CITY OF SYDNEY

Creative Spaces Design Guides

Prepared by

ARUP

Design guides
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The Council of the City of Sydney acknowledges Aboriginal and Torres Strait Islander peoples as the traditional custodians of our land – Australia.

The City acknowledges the Gadigal of the Eora Nation as the traditional custodians of this place we now call Sydney.

Contents

Introduction

Purpose of the Design Guides

An abundant and diverse supply of creative space is essential to support a productive cultural sector. However, creative spaces are often delivered without due consideration for the operational, spatial, and technical requirements necessary for them to function as needed by users, operators, and the community. This can result in spaces that are not fit for purpose, limited in creative potential or are operationally inefficient, creating ongoing cost burdens to the owner and/or operator.

These Creative Spaces Design Guides have been developed to guide good decision making in the planning and delivery of creative space projects. They demonstrate best practice in effective, efficient, and sustainable design of creative spaces. Not all aspect will be applicable or achievable for every project.

These guides are technical in nature, relating to structure, amenity, and serviceability of space. Readers and users of these guides should be mindful of the very specific technical focus of the documents and use them in conjunction with other guidance on the proposed programming, management, and operation of the creative space they will design and deliver.

These Design Guides are a live document that may be updated from time to time. They do not capture the breadth of all the possible types of creative space, but prioritise spaces identified by key stakeholders as being in high demand and of low supply. Guidance on other types of spaces will be added in future iterations.

How to Use the Design Guides?

These Design Guides are intended to provide a preliminary technical brief for a creative space prior to design work being undertaken. These technical requirements include architectural, engineering, and specialised design advice. The Design Guides:

- are aimed at providing ‘best in class’ outcomes and should be considered a launching point for detailed design briefs to be developed with project teams,
- are intended to be a practical resource to inform early planning and design conversations,
- should be used as a tool to facilitate early engagement with operators and user groups. Continued engagement throughout design and delivery is key to the development of fit-for-purpose creative spaces,
- are intended to support understanding and a shared language between stakeholders about the technical requirements for the type of creative space they wish to deliver,
- do NOT substitute specialist design, architectural and engineering advice as would be expected and required on any design and construction project,
- do NOT substitute early engagement with operators and end-users whose specific needs would need to inform project specific design briefs.

Users of the Design Guides

The intended audience and users of these Design Guides might include:

- Private property developers incorporating creative space into a larger property development,
- Local and/or state government arts and culture agencies that are delivering or supporting the delivery of creative space,

- Arts and creative organisations that are planning to upgrade, deliver or occupy creative space.

Report structure

The first section titled **Key Principles for Designing Creative Spaces** provides guidance that applies equally across all space types and important considerations that need to be addressed alongside the technical framework of these guides. These include:

- End-User and Operational Needs,
- Project process,
- Procurement,
- Code Compliance,
- Inclusive Design,
- Sustainability,
- Departure guidance.

These second section consists of standalone guidance documents for the following types of creative space:

Document 1: Rehearsal Space

Type A - Theatre focus

Type B – Dance focus

Document 2: Sound Recording Studios

Document 3: Small Multi-Use Theatre

Document 4: Light industrial Fabrication Space

Type A – Timber

Type B – Metal

Type C – Paint and Scenic

Each of these design guides identifies the following technical requirements:

- Programmatic – key spaces and spatial relationships within space,
- Spatial – key dimensions and spatial relationships within spaces,
- Technical Systems – specialised equipment suited to functions of the spaces,
- Code Compliance – highlighting areas of specific focus on / departure from NCC,
- Structural Engineering,
- Lighting,
- Electrical Engineering,
- Acoustics,
- Fire Engineering,
- Hydraulic Engineering,
- Mechanical Engineering.

A glossary section is also included for reference.

Key Principles for Designing Creative Spaces

Embedding Good Design in a Creative Space

Creative spaces are places where people gather, inspire, connect, create, and present their work. They are unique and respond to the needs of the environment in which they are located. These spaces will be used by professional artists, producers, construction and technical production staff and the broader community. It is imperative that good design is at the core of every creative space delivered.

The Better Placed integrated design policy document by the Government Architect NSW recognises that “Good design creates useable, user friendly, enjoyable and attractive places and spaces, which continue to provide value and benefits to people, the place and the natural environment over extended periods. Good design brings benefits socially, environmentally and economically, and builds on these benefits over time – continually adding value.”

Incorporating good design in creative spaces includes designing for and understanding:

- user and operational needs,
- the project processes,
- efficient procurement of goods and services,
- compliance to codes and standards,
- inclusivity,
- sustainability,
- the local, national, and international arts and culture eco-system.

Operational & End-User Needs

Early and ongoing engagement with operators, user groups and other stakeholders is a key component in the successful delivery of creative space projects. The development of a vision and critical success factors with primary stakeholders lays the foundation for the development of spatial, operational and management structures. The establishment of a vision, operating models and target markets are all essential to designing creative spaces with a unique identity and place within the arts and cultural eco-system.

Defining Operational and End-User needs is often the first step in a project delivery process.

Project Process

These guidelines provide the key requirements for best practice design. However, design itself does not guarantee good project outcomes. Design of creative spaces, as a process, is part of a bigger 'process' of project delivery. As such, these design guides are not a starting point but a tool to be deployed throughout a project process with differing points of value throughout that process.

The diagram above outlines one possible project process. The design guides is potentially of value to this process at each point in the following ways:

Project Visioning

Potential uses	Example of usage
Assist a property developer to determine appropriate creative infrastructure aligned to a development vision	• What are the spaces used for and what needs to be built; how does that align to your intended project outcomes?
Assist arts organisations to survey possible options for creative spaces	• Your organisation is ready to find a new home – what technical and spatial capability does the site need and how much might it cost?
Assist with site selection and due diligence by validating if sites can accommodate technical needs	• Your arts organisation has found space that could be converted into creative space – does it have the clear height and services on site to support your needs?

