, electrical and mechanical subcontractors, acousticians, audiovisual consultants and project managers.

Details of revisions			
Level	***Details***	***Date***	***Initial***
1	*Original document created from Audio Visual Standards Part 6 - Guidelines for Design and Build Professionals (v0.5)*	*Nov-16*	*RPS*
2	*Overall review of content. Update with minor modifications. Added list of figures. Reformatted 'rules'.*	*Jun-18*	*IRC*
2	*Inclusion of wording to allow departures from the existing guideline*	*Dec-19*	*RPS*

CONTENTS

LIST OF TABLES

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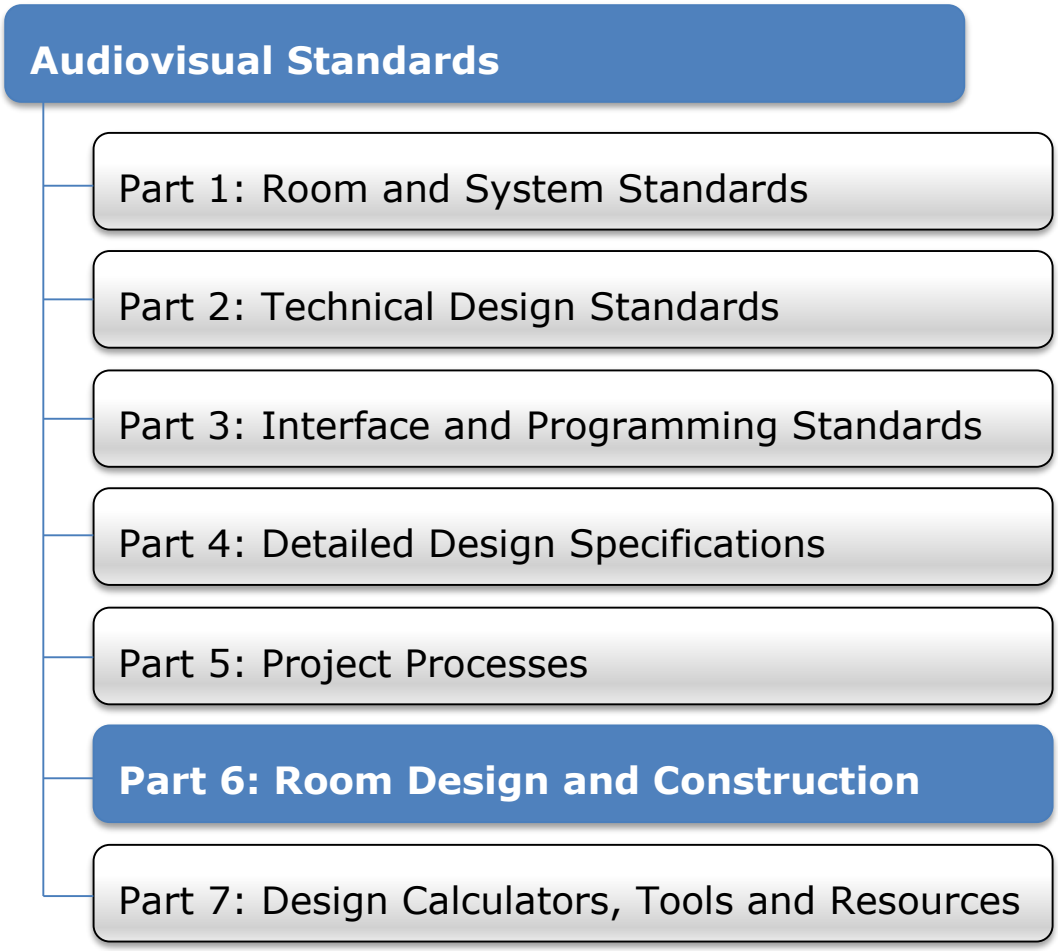
RELATED DOCUMENTS

Title	Version	Date	Location
AETM Audiovisual Design Guidelines – Tertiary Teaching Spaces	2nd Edition	2012	www.aetm.org
AV/IT Infrastructure Guidelines for Higher Education		2014	www.infocomm.org
ANSI/Infocomm 3M-2011: Projected Image System Contrast Ratio		2011	webstore.ansi.org
000312 PDG Electrical Services Guidelines		October 2016	IMS
000313 PDG Data Communications Cabling Requirements		October 2016	IMS
AS/NZS 1680 for Interior Lighting for Educational and Training Facilities		2008	
National Construction Code	NCC 2016	2016	www.abcb.gov.au

Audiovisual Standards Part 6 – Room Design and Construction Guidelines



1 INTRODUCTION

1.1 DOCUMENT BRIEF

This Project Delivery Guidelines document provides room design and construction guidelines for teaching, learning and meeting spaces at Curtin University. The intended audience is design and build professionals such as architects, builders, interior design, electrical and mechanical subcontractors, acousticians, audiovisual consultants and project managers.

The information on projectors and displays and placement in the room (Section 4) will be of interest to architects, electrical consultants, interior designers and audiovisual consultants.

The section on screen placement and sightlines for the seated audience in the room (Section 5) is important for architects and interior designers.

The guidelines on artificial lighting and control of ambient lighting in Section 6 should be read by architects, builders, electrical consultants, interiors designers and audiovisual consultants.

Section 7 on acoustics is of interest for architects, acousticians, mechanical subcontractors and interior designers.

The remaining sections on infrastructure – such as equipment rooms, enclosures cabling and containment (Section 8) and the in-room environment requirements about power, furniture and HVAC (Section 9) – should be read by architects, interior designers, electrical and mechanical subcontractors and audiovisual consultants.

The definitions that apply to this document are listed in the Glossary of Terms in Appendix A.

The Project Delivery Guidelines have been prepared in consultation with Curtin University subject matter experts and stakeholders. It is recognised that the subject matter of Guidelines will not always be suitable for all project elements and departures from the Guidelines may be required or desirable. Departures from Guidelines must be agreed upon in consultation with the relevant University Guideline subject matter expert. Departures must be recorded in a project register and recorded and reviewed in the Project Control Group meeting minutes under its own meeting agenda item "Project Delivery Guideline Departures". Where the University subject matter expert identifies that a departure adds ongoing value to the University, the subject matter expert will update the relevant Guideline.