Concept Design

Potential uses	Example of usage
Assist a property developer to determine appropriate creative infrastructure aligned to a development vision	• The design guidelines establish some primary design requirements to be incorporated into early design – has the design team made the right spatial, structural and services allowances?
A departure point for a design brief which recognizes that the design guides are 'best practice' and can be descoped with the guidance of the consultant/design team	• The preferred site and design of an arts organisation cannot achieve the guideline clear height for dance – what are the impacts of a reduced clear height and is this acceptable to the organisation?

Detailed Design

Potential uses	Example of usage
Detailed design and engineering requirements to be used as 'basis of design' for project design team	• The design guidelines provide a clear set of functional and performance design criteria that need to be delivered unless otherwise agreed – for example: can the appropriate background levels be met against the nominated criteria or has the design team agreed to relax them for this project?

Construction

Potential uses	Example of usage
Provide a reference point for collaborative discussion between stakeholders, designers and builders as projects are being delivered	• The design guides are a common point of reference for a shared understanding of what is being built and why – for example: does the kitchen have all the facilities that the company requires?

Operation

Potential uses	Example of usage
Post-occupancy validation	• To check whether the intended functionality and performance has been delivered?
Real world implementation of design guides used to provide lessons learned for future refinement of the design guides.	• If aspects of the guidance are proven to be persistently difficult to practically achieve – this feedback can be recorded and submitted.

Ultimately, the success of these design guides will be realised through their application throughout a design and delivery process. The intention is that they are used as a constant reference at different stages of a project as well as being a tool to facilitate collaborative discussions as the details of the project unfold during design and construction.

Procurement Considerations

Procurement methodologies – for both design and delivery – should be structured in a manner that ensures alignment with, and ability to deliver against, the vision articulated by project stakeholders. The many varied ways that the design and construction of building projects can be procured are beyond the scope of this design guide - and each project will require its own specific procurement methodology.

Below are some examples of procurement methods that might be considered to ensure best alignment of the creative space with the vision articulated by project stakeholders:

- A private developer delivering a creative space as part of a construction consent condition might be required to put in place governance structures that ensure stakeholders are consulted and their requirements are demonstrably met.

- Consent authorities provide incentives to developers to establish and maintain ongoing outcome-oriented relationships with creative arts community members.
- Arts organisations are recommended to engage with specialised consultants at the outset of a project to determine their specific needs, aligned with organisation mission and values, to form the basis of a project brief.
- Arts organisations should be provided with quality advice for the procurement of design and/ or construction services.

Compliance to Codes and Standards

Any creative space needs to be designed, built, and certified in accordance with current relevant statutory regulations. Of particular note:

- The facility is to comply with the current version of the National Construction Code of Australia (NCC) and all relevant associated Australian Standards.
- A Building Code of Australia (BCA) consultant and a Disability Discrimination Act (DDA) consultant should be engaged to provide comprehensive advice and compliance check through design and documentation of the facility.
- For a 'change-of-use' and/or works within an existing building, consideration is to be made of Clause 93 (59) & 94 (61) of the Environment Planning & Assessment (EP&A) Regulations by a BCA Consultant. This assessment should be carried out pre-submission of a Development Application.
- Input from a Fire Safety Engineer may be necessary to assist in defining the extent of upgrade to meet the required level of safety and assist the consent authority to determine the acceptable level of upgrade needed.
- For facilities proposed within an existing building, the extent of upgrade required for compliance is to be assessed by a BCA Consultant in conjunction with Clause 93 & 94 of the Environmental Planning & Assessment (EP&A) Regulations.

Inclusive design

Creative spaces should work for everyone, but too often they fall short of this ambition. For a creative space to be inclusive, it must reflect and respond to the widest range of people's requirements, enhance visitor and user experience providing equal opportunities to access the space and use its facilities/services.

Inclusive design should be considered at every stage of the project lifecycle. By considering this earlier in the design phase, expensive late-stage alterations can be avoided, and the cost of management and maintenance can be lowered.

For inclusive design to be integrated into a creative space, compliance is required with the following codes:

- The access provisions of the current National Construction Code (NCC),
- The DDA Access To Premises Standard,
- The local Council's DCP relating to Access for People with a Disability,
- AS 1428 suite of Standards,
- AS 2890.6 for car parking.

Evacuation of mobility impaired, hearing impaired and vision impaired occupants is to be considered within the design.

Sustainability considerations

Every industry can influence emissions and their sustainability performance. Sustainability and climate change are increasingly at front of mind for the general public and inform consumer decisions. Effective sustainability approaches should entail the application of systems thinking, considering the project holistically from its conception (do we need to create something new, or will repurposing something we already have suffice) to its end of life. With this in mind, some key considerations for each of the Creative Spaces which may improve sustainability performance include:

Green House Gas emissions

Any creative space project design should aim to:

- Understand and quantify Scope 1, 2 and 3 greenhouse gas emissions for the creative space over its lifetime,
- Develop emissions reductions targets, targeting net zero emissions in line with the City of Sydney's emissions reduction targets.

Energy usage

Reducing energy usage and selecting a low emissions source of energy can significantly reduce your greenhouse gas emissions profile including:

- Energy efficiency
    - Use energy efficient appliances with an Energy Rating label, economy mode,
    - Obtain an energy rating for the space or meet energy rating requirements if rating is not available (NABERS, Green Star),
    - Exceed National Construction Code Section J Energy Efficiency requirements,
    - If space is to be leased within a broader building context, ensure landlord has an energy rating for the base building (NABERS, Green Star),
    - Monitor energy usage through use of on-site energy metering,
    - Ensure energy efficiency through design, including:
        - use of programmable Building Management Systems,
        - insulation to reduce heating and cooling loads,
        - passive lighting and temperature control,
        - specification of LEDs,
        - specification of solar hot water and electricity panels.
    - Minimise natural gas usage, replacing gas with electricity for cooking and heating wherever possible.
- Energy source - procure energy for the operation of creative spaces, applying the Energy Hierarchy (outlined below) when selecting a provider:

Hierarchy	Energy source
1	Sustainable energy production: a. Renewable energy from sun, wind, waves, tides or rainfall, or geothermal energy b. Bio-energy from the combustion of biomass c. This includes on-site renewable energy generation, Power Purchase Agreements and other renewable energy options from energy suppliers
2	Low impact energy
3	Energy generation that makes use of carbon capture and storage to reduce emissions from generation
4	Offset - Offset the emissions from your energy usage using certified emissions offsets

Water management

Reduction of water usage overall and use of non-potable water sources where possible contribute to sustainability performance and are important considerations in a drought-prone city. Water management in Creative Spaces should consider:

- Use of efficient fixtures and fittings with a WELS rating,
- Monitoring water usage through on-site metering,
- Obtaining a water efficiency rating for the space or meet water rating requirements if rating is not available (NABERS Water, Green Star),
- Ensuring water efficiency through design, including use of recycled water, reticulated wastewater, rainwater capture.

Waste management:

This includes single use items, fit outs and food waste (organics diversion). Waste management in Creative Spaces should consider:

- Obtaining a waste rating for the space or meet waste rating requirements if rating is not available (NABERS Waste),
- Setting targets to reduce waste production overall, from both construction and operation of the Creative Space,
- Setting targets to maximise diversion of waste from landfill and aligning with City of Sydney targets. Strategies may include:
    - Having separate collection for multiple waste streams, including organics waste, and adequate space to accommodate these waste streams,
    - Educate staff on waste sorting,
    - Provide signage and nudge mechanisms for audiences and clients to promote waste sorting.
- Minimise the use of hazardous waste, that is waste that has the potential to harm humans or the environment, in the construction and operation of the space, and provide adequate and safe storage and disposal options for hazardous waste where use of hazardous materials is unavoidable.

Departures from Design Guides

These Design Guides articulate a set of functional and performance requirements that should be delivered in order to realise best practice outcomes for a creative space project. However, it is not always possible, or appropriate, to achieve best practice outcomes. Indeed, the design should align with the capability and expectation of key users and stakeholders. The risks of misalignment between design and user/stakeholder expectations include: not fit-for-purpose facilities; operationally burdensome facilities; facilities that don't align to their broader built environment.

These design guides are intended to be a 'point of departure'. That means that stakeholders should recognize that these are best practice and be empowered to descope from these requirements where appropriate. In which case it is crucial to have the advice of a design, architectural, engineering and consultant team who can help to explain the implications and impacts that might occur should these requirements be descoped.

Departure Guidance: Throughout the design guide document there are boxes formatted in this style. In these boxes are commentary on the potential implications of descoping against specific requirements. Please note that the descoping can have broader and more/less significant impact than the example given. It is important to gain advice from a professional design and engineering team to help understand these decisions on a case-by-case and project specific basis.

Document 1:

Rehearsal Space

Description

A rehearsal space is used for the creation, development, and planning of a performing arts production. A rehearsal space provides a private, safe and comfortable space for performers and artists to create, practice and experiment.

A rehearsal space (also referred to as rehearsal studio or rehearsal room) has several generic and specific requirements dependent on planned usage. Specific requirements must be met to successfully support individual performance types. Rehearsal spaces have several support spaces including changing rooms, kitchen, break-out or meeting rooms and storage.

Rehearsal spaces can also be used for informal performances and more general public uses for example dance or performance classes, play-reading, meditation, and yoga groups.

The general requirements of a rehearsal space are outlined within this guide, with the individual needs of two specific variations indicated below:

Type A – Theatre focus

A rehearsal space to support rehearsal of a theatrical production

Type B – Dance / Contemporary performance focus

A rehearsal space to typically support various styles of dance including, but not limited to; ballet, modern, contemporary, percussive dance (such as Irish dancing, Flamenco and tap), hip-hop, jazz, salsa, street, aerobics, and zumba.

Usage profile

Rehearsal rooms have a range of usage profiles:

- Single user group for several weeks for up to 8 hours a day, 5-6 days per week.
- Single user group for a single day or a few days at a time for up to 8 hours a day.
- Multiple user groups for a few hours of time per day.

Expectations of the operator and user groups should be considered during the design phase. For example, a scenario where one user group books a space for an 8 hour day for a period of several weeks for rehearsals, while other users maintain access for evening bookings for example dance classes. In this example greater storage requirements may be required to cater for the security of both user groups.

References: Type A - Theatre focus

Sydney Theatre Company Rehearsal Room © Sydney Theatre Company

References: Type B – Dance/Contemporary performance focus

Queensland University of Technology Creative Practice Labs – Dance Studio © Arup

Programmatic requirements

Common to Type A and B

Key programmatic requirements are outlined below:

Performance area for rehearsal,

Work Area surrounding the performance area for technical equipment, production & creative teams,