1.2 DOCUMENT ACCESS

All design and build professional must ensure they have the most current version of all standards prior to engaging in any work.

The most recent version of this document can be found on the web at: https://properties.curtin.edu.au/workingwithus/guidelines.cfm.

1.3 RELATED DOCUMENTS

This guideline document, and the collection of standards to which it belongs, is aimed at providing clear guidance to contractors and staff engaged to undertake audiovisual works in University teaching spaces and meeting rooms. The objectives of the standards documents are to ensure consistent interpretation of technical requirements, and consistent delivery of functioning and maintainable spaces.

Other related documentation is listed in a previous section of this document.

1.4 ROLES AND RESPONSIBILITIES

The following table outlines the responsibilities of roles relating to the upkeep and maintenance of the guidelines described in this document.

Table 1: Roles and Responsibilities

Role	Responsibility
AV Standards Manager	Owner of the document. Maintains currency and approvals through document control and versioning.
AV Project Manager	Acts as liaison for design and build professionals in discussions relating to the content of this document.
AV Project Staff	Refer to this document in discussions with design and build professionals. Contribute to maintaining the document currency.
Project Manager (PF&D)	Ensures that the latest version of this document is provided to design and build professionals early in the project initiation phase.
Design and Build Professionals	Read and understand these guidelines before conducting design activities relating to teaching, learning and meeting spaces at Curtin University.

2 INVOLVING CURTIN AV STAFF

Since projects relating to teaching, learning and meeting spaces will almost certainly have to integrate with the University's existing audiovisual infrastructure it is very important that the Curtin AV Project Manager and staff are involved in the process from the start with concept design. These people have years of practical experience specific to educational technology at the University and are a valuable resource to the project. The Curtin AV staff are important stakeholders for another reason – they will be supporting the infrastructure after the project's conclusion.

The following sections indicate what involvement should be provided for the Curtin AV Project Manager and staff. In some cases, these activities may be delegated to an audiovisual consultant but this needs to be clearly defined in writing for each project.

2.1 PROJECT INITIATION

The Curtin AV Project Manager should be advised in writing of the proposed project's critical dates and milestones, stakeholders, budgets and impact on existing AV infrastructure. In particular, the effect of the project on the level of support for a modified AV infrastructure must be taken into account.

It is important that the Curtin AV Project Manager is involved in briefings with the clients during the project initiation phase, together with the audiovisual consultant if one has been assigned to the project. The AV Project Manager can use their experience with educational technology, latest trends and local infrastructure knowledge to assist clients and project staff to identify affordable technology options that best fit the current and future needs.

2.2 CONSULTATION

The Curtin AV Project Manager must be consulted to:

- specify brands and models of AV equipment to ensure commonality requirements of standards are being met
- specify access requirements to equipment, housing and cabling
- specify electrical interconnection standards to ensure compatibility with portable and user-supplied equipment.

At least one month's notification of the proposed tender issue date is required, to allow for the preparation of AV specifications and/or review of specifications by the audiovisual consultant.

2.3 COMMUNICATION

The Curtin AV Project Manager must be informed of all relevant project site meetings and consultant meetings. The following documentation is to be forwarded in electronic format for markup and comment:

- floor plans
- elevations

- reflected ceiling drawings
- electrical drawings including lighting fixtures
- mechanical drawings
- lighting and acoustician's reports
- works schedules.

2.4 APPROVALS

The approval of the AV Project Manager should be sought for all shop drawings listed above. This includes re-approval for all changes and amendments prior to issue to construction contractors. This approval step is important as the AV Project Manager (or consultant if delegated) is responsible for the complete audiovisual experience of the facilitator (e.g. lecturer) and audience in a venue, including lighting, availability of power for laptops, screen sightlines etc. that are described in these drawings.

Please note in particular regarding approvals by the AV Project Manager:

- Any AV components that are not part of the AV specifications for the project must be provided as samples for approval.
- Final positions and quantities/sizes of installed components must be approved, as the positioning in most design documents are indicative only.
- The acceptance testing of the final installation must be approved to confirm that it complies with the tender specification.

2.5 DOCUMENTATION

Copies of all audiovisual system "as-built" drawings are to be provided to the Curtin AV Project Manager at practical completion.

3 DESIGN PRINCIPLES

The Curtin University design principles for all audiovisual installations are:

Safety: staff and students have access to a workplace with managed OH & S hazards.

Standards compliance: conformance is required to all relevant regulatory, international and industry standards as well as Curtin standards, including, in particular, mandatory NCC and DDA requirements.

Flexibility: Curtin standards and designs are to be flexible so as to meet the diverse needs of the University's varied business requirements.

Consistency and familiarity: uniformity of function is required across Curtin to improve efficiency and ease-of-use as staff and students move around the University, and to minimise training, productivity and opportunity costs.

Ease-of-use: a single familiar intuitive user interface device is required to cover all functions, subject to formal usability testing. Handheld remote controllers are not acceptable.

Total solution quality: standards and their implementation ensure a holistic, quality, and usable result considering all aspects of the space including interior design and general amenity.

Simplicity: avoid complexity so as to reduce design cost, system cost, support cost, training cost and documentation cost, while improving reliability, performance, fault rates and repair times. This principle includes a preference for:

- 'single-box' solutions
- 'out-of-the-box' solutions
- getting most value out of existing components
- Integrating and customising only to the extent necessary.

Fit-for-purpose: solutions are fit-for-purpose, neither 'gold-plated' nor 'prehistoric', and are of a consistent quality level across the whole University.

TCO: reduced Total Cost of Ownership is delivered through all these design principles.

Standard designs: each standard system type and room type has an exact detailed design which shall always be implemented exactly as detailed. However, these standard designs can be adapted for non-standard applications, generally by removing components from the standard design. Each standard design nominates specific optional components that can be removed. In some cases, adaptations can be by substitution or addition of components to the standard design. In other cases, non-standard applications can be satisfied by combining multiple instances of a standard design, or by combining aspects of multiple standard designs. Custom solutions shall always be based on the nearest standard room type and nearest standard detailed design. The custom solution shall be expressed solely in terms of exactly enumerated differences with respect to the nearest standard design, and not as a complete recital from scratch disconnected from a standard solution.

Reduced standard parts-list: the University selects a reduced set of suppliers (usually one) for each range of products, and selects a reduced sub-set of components from each of those suppliers' ranges.