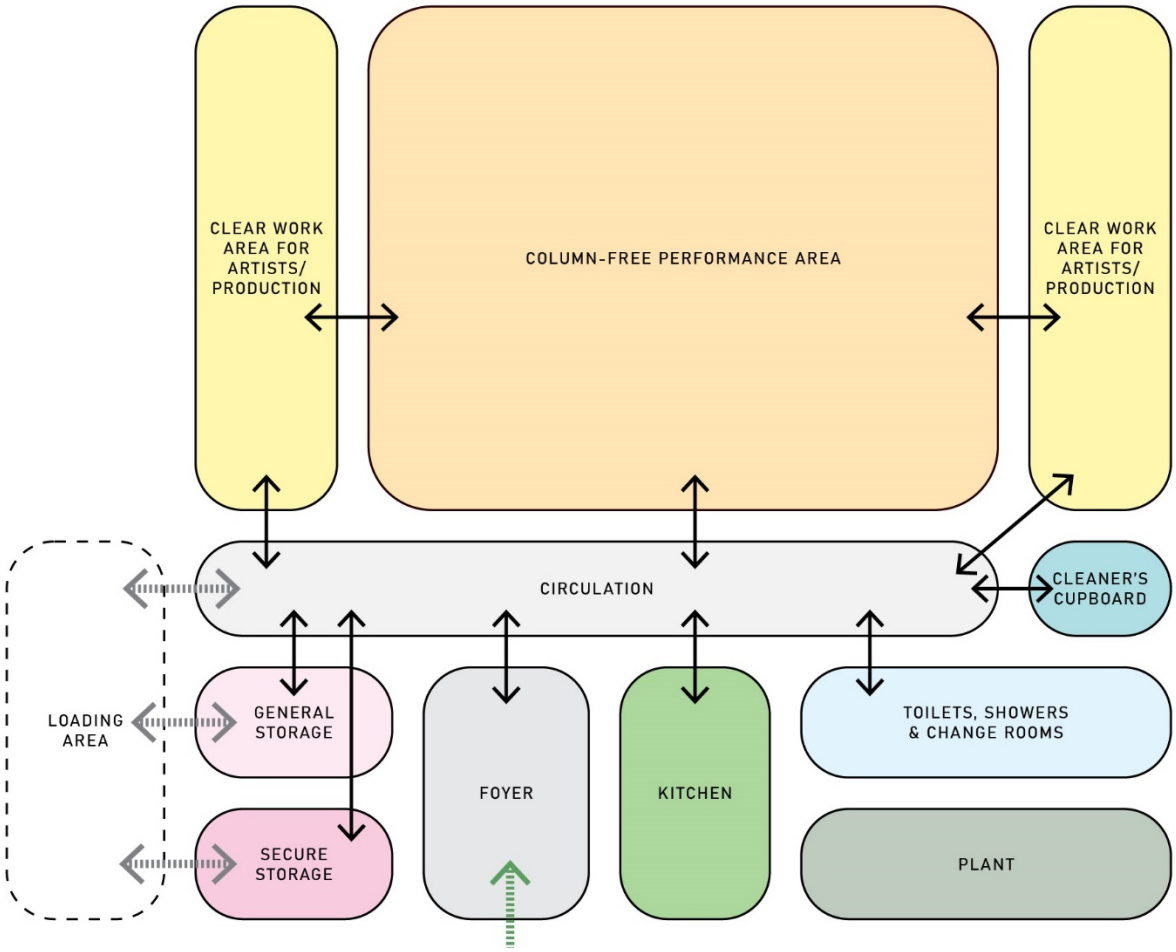
Amenities including basic kitchen, changing rooms with dedicated toilet and shower amenities,

Storage areas,

Loading zones for incoming technical equipment and rehearsal items,

Step-free circulation and **obstruction free access**, sized (at minimum) for a grand piano or elevated work platform from the building exterior,

Inclusive and legible **wayfinding signage.**



Rehearsal space – Spatial adjacency diagram

Spatial requirements

The rehearsal space should support performers, artistic staff, technicians, and occasionally audiences / observers.

Early engagement with the operator and user groups to determine the usage is key to defining area requirements. As an early planning guide the rehearsal space should provide a minimum floor area of **14m x 14m**. Within this a **10m x 8m** column free performance area is required. The areas surrounding the performance area will house creative and production teams sitting at desks and occasionally seated audiences / observers.

Changing Rooms**: 2 m^2 per person**

Toilets**:** As per **NCC**

Showers: As per **NCC**

Kitchen: **10m^2**

General Storage: **15m^2**

Technical Equipment Storage: **20m^2**

Secure Storage: **15m^2**

Cleaners Cupboard: **2m^2**

All spatial requirements listed above denote Net Internal Area.

A minimum clear height (clear of structure and services) of **5m AFFL** should be maintained above the performance area, and where possible the remainder of the room. Any reduction in clear height inside the room should be carefully considered and coordinated.

Internal linings for walls, floors and ceiling require acoustic treatment. Refer to the Acoustic requirements section for more details.

Natural light should be provided by windows, excluding roof lights that:

- have an aggregate light transmitting area measured exclusive of framing members, glazing bars or other obstructions of not less than 10% of the floor area of the room; and
- are open to the sky or face a courtyard or other space open to the sky or an open veranda, carport or the like. Refer to lighting requirements for more details.

Whilst providing windows for natural light, privacy must always be maintained. Any windows to publicly accessible areas should be fitted with privacy glass, or other strategy to ensure privacy for rehearsal participants. A method to successfully black-out the rehearsal space e.g. curtains, blinds, shutters in the event technical systems require a ‘black out’ theatre environment should be provided.

Secure, straightforward, and controllable access for user groups should be provided from the building exterior, such as an electronic keypad entry, or similar.

Departure Guidance: If a reduction in height is considered, please note the impact on functionality of the space. For dance or movement purposes, a minimum height of **5m AFFL** enables choreography in which performers are lifted. For theatre purposes a reduction in height may impact rehearsal scenery and rigging capability of the space to accommodate lighting, special effects, etc.

Common to Type A and B

Kitchen

A Kitchen is intended only for basic meal prep and reheating of pre-prepared meals. The kitchen should allow for food rinsing, utensil washing and the sanitary disposal of associated wastewater. There is no need to provide oven and stove top unless specified by the operator or user groups.

A minimum clear height of 2.4m above finish floor level should be maintained in the kitchen.

Basic kitchen provisions to include: a large fridge, microwave, sink and instantaneous hot water boiler for efficient tea and coffee preparation. A reasonable amount of bench space and storage should be provided. A dishwasher may be considered.

Toilets, showers and changing facilities

The National Construction Code of Australia (NCC) sets out the ratio of male and female toilets to the number of occupants, and the specifications for toilets. Provide at least one shower cubicle for every 10 occupants. Showers should have a floor area of not less than 1.8 sqm

A minimum clear height of 2.4m above finish floor level should be maintained in the toilets, showers and changing facilities.