Within manufacturers' specifications: designs are to be constrained for operation within manufacturers' published specifications in all regards, and not be reliant on something that has been observed to apparently work by local experiment.

Remote management: centralised remote monitoring, control, adjustment, upgrade, fault diagnosis and management (e.g. reporting and statistics) capabilities are to be provided for all systems.

Ethernet management and control: all devices that have any level of Ethernet monitoring, control or management capability shall be connected to the University's (wired) Ethernet network, rather than by some other form (e.g. RS-232) of communications.

Future-proofed: all standards, designs, product choices, implementations and installations shall be future-proofed to the extent practicable.

Cyclic refresh: solutions shall be provided in the context of formal continuous cyclic technology refresh arrangements. In this regard most AV technologies are expected to have a service life of at least six years, thus an approximate 6–7 year refresh cycle should be accommodated.

4 PROJECTORS AND DISPLAYS

This section describes some of the considerations to be made when incorporating projectors and/or flat panel displays into a room design. Each technology has its benefits and particularities leading to use cases where one or both can be included in the design.

4.1 PROJECTORS VERSUS FLAT PANEL DISPLAYS

Flat panel displays are now the recommended option over projectors for small teaching spaces (e.g. maximum viewing distance of less than 5 metres), breakout informal learning areas and especially videoconferences, for the following reasons:

- better contrast ratio performance in ambient light
- lower maintenance costs with zero consumables
- procurement cost being reduced significantly in recent years.

Projectors are still the best technology for large screen sizes requiring high brightness such as in lecture theatres.

4.2 DUAL PROJECTION/DISPLAY

Curtin recommends dual projection for lecture theatres and larger presentation spaces, for the following reasons:

- the presenter is able to show complementary or comparative material simultaneously
- classes can continue should a projector lamp fail
- improved sightlines for audience in many cases
- more conducive to video and web conferencing applications.

4.3 PROJECTION SURFACES

Curtin recommends that painted (matt white) surfaces are used, where possible, in teaching spaces to increase the flexibility for future projection standards and to reduce the amount of mechanical infrastructure. Where a drop-down screen is necessary (e.g. in front of a window, over a whiteboard) it should be motorised and be manufactured from matt white projection screen material with a gain of 1.0 (where gain is a measure of surface reflectivity).

Projection onto whiteboards is to be avoided due to unacceptable glare reflected into the audience. The only exception is the special circumstance when a whiteboard surface is being used in conjunction with an ultra-short-throw interactive projector, where the glare is angled towards the floor.

4.4 CONTRAST RATIOS

The contrast ratio of an image describes the difference between the peak white and black areas in that image. The importance to room design is that these are often

determined by the strength of the projected light (measured in lumens) and the amount of ambient light falling on the projection surface from windows and light fixtures.

Curtin accepts the AETM endorsement of the published standard ANSI/Infocomm 3M-2011: Projected Image System Contrast Ratio. **Table 2** shows how the standard light 'presets' in a teaching space can be used to help achieved the recommended minimum contrast ratios for different media types.

Table 2: Contrast Ratios for different Media Types

Media Type	Examples	Minimum Contrast Ratio	Lighting Preset
Text and Numerals	Documents, spreadsheets, charts	7:1	Note-taking mode (only lights over screens off)
Pictorial	Photographs, artwork	15:1	Detailed projection mode (about 50% lighting)
Motion Pictures	Film, video, television	50:1	Cinema projection mode (only aisle and exit lights on)

4.5 PROJECTOR PLACEMENT

The placement of a projector should be in a horizontally level position with vertical height and distance from the screen dependent upon the manufacturer's recommendations for a given screen size. There are often a range of positions possible using the projector's optical zoom, lens shift functionality and alternate lenses.

Other considerations in making the decision on projector placement are:

- ease of maintenance
- projector noise intrusion
- keeping the presenter free of glare (see Figure 1)
- additional cost for telephoto or wide angle lenses
- mounting area and light path to screen are free of obstructions
- security from theft and damage.

The use of a projection booth, where available, should be considered to resolve the maintenance, noise and security issues.

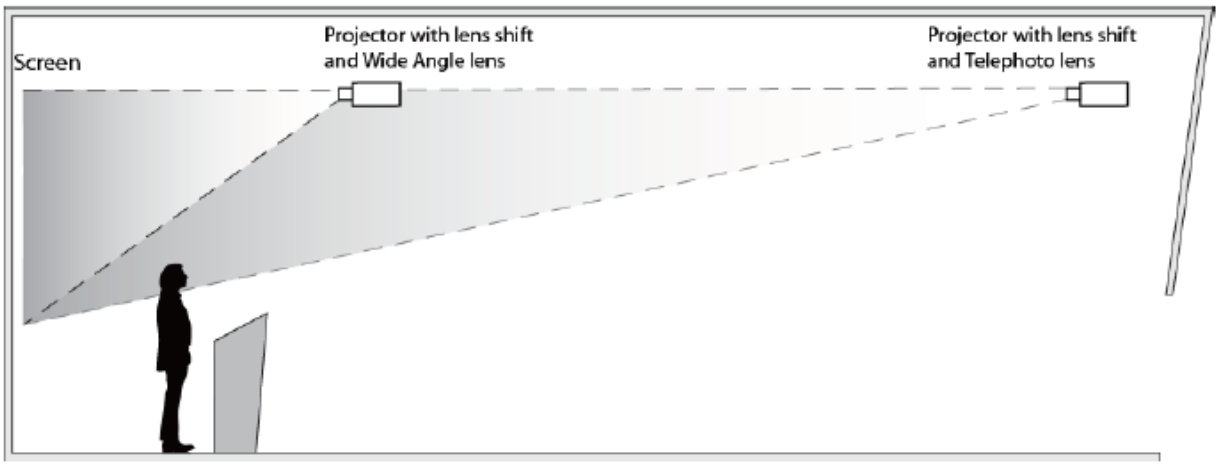


Figure 1: Projector Placement to Prevent Glare in the Presenter's Eyes

5 SCREENS AND SIGHTLINES

In this section the term 'screen' is used to represent the surface being used to show images or content to an audience. This may be a fixed projection screen, a drop-down screen, a painted surface, an interactive whiteboard or a flat panel display. The size and location of this screen is important in room design to ensure that the audience in all furnished locations is able to comprehend the detail of a displayed image or written text. A rough rule of thumb is having the screen large enough for people in the back row to be able to read 10 pt text on a standard website. Another consideration for comfort of the audience is a limitation on viewing angles in the horizontal and vertical planes with regard to seating placement.