Changing facilities should also be provided with a clear space of no less than 1.5 sqm for each occupant changing at any time. Change rooms should be equipped with lockers for storing clothing and personal belongings. Lockers should be well ventilated, accessible, and secure. There should also be a clear space of at least 1800 mm between rows of lockers facing each other and at least 900 mm between lockers and a seat or wall.

Accessible toilets, showers and changing facilities should also be provided for people with a disability compliant with the National Construction Code of Australia (NCC) and the AS 1428 suite of Standards

Departure Guidance: Change and bathroom facilities are not a luxury for a rehearsal space. Activities within the rehearsal space can involve a lot physical movements thus requiring showers for users. Rehearsal spaces also require discrete change facilities to change from day wear to active wear and/or costume as required.

Storage requirements

General storage areas adjacent to or within the rehearsal space should be provided and capable of storing:

- Height access equipment / machinery platform ladder, with consideration given to manoeuvring a ladder between storage and the rehearsal space,
- Loose furniture such as folding tables and chairs.

Secure storage adjacent to or within the rehearsal space should be provided, to safely store:

- Technical equipment associated with the room (audio equipment, etc.),
- High-value items belonging to users of the room.

Technical Equipment storage must be provided within or adjacent to the rehearsal space, and may be used for:

- Lighting equipment,
- Audio equipment,

- Video equipment,
- Loose cabling.

Cleaner's cupboard must be provided adjacent to or within the rehearsal space with the following:

- Mop sink,
- Area to hang wet mops, and brooms,
- Cupboard to store general cleaning products securely and safely (dustpan & brush, bin liners, cleaning fluids, etc.).

Departure Guidance: Storage is a commonly overlooked facility in creative spaces design, sometimes sacrificed to allow area for other functional requirements. The saying 'you can never have too much storage' is true and failure to do so can have an impact on the safety and operation of a facility.

Technical Grid

The rehearsal space should be fitted with overhead rigging infrastructure to support the temporary installation of production equipment and scenery. The technical grid should span the entire rehearsal space. This may be presented as a distribution of rigging points or a pipe grid system. Services zone should be nominated above the rigging infrastructure and integrated with production system cabling containment and facility panels. Please see Technical System and Structural design requirements.

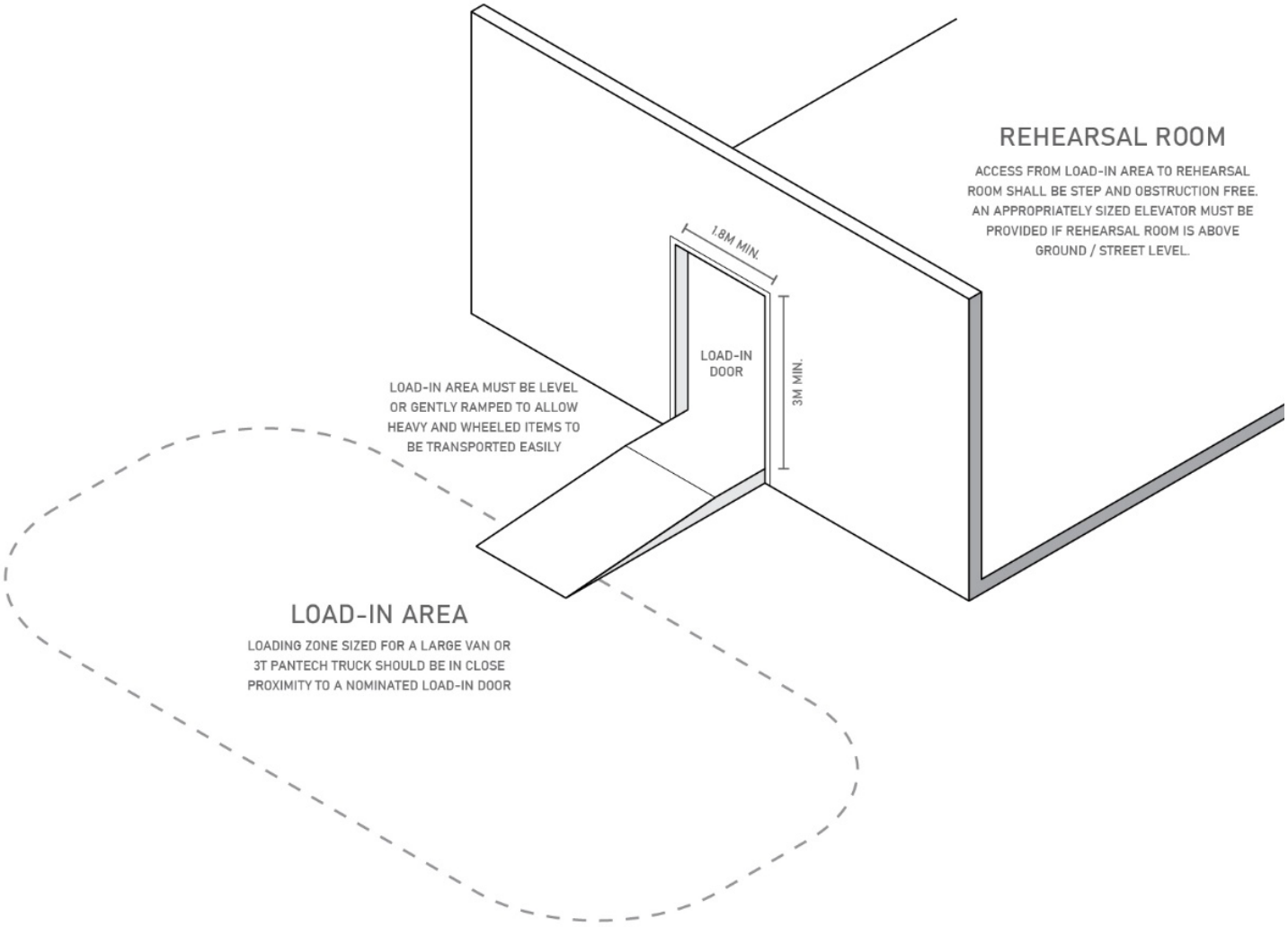
Loading zone and circulation requirements

The loading & unloading of equipment into the rehearsal space and/or the building in which the rehearsal space is housed should be carefully considered. The building's load-in door should be a minimum of 1.8m wide by 3m high to allow for large items and equipment destined for the rehearsal room. The load-in area shall be level or gently ramped to allow heavy and wheeled items to be safely transported.

Circulation paths from the load-in area to the rehearsal room should be step and obstruction free and have legible way-finding signage. Doorways and accessways should be a minimum 1.8m. An appropriately sized elevator should be considered if the rehearsal room is situated above ground / street level.

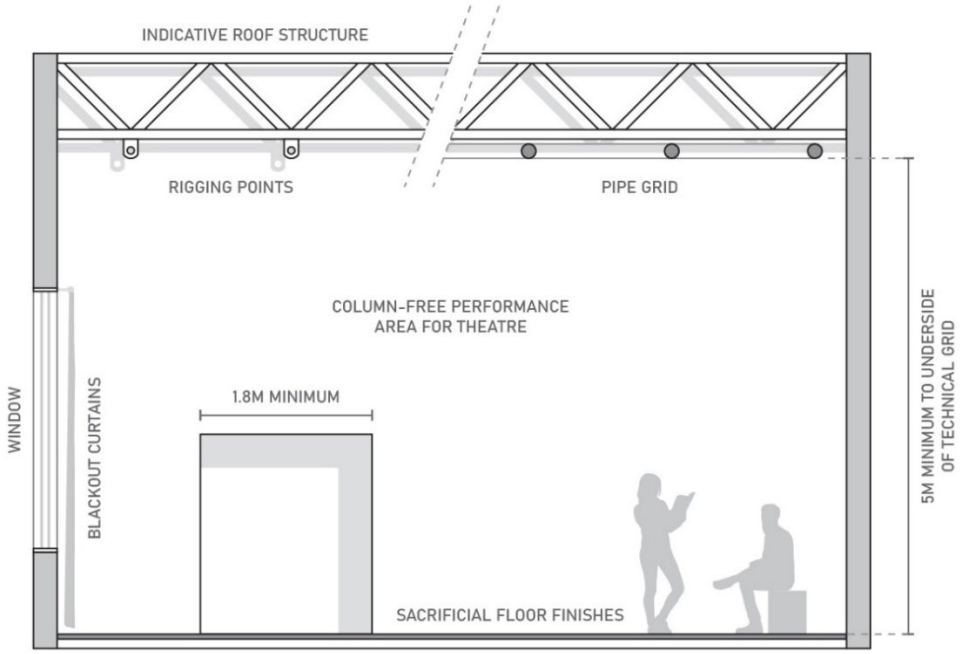
A dedicated loading dock is not required to support this type of space, however a loading zone sized for a large van or 3t Pantech truck should be in close proximity to a nominated 'load-in door'.

Departure Guidance: Inadequate loading and circulation requirements can result in: operational inefficiencies, unsafe practices, disturbance to neighbours, potential loss of reputation and revenue. Rehearsal Spaces may be shunned by operators if they experience operational inefficiencies for 'bump-in' of events and productions. As such load in paths should avoid; stairs; lifts; lots of turns and bends; and uneven surfaces from the loading zone to the rehearsal spaces.



Rehearsal space – Loading zone diagram

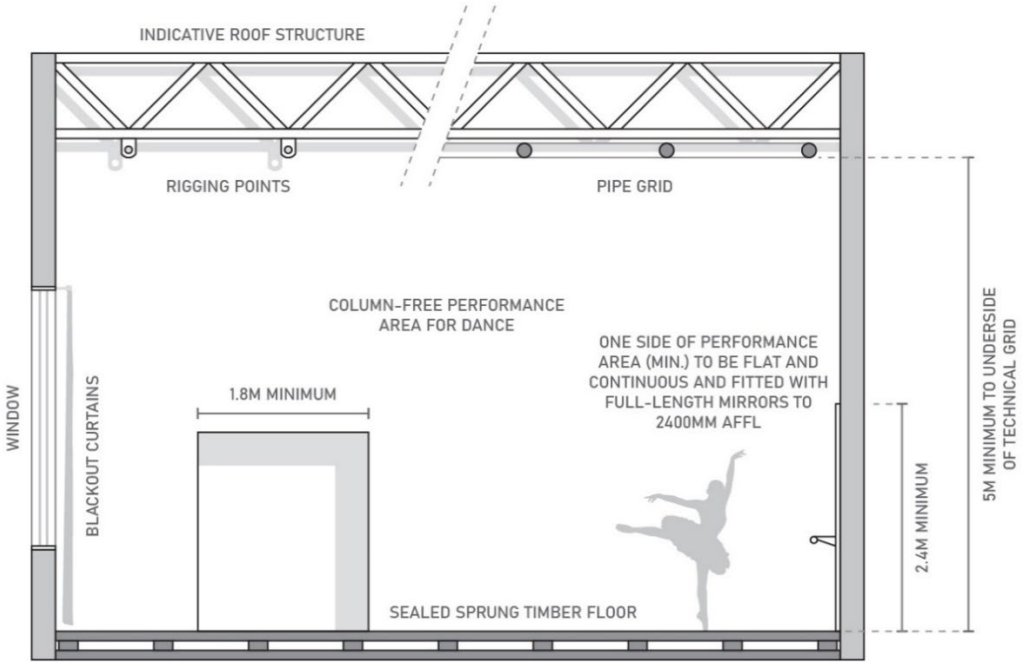
Type A – Theatre focus requirements



Type A (theatre) rehearsal space – Sectional diagram

- A sacrificial floor finish that can be fixed into (for example screwing scenery to the floor by users as needed) should be provided to create a flexible work environment for rehearsal scenery to be temporarily installed. A typical construction example would consider plywood layers on joists, with a replaceable painted top layer painted for example Masonite or equivalent.
- Resilient wall finishes that can be attached to as needed or painted should be provided to support temporary installation of rehearsal scenery and props.