Many modern teaching spaces have a requirement for two or more independent images on separate screens. In this case the rules for screen size and viewing angles apply to each screen individually.

Curtin adopts the rules of the AETM Design Guidelines as being sufficient to meet these requirements.

Where compliance to these rules is not 100 per cent achievable due to site conditions, such as ceiling heights, alternatives such as additional screens towards the rear of the venue should be considered.

5.1 SCREEN HEIGHT AND VIEWING DISTANCE

Maximum Viewing Distance = 5.3 x Image Height (H)

Closest Viewing Distance = 2 x Image Height (H)

Representations of the rules relating screen height to the maximum and closest viewing distance are shown in Figure *2*.

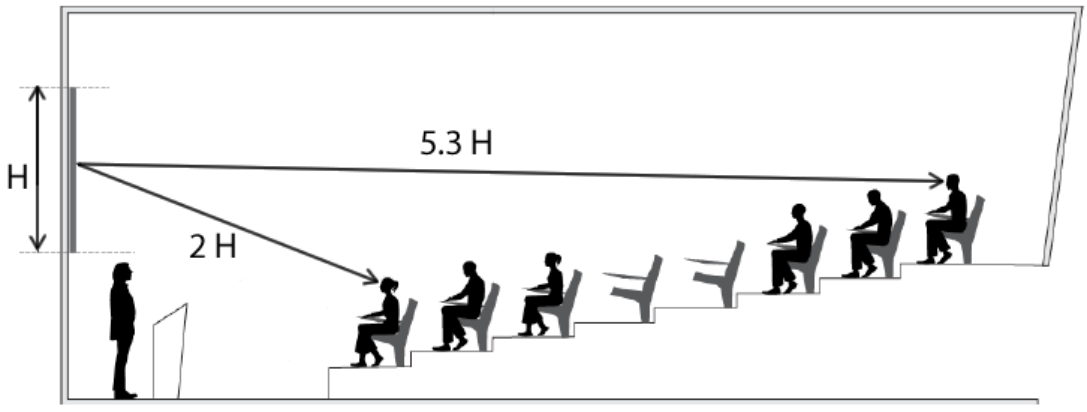


Figure 2: Maximum and Closest Viewing Distance

5.2 SCREEN LOCATION ABOVE FLOOR LEVEL AND CEILING HEIGHT

Minimum Height of Screen Bottom Edge above Floor Level (Classroom) = 1.2 m

Minimum Height of Screen Bottom Edge above Floor Level (Meeting) = 1.1 m

Maximum Height for Interactive Whiteboard Top Edge = 2.1 m

The rule relating to minimum height of the bottom edge of the screen above the finished floor level (AFFL) is to ensure that a person's view is not obstructed by other audience members. In a larger venue it would be expected that the height of the lower edge of the screen is increased to account for obstructions created by the standing presenter and furnishings such as lecterns and benches. Curtin's preference for a classroom is a height of 1.35 m for a non-interactive screen.

The maximum height for the top edge of an interactive whiteboard (e.g. Smartboard) is provided to ensure that all parts of the surface can be easily reached by the presenter. In most designs there is a conflict between this requirement and the rules relating to heights for the bottom edge and screen size. This needs to be resolved in consultation with the user group where alternatives such as interactive tablets can be explored.

Table 3 shows the required ceiling height for distances to the furthest audience, allowing for the minimum screen height AFFL and screen size using the 5.3 ratio. Further allowances must be made for bulkheads, air conditioning ducts, beams and other ceiling obstructions where the screen is to be fixed.

Table 3: Ceiling Height for Distance to Furthest Audience Member

Distance to Furthest Audience Member	Required Ceiling Height (using 1.2 m AFFL and 5.3 ratio)
< 7.5 m	2.7 m
7.6–8 m	2.8 m
8.1–8.5 m	2.9 m
8.6–9.1 m	3.0 m
9.2–9.6 m	3.1 m
9.7–10.1 m	3.2 m
For every extra 475 mm	add 100 mm ceiling height

5.3 VIEWING ANGLE LIMITS

Maximum Horizontal Viewing Angle = 45° (from screen centre-line)

Maximum Vertical Viewing Angle = 15° (looking up to screen centre-line)

Representations of the rules relating viewing angles are shown in Figure 3 and Figure *4*.

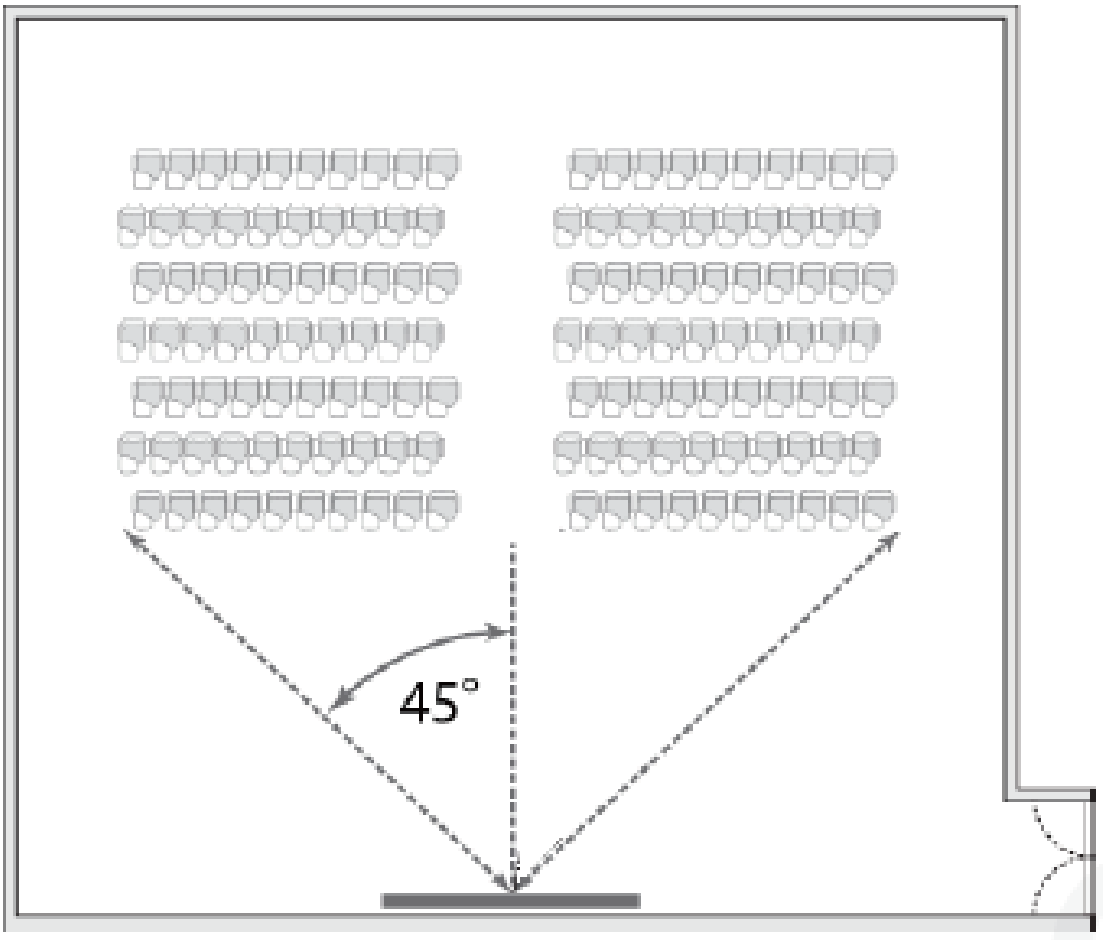


Figure 3: Horizontal Viewing Angle Limits

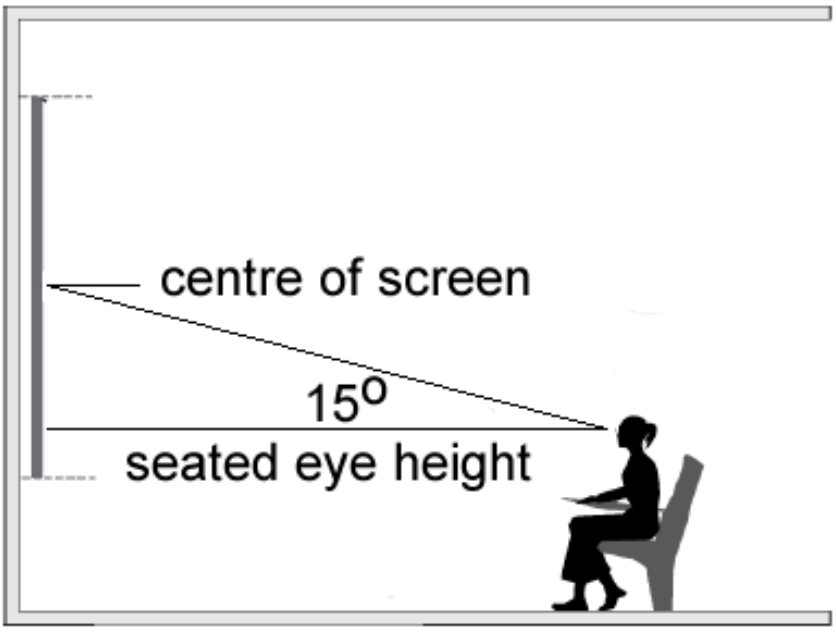


Figure 4: Vertical Viewing Angle Limits

6 LIGHTING

The lighting provided in teaching and meeting spaces at Curtin University must meet the requirements of Australian and New Zealand standards – AS/NZS1680 for lighting – and the relevant sections of electrical design briefs provided by Curtin.

With respect to teaching spaces, the lighting design must consider the following objectives:

- control of ambient light to allow required contrast in projected images
- provision of sufficient note-taking light for students
- proper illumination of the presenter, especially in videoconferencing.

To design an effective lighting solution for a teaching space requires a careful selection of lighting zones, levels, fittings, ambient light management and integration into control systems.

6.1 LIGHTING ZONES

It is recommended that a minimum of three separate lighting zones are considered, each controlled with its own dimming circuit, as shown in Figure 5:

1. **Board Zone** – Front (or board) lights that spill directly onto the screen
2. **Presenter Zone** – directional lights to illuminate the presenter without spill onto the screen
3. **Audience Zone** – lighting covering the majority of seats or open space.

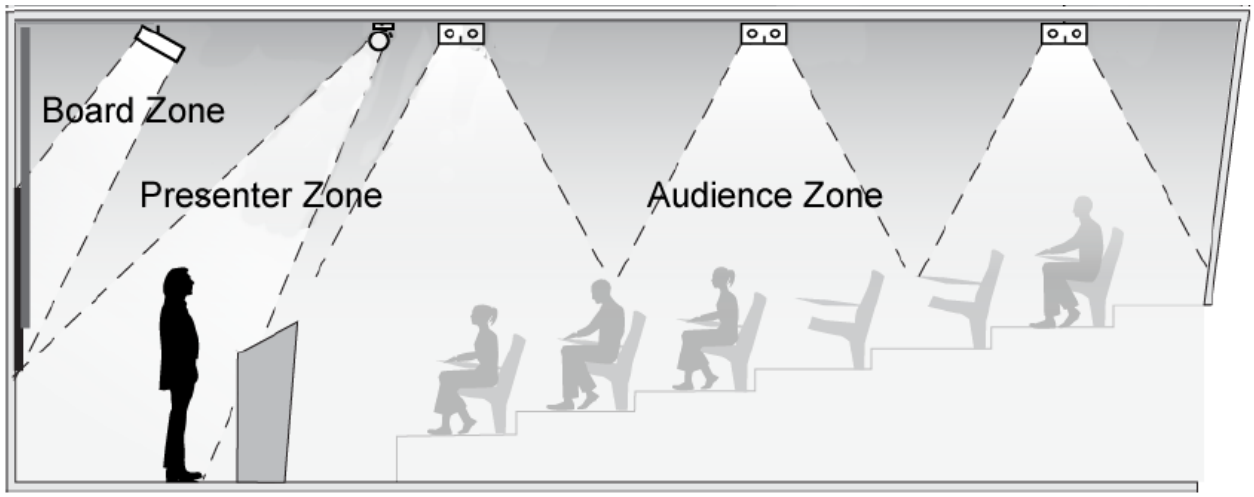


Figure 5: Typical Lighting Zones

Small to mid-sized venues could be designed without the presenter zone lighting, provided that the presentation area is adequately lit by the room lighting. Any venue with cameras for lecture recording or videoconferencing must have presenter zone lighting. Lecture theatres and larger presentation spaces may have the room lighting separated into several audience zones (e.g. front, middle, back).