Type B – Dance focus requirements



Type B (dance) rehearsal space – Sectional diagram

- A sprung, sealed timber floor should be installed to provide a safe work surface for dancers. The specific conditions and criteria for the floor product (shock absorbance, deflection, etc.) should be determined in consultation with the operator and end-users.
- At minimum one side of the rehearsal spaces should be fitted with full height mirrors to 2400mm AFFL.
- Wall or floor mounted ballet barres may be fitted along the wall in front of the mirrors. If not fitted, adequate storage will be required for portable barres.
- A curtain track system should be installed to close off the mirrored wall when not in use or to alter the acoustics of the room.

Departure Guidance: The flooring requirements provided above reflect functional, comfort and safety requirements. A floor that can't be fixed into is of less value to a theatre company. A floor that isn't sprung and sealed can have impacts on dancers' feet and cause injury.
Some rehearsal spaces will seek to service both dance and theatre uses. In this case, generally, flooring for dancers is prioritised, however the preference of the operator or end users should be considered.

Technical System design requirements

Key technical system requirements are outlined below:

Early engagement with the operator and user groups to determine the usage is key to defining technical system requirements. The overall design and capacity of the infrastructure or systems should be determined at the start of the design process.

Technical Grid

Overhead rigging infrastructure should be provided above the entire rehearsal space to support the rigging of production equipment such as lighting fixtures, video projectors, LED walls, loudspeakers, curtains, and scenic elements brought in for a particular production. These systems will be reconfigured regularly as per each individual user's requirements. The overhead rigging may include one or a combination of the following systems:

Pipe Grid

A pipe grid suspended from the structure above to allow for efficient rigging of permanent and temporary lighting or equipment. Key design requirements include:

- arrangement of 48.4mm OD steel pipe,
- nominal 1.5m - 2m spacing in two directions,
- capable of supporting:
    - 50 kg per lineal meter,
    - 100 kg point loads.

Rigging Strong Points

Rigging strong points to host a series of hoisting equipment (e.g. chain-motor or chain block) that is subsequently connected to either suspended objects or a production truss arrangement. The truss can be used to support a range of production equipment for example lighting fixtures, video projectors, LED walls, loudspeakers, curtains and scenic elements. Key design requirements for rigging points are outlined below:

- Rigging points may be presented as lugs fitted directly to building trusses or ceiling slabs.
- Rigging points should be capable of individually supporting up to 500kg. Simultaneous loading of multiple points to support a distributed load will be required pending detailed design

Building Structure

Any steel building structure within the rehearsal space should expose steel members (such as universal beams and steel trusses) that can provide temporary rigging support for point loads via temporary means (such as beam clamps and spansets).

Please refer to Structural design requirements.

Curtain System

Hand-operated curtain track systems should be considered to control natural light.

Production Lighting

Temporary production/theatrical lighting should allow users the capability to suspend and control temporary theatrical lighting fixtures with infrastructure at floor and ceiling levels. Connections to dimmer racks and lighting control will be managed by wall and floor facility panels.

Production Sound

Temporary sound reinforcement system should allow users the capability to suspend and control temporary loudspeakers with infrastructure at floor and ceiling levels. Connections to an audio playback system should be managed through multi-core audio cables linked to the wall and floor facility panels.

An external portable sound rack housing equalizers, compressors, and Digital Signal Processors (DSP) devices should be linked to the console to provide signal processing to the final audio mix.

Production Video

Temporary production video system should include overhead and floor level infrastructure to support temporary video installation and control. Connections to analogue or digital switching devices to distribute and process the video signal from video cameras will be managed via cabling linked to the wall and floor facility panels.

Production Infrastructure

Facility panels will be required, mounted to the ceiling, wall and floor to interconnect the different Production Audio / Video / Lighting systems across the rehearsal space. Facility panels provide an identifiable connection point for analogue and/or digital signal cables between various systems and locations within the room.

Overhead Access

Overhead production equipment may be accessed via:

- A suitable platform ladder,
- Lightweight portable scaffold tower, or
- Height access machinery, such as a vertical lift or scissor lift.

Height access requirements should be assessed with operators and end users to determine the method of height access required. The assessment will need to consider the operational impact, risk profile, user needs and use-cases, frequency of use, adequate floor loading criteria, storage areas and access paths.

Departure Guidance: The ability to easily access overhead rigging systems for temporary rigging/hanging equipment (lights, drapes, scenery etc.) allows for efficient bump-in and bump-out of rehearsals. If the structure of the building does not have adequate rigging capability, it can introduce inefficiencies and complexities for temporary rigging of equipment thus making the space less desirable for users.

Additional code compliance requirements

- Rehearsal spaces are occasionally used for small-scale performances and events. The Classification of a space must not restrict advantageous uses of a facility. If a rehearsal room is to be used as an Entertainment Venue and/or Assembly Building this must be reflected in the Classification of the facility and outlined in the Project Brief, as this will change the NCC requirements.
- If used as an Entertainment Venue, NCC Part NSW H101 will apply in NSW. The area of the stage will have a bearing on the complexity of fire safety measures in the venue.
- If used as an Entertainment Venue, the design and operation of the space is to be in accordance with Schedule 3a of the EP&A Regulations.

Structural design requirements

Key structural design requirements are outlined below:

Floor Loading

Load allowances for the rehearsal room floor and adjacent spaces should consider the use of space and comply with AS1170.1:2000.

Generally, the rehearsal space floor shall be designed for:

- Uniformly designed load (UDL) of 5 kPa,
- Concentrated point load of 3.6kN over a minimum area of 300 mm x 300 mm,
- Special consideration for the allowance of concentrated point loads shall be made for scenery and production equipment. If these loads exceed the code specified maximum, the floor shall be designed for the higher load requirement. Some heavy items that are likely to be used in the space might include:
  - A fully loaded chair trolley,
  - A heavy road-case of technical equipment,
  - A heavy trolley supporting multiple rolls of dance floor / Tarkett,
  - Heavy scenic elements such as stage decks, flattage, etc.