6.2 MODES AND LEVELS

The recommended lighting levels for the several typical modes in a teaching space are shown in **Table 4**. Further details about these target light levels can be found in the AETM Guidelines and AS1680.2.3:2008 – Interior Lighting for Educational and Training Facilities.

Table 4: Lighting Levels for Typical Teaching Modes

Mode	Zone	Note-taking light at student writing level	Illumination of the presenter	Illumination of the whiteboard	Spill light onto projection surface
All On	Board – 100% Presenter – 100% Audience – 100%	N/A	N/A	N/A	N/A
Board or Demonstration	Board – 100% Presenter – 100% Audience – dimmed	Horizontal -320 lux (min)	Horizontal –150 lux (min) Vertical – 50 lux (min)	Vertical – 300 lux (average)	N/A
Presentation (Note-taking Projection)	Board – 0% Presenter – dimmed Audience – dimmed	Horizontal -150 lux (min)	Horizontal –150 lux (min) Vertical – 50 lux (min)	N/A	Ratio 7:1 projected white to spill light
All Off	Board – off Presenter – off Audience – off Aisle – delayed dim	N/A	N/A	N/A	Ratio 50:1 projected white to spill light
Custom	Board – selected Presenter – selected Audience – selected	N/A	N/A	N/A	N/A

Dimming within each lighting zone is recommended to achieve these target light levels with the additional benefit of more efficient use of energy. The use of the appropriate dimming technology to suit the installed light fittings is essential to avoid flicker, audible noise, electronic interference or other undesirable artefacts throughout the dimming range.

6.3 LIGHT FITTINGS

Light fittings shall be selected as appropriate to provide a lighting system in compliance with the relevant Australian standards, NCC requirements, and electrical design briefs provided by Curtin. In any case, the lighting consultant shall obtain Curtin's approval (Electrical and Audiovisual) before tender.

The following design guidelines are provided for the selection and placement of light fittings:

- Light fittings within 1.2 m of projection surfaces need to be grouped and individually assignable by the lighting control system. In addition, these fixtures need good directional control to eliminate glare and unwanted light spill onto screens (e.g. fittings having cut-off or shielding angle of 50 degrees or less).
- Light fittings should have non-reflective louvres or side shields to prevent horizontal light reflection.
- Lighting needs to be capable of being switched on and off (or dimmed) quickly to allow different lighting modes in rapid succession.
- Spotlights on the Presenter Zone should be placed between 45 to 60 degrees elevation and 45 to 60 degrees horizontally from the presenter's eye line to prevent glare. Larger venues need at least two narrow beam focussing spotlights to light the presenter at the lectern.
- Light fittings should not be placed so as impede the projector's light path.

6.4 AMBIENT LIGHT MANAGEMENT

Control of ambient and spilled light falling on the projection screen is essential in all spaces but is especially critical in larger venues where more powerful (and expensive) projectors are required to overcome light spreading over distance. Generally light from all external sources should be excluded or controlled to allow attainment of contrast standards at any time of the day and any time of the year.

The following design guidelines are provided for the management of ambient light:

- Where windows or skylights are present, the use of curtains, blinds or louvres is essential. These should be motorised and controlled by the AV system.
- Light-coloured floor coverings and furniture near projection screens should be avoided to reduce reflection from other light sources onto the screen.
- Aisle lights must not spill onto projector screens.
- Exit lights should not produce unacceptable levels of ambient light.

6.5 INTEGRATION WITH AUDIOVISUAL CONTROL SYSTEMS

Light switches should be installed and located as applicable in compliance with the relevant Australian standards, NCC requirements, and Curtin's electrical design brief. Since presenters need ready access to change lighting levels, lighting control should also be available via the AV system control panel located at the lectern or presentation position. In lecture theatres and larger presentation spaces this is an essential requirement.

In the absence of network-controlled lighting, inline relays may be fitted to allow light fixtures to be controlled directly by the AV system.

The following design guidelines are provided for the integration of lighting control into the AV control systems:

- A lighting control interface, either serial or IP interface, is to be provided by the lighting contractor inside the AV rack location in an appropriate enclosure. The electrical consultant is to provide group addresses to the AV integrator.
- The occupancy or motion sensing in the venue, used by the BMS or lighting system to control the energy usage of the lighting, should be provided as an input to the AV control system for the same reason. The sensor technology should be capable of detecting the presence of stationary occupants, not just those traversing the space.
- Where required, the AV control system should accept signals from the building's emergency warning system and act appropriately according to the regulations.

6.6 SPECIAL REQUIREMENTS FOR VIDEOCONFERENCE SPACES

Lighting for videoconference spaces needs to be given special consideration to ensure good broadcast quality images from the installed cameras. The best general lighting is diffuse fluorescent with a colour temperature of approximately 3200 Kelvin, 500 lux.

The following design guidelines are provided to ensure proper lighting of the presenter in the videoconference 'capture zone' (i.e. the camera's field of view):

- Use indirect lighting for 80 per cent of light and evenly distributed direct lighting for the remaining 20 per cent.
- Select light fittings to ensure even illumination of the presenter's face at approximately 500 lux. Best practice is asymmetric wall washer fluorescents at 45 degrees to present eye shadows with some side lighting to provide facial shaping and highlights.
- Prevent all exterior lighting from entering the capture zone.
- Ensure backgrounds and furniture in the camera's field of view are not too dark or light as this can affect the camera's auto iris control.

7 ACOUSTICS

It is of fundamental importance to consider acoustic performance in the design of a teaching space to ensure high speech intelligibility. The speech intelligibility of a space is quantified by the Speech Transmission Index (STI). To achieve good acoustic performance, the layout, construction, materials and finish should be selected in such a way to control reverberation, echo and isolation from all internal and external noise sources. The Australian standards relating to acoustics within building interiors are AS/NZS2107:2000 and AS/ANZ/ISO717:1:2004.

The following design guidelines are provided to ensure good acoustic performance in teaching spaces:

- It is strongly recommended that professional advice is sought from an acoustic consultant who can model the performance of the design and recommend loudspeakers and treatment of potential acoustic issues.
- Mechanical services (HVAC) are one of the most common causes of noise and therefore degraded acoustic performance. As well as the sound insulation regulations of AS/ANZ/ISO717:1:2004, consider the following possible measures – Z transfer ducts for air exchange, low velocity air conditioning, slab-to-slab constructed partitions, staggered stud partitions with dense insulation, insulation/expansion foam packed into any partition penetration, door seals, acoustic doors, acoustic ceiling tiles, suspended ceiling with sound traps, perforated anti-resonance panels.

7.1 SPEECH TRANSMISSION INDEX

Minimum Acceptable Value for STI = 0.6

The minimum accepted value by Curtin is the lowest value in the speech transmission index range 0.6–0.75 which is considered ‘good’.

7.2 AMBIENT SOUND LEVELS AND REVERBERATION TIMES

Minimum Ambient Noise Level = 35 dB(A)

Typical Reverberation Time = 0.7–1.0 s

Ambient noise and room reverberation times are two important measures of acoustic performance. The figures shown above are the AS/NZS2107:2000 recommendations for a tutorial room of up to 50 seats. The values for other room types are available in the standard.

8 INFRASTRUCTURE

8.1 AV EQUIPMENT ROOMS

AV equipment rooms shall be co-located with network/communications rooms where possible, and meet the requirements described in the Curtin's data communication cabling standards. In all new/renovated buildings, AV equipment rooms must be connected to the BMS system before the hardware is powered up. This enables temperature monitoring and mitigates the risk of hardware overheating.

Where co-location is not possible, the room shall be designed with due consideration to as many of the following points as applicable:

- AS/NZS3084 Clause 6 and Appendix ZB
- **safety** – layout of racks and enclosures shall not restrict escape routes
- **acoustic noise requirements** – within limits specified by the National Standard of Occupational Noise – NOHSC:1007(2000)
- **adequate access** to equipment for installation and maintenance – 900 mm minimum clearance to front and rear of racks and enclosures
- enclosures well **removed from exposure to moisture** e.g. air conditioning vents, salt and chemical corrosion
- **heat loads** generated by active equipment – maintain a comfortable working temperature in accordance to AS/NZ3084 ZB2.3.4.6.2
- **redundancy** in plant for any venting or HVAC – this includes a secondary (local) A/C unit as a backup in the case of a main unit failure
- **security** of equipment – there shall be at least two points of restriction of access to equipment from outside, usually locked doors at the equipment room and rack/enclosure
- **fire rated** – due to use of electrical equipment, the room must not be fitted with fire sprinklers
- room for **future expansion** – an increase in the number of racks and enclosures by 25 per cent or one rack, whichever is the greater.

Sometimes, due to availability of space, the AV equipment may be housed in a shared area such as a theatre 'biobox' or in a space no larger than a cupboard. In these cases, the above considerations need to be addressed on a case-by-case basis by the PF&D Portfolio Manager and AV Project Manager.

8.2 EQUIPMENT RACKS

Each equipment rack shall be a fully welded rack for 19" mounted equipment with vented panels, metal front and rear doors and meet the international standard IEC-60297. Metal surfaces of the enclosure and accessories shall be powder coated, painted or otherwise protected against corrosion. Black finish is preferred for racks.

There must be sufficient air flow to prevent temperature rise of the contained equipment beyond the relevant manufacturer's specification. Door vents and/or ceiling

extraction fans shall be provided where natural ventilation is not sufficient. Side panels and doors should not be removed to improve ventilation – air conditioning should be considered instead.

For fixed racks, the front and rear must be accessible with a 900 mm minimum clearance. For racks in cupboards or other tight spaces, the rack must be moveable from the space and pivot 90 degrees to provide clear access for maintenance without straining any connected cables. The door locks will be keyed to the standard Curtin rack key. The rack side panels shall be made secure to prevent unauthorised access.

Enclosures and racks shall be bonded to the protective earth system using a minimum 6 mm^2 green/yellow conductor.

A patch panel shall be located at the top of each rack, provided and installed by the communications contractor in accordance with the current Curtin Data Communication Cabling Standard. These outlets are to be connected to the network patching frame so they can be patched to any field outlet in the building. The minimum quantity of outlets required is to be provided by the AV Project Manager (or audiovisual consultant if delegated).

8.2.1 DIMENSIONS

Where co-located with communication racks, the AV equipment rack shall be the same type with the same dimensions and accessories. Otherwise AV equipment racks shall be sized to fit current and expected future capacity (at least 25 per cent free space) and have a minimum depth of 700 mm. The minimum width for a rack opening in joinery or built cupboards is 600 mm clear of all obstacles (including hinges, locks, and service terminations – power points, network outlets).

8.2.2 RACK POWER AND UPS

Where a centralised building UPS system is unavailable, the audiovisual contractor will provide a dedicated UPS for the audiovisual equipment rack.

All equipment in the rack will be powered from a network-controllable power distribution unit. Installation and use of power boards or double adaptors within the racks shall not be accepted.

8.2.3 RACK ELEVATIONS

A rack elevation drawing is to be issued to the AV Project Manager for approval prior to rack construction. The following requirements regarding spacing shall be taken into account:

- Allow for 1 RU spaces between all devices
- 2 RU rack drawer to be provided for remotes, as-built schematics etc.

8.3 CABLING AND CONTAINMENT

All network cabling shall be in accordance with the Curtin's data communication cabling standard. Specific requirements for audiovisual cabling and containment are detailed in the following sections.

8.3.1 SEGREGATION FROM OTHER SERVICES

The minimum segregation requirements for all audiovisual cabling, including earthing cabling, from power cables shall be in accordance with AS2834. Specifically, AC power cable and feeder cable for hearing augmentation loops shall be separated from all other cables according to standards and to manufacturers' specifications. Separation between AV cabling and electrical services must be a minimum 300 mm and they shall only cross at right angles. The minimum separation between AV cabling and other services must not be less than 150 mm.

8.3.2 MINIMUM BEND RADIUS

Wherever a change of direction occurs in cable/conduit runs, cables and conduits shall be curved with a minimum inner radius of bend as prescribed in the manufacturer's specification or eight times the cable diameter, whichever is greater.

Where cables of different sizes run together, the minimum radius of bend for all cables should be that applicable to the largest cable in the group.

Cables not installed within conduits should be anchored immediately before the start and after the finish of the bend.

8.3.3 TRAY SUPPORT SYSTEMS

Tray systems and supports where used shall comply with the following requirements:

- Trays carrying audiovisual cabling shall maintain segregation from other services.
- Trays shall have a minimum clearance or stand off from walls of 25 mm to allow suitable cable fasteners to be used.
- Trays shall provide a minimum vertical open working space of 150 mm.
- Changes in tray direction shall be made using commercially pre-made standard formed bends compatible with the main tray.
- Bolts or sharp objects shall not protrude through the cable bearing surface.

8.3.4 PENETRATIONS

Wall and floor penetrations shall not be created without written approval from Curtin Properties. Refer to the National Construction Code for restrictions on the size and spacing of penetrations. Acoustically seal penetrations for cables conduits, ducts and busways passing through acoustic-rated floors and walls to maintain the acoustic properties.

8.3.5 CONDUITS

All conduits and containment paths shown on AV-related drawings are designated for AV use only. No power or data is to be run through these conduits. All conduits are to be installed with a draw cord.

8.3.6 UTP OUTLETS

Electrical drawings indicating the UTP outlet locations are to be issued to the AV Project Manager for approval prior to ordering and construction.

8.3.7 FLOOR BOXES

Two plates in the floor box are the minimum requirements for AV purposes, with two corresponding 40 mm conduits. See Audiovisual Standards Part 7 – Resource 3: Approved Equipment List for the recommended floor box.

9 IN-ROOM ENVIRONMENT

9.1 POWER

All audiovisual designated circuits within an installation shall be derived from the same load centre and maintain the same neutral and earth relationship throughout the installation. All equipment that is part of the AV installation (e.g. including LCD panels, projectors, house PC, etc.) is to be protected.

With the growing number of user devices such as laptops, iPads and smart phones, a small number of 240 V AC GPOs and reasonable number of 5 V DC USB charging points shall be provided in table boxes and in convenient locations in classrooms. Placement of outlets should be designed so as not to create trip hazards.

GPOs in teaching spaces and lecture theatres shall be either fixed to the seat/desk or, if the room furniture is not secured, recessed in a suitable floor box.

Use of 'soft power' options must be approved prior to selection and purchase, by both Electrical Services and Curtin AV project staff, for standards compliance and to ensure the product is fit for intended purpose.

9.2 FURNITURE

Any furniture in a venue that will house audiovisual equipment must be designed with the following considerations in mind:

- Internal racks must be mounted at floor level, on casters, so that it can easily be pulled out for servicing – i.e. the credenza joinery plinth and base must be cut away so there is no step down to floor level.
- There must be adequate airflow for the installed equipment.
- For the protection and safe operation of audiovisual equipment, the maximum allowable operating temperature for any audiovisual rack, cabinet or credenza fitted to house equipment must not exceed 35 ˚C.
- Use of low-noise or low revolution in-rack fans is permitted.

9.3 HVAC

HVAC systems must be designed so as not to exceed the acoustic noise requirements described in Section 7.2.

The Curtin AV Project Manager, or delegated AV consultant, may request mechanical services drawings for spaces that require ceiling-mounted, suspended, or recessed AV equipment for coordination of their placement in relation to HVAC components.

9.4 SPECIAL CONSIDERATIONS FOR VIDEOCONFERENCE-ENABLED ROOMS

There is a range of special considerations required for videoconference-enabled rooms.

ACOUSTICS

The appointment of an acoustician is recommended to ensure adherence to the tighter acoustic noise limits, e.g. to accommodate ceiling microphone arrays. Airflow voids must not allow noise ingress into the room. Ideally there should be no such voids, so that a controlled acoustic environment can be guaranteed. In particular there must be no openable windows, nor gaps, airflow holes, grilles, etc. to corridors or externally, nor to adjacent rooms.

Similarly, airflow fans for AV equipment within the room must not exceed the acoustic noise requirements.

SURFACE FINISHES

Any tables within the conference environment should have a light top surface. The best table surface is a flat satin finish. Glossy tops should be avoided, as should strong colours or any bold woodgrain. If glossy or saturated colour surfaces are unavoidable, proper lighting can help reduce (but not necessarily eliminate) their ill effects.

COLOURS

Wall, blind and curtain colours within the field of view of the camera have a significant impact on the visual quality of the videoconference. Certain colours are better suited to video transmission than others. In general, light grey with just a touch of blue seems to work best. For rooms that have marginal lighting, slightly darker colours are quite useful. In keeping with these colour recommendations, the acoustic panels (discussed elsewhere in this section) should be light colours such as silver-grey, quartz or champagne for panels within the camera field of view. For aesthetics, however, panels may be alternated in colour along the wall.

CAMERA PLACEMENT

In meeting spaces with a fixed table position, the camera should be placed midline to the table just above seated head height. In classrooms, provision should be made for a rear-mounted (‘presenter’) and front-mounted (‘audience’) camera, taking into consideration camera angles for maximum fields of view.

10 APPENDICES

APPENDIX A: GLOSSARY OF TERMS

Term or Acronym	Definition
AV	Audiovisual
AVIP	Audiovisual Interface Point (aka lectern)
AETM	Association of Educational Technology Management Inc
Audiovisual (AV) System	All equipment integrated into the infrastructure necessary to fulfil the intent of the communicating audio and/or video content to an audience. It is a set of specified, individual audio and video components designed and configured to operate as one comprehensive system.
Audio	Any audio signal in either analog or digital format.
BYOD	Bring Your Own Device, e.g. laptop, tablet, smart phone.
CITS	Curtin Information Technology Services
CITS–AV	CITS Audiovisual (project and support team)
DDA	Disability Discrimination Act
HVAC	Heating, Ventilation and Air Conditioning
Information and Communications Technology (ICT)	Any communication device, application, or service related to radio, television, mobile, telephony, computing, networking and satellite systems
Instruction	A direction issued to the Contractor by the Principal or their nominated representative
NCC	National Construction Code
Participant	An occupant of the venue. In a teaching space this may be a student or an audience member.
Provide	Supply, install and commission
Resident Computer	In-house computer usually installed in the AVIP
STI	Speech Transmission Index
UPS	Uninterruptible power supply