The rehearsal room floor should have the capacity to support concentrated and uniformly distributed loads for temporary equipment (e.g. elevated work platforms (EWPs), to facilitate access to the overhead structure for operation and maintenance. The loading capacity of the travel paths for the temporary equipment should also be considered in the design and floors should be designed to facilitate these temporary loads. The equipment and the procedure implemented for overhead operation should also be carefully selected to ensure the floor is not damaged, in particular, the Type B (Dance) space sprung floor.

Overhead rigging suggested allowances

The following load allowances should be considered for rigging infrastructure outlined in Technical Systems requirements.

- Pipe Grid
  - Typically, 2kN point load at 2m grid, or 0.5 kPa UDL
- Rigging Points
  - Nominal 3m - 6m centres with a 5kN load capacity per point.
  - A defined limit to the number of rigging points that are coincidently loaded should be discussed and agreed with the end user to avoid excessive loading requirements for the overhead structure.

- Rigging to structure is only to occur at agreed rigging point locations.

Overhead rigging infrastructure should be supported from the floor / roof structure above. This floor / roof shall be designed considering the hanging loads from the rigging equipment, including any dynamic load factors. Any items supported from the rigging system that are sensitive to vibration (e.g. lighting, sound) or have specific performance requirements, should be specified for consideration in the design of overhead rigging support structure.

The overhead rigging is frequently supported using chain hoists, clamps and other rigging hardware (as described in technical systems requirements). Exposed steel members (such as universal beams) are an effective support for rigging points. The possibilities for clamping to beams may be limited if fire treatment is required on the beam. These steel members can be secondary members attached to the primary structure, or direct attachment to the primary structure may be appropriate.

Departure Guidance: A building that does not have adequate floor or ceiling / roof loading capacity could significantly impact the functionality of the space; ceiling / roof loading should allow for the rigging of equipment and / or connections for aerial performances; floors should allow loads such as large set constructions; floor should also allow for the concentrated loads of elevated work platforms to allow access to rigging points.

Vibration Performance Criteria

The impact of rhythmic activities such as dancing shall be considered in the design of the rehearsal room and adjacent spaces. Large repeating loads due to dancing or other types of high energy movement are applied to the structure which can generate structural vibration that may cause complaints or concern to the occupants. Due to the architectural constraints of the space, namely the column free structural arrangement, suspended floors can have relatively low frequencies. This means that people can dance at the same frequency as the structure, causing large movements.

There may be areas in the structure where rehearsal rooms also support spaces with more sensitive usages increasing the potential to transfer structural vibrations between floors.

Careful consideration is required into whether vibrations within the rehearsal spaces and transferred vibrations into other spaces through the building will cause concern to occupants. Expected vibrations levels can be predicted using published loading and acceptability criteria from international codes and standards, including AISC Design Guide 11 and ISructE.

Lighting design requirements

Key lighting design considerations and requirements are outlined below:

Lighting design considerations

- Fixtures with indirect or diffuse light sources should be used to provide adequate lighting to the vertical plane to highlight faces.
- Natural light throughout is preferred. Control of natural light with blinds / shutters / drapes should be provided on all windows and glass surfaces.
- The colour temperature of the fixtures to be 3000K or 4000K and consistent throughout
- Luminaires to be concealed where possible and with a unified glare rating (UGR) of 19 or less.
- The colour rendering (CRI) of the luminaires to be 90 or higher.

Lighting controls

- All lighting should be dimmable, with smooth fading from 0-100%.
- A local control or over-ride should be provided so that creative teams can dim or black-out the room lighting when performing under temporary production lighting systems.
- A panic button should be incorporated to instantaneously activate room lighting in an emergency.
- Room lighting should be coordinated and controllable from the Building Management System.
- Lighting within the rehearsal venue should be zoned – the performance area should be one single zone, separately controlled from the remainder of the space.

Lighting design compliance

- Lighting illuminance and uniformity requirements must comply with AS 1680. The average horizontal illuminance level should meet 240 lux. This is indicated in AS1680.2.3 (Specific applications – educational and training facilities), Table D1 Auditoriums. The uniformity of the space should meet 0.3 as a minimum.
- The NCC Part J6.2a states that the maximum illumination power density for auditoriums, churches and public halls to be 8w/m2. Motion sensors and lighting timers should also be considered to turn off the lighting and conserve energy when room is not in use.

Emergency Lighting and Exit signs

- AS2293 and NCC Section E4 compliance emergency lighting and exit signs to be provided throughout as required.
- Consideration shall be given to incorporate integrated emergency lighting to the general lighting within the space.
- Exit signs to have capability of using minimum brightness allowable for exit signs to eliminate glare and light spill during a ‘theatrical black out’.

Electrical design requirements

Key electrical design requirements are outlined below:

Electrical requirements

- Incoming power supply to the rehearsal space and the power supply authority power metering requirements to be provided based on the incoming power supply to the building and as per local power supply authority requirements.
- A dedicated distribution board must be provided for the rehearsal room with separately metered power and lighting as required by NCC and ESD purposes.
- General power outlets to be provided for the user ports and cleaners’ outlets around the perimeter.
- Equipment power to be provided for all kitchen equipment together with spare general power outlets within the kitchen bench.
- Power provisions to be provided for AV racks, toilets and loading docks as required.
- Power provisions to be provided for all mechanical and hydraulic services equipment and to be coordinated with mechanical and hydraulic services installations.

Departure Guidance: It is important for incoming power supplies for rehearsal spaces to be adequately sized to allow for the relatively large power demands of theatrical lighting. These loads are often transient in nature and supplies should be designed to accommodate these transients as opposed to average loads.

The rehearsal room should include at minimum:

- 2 of 40A 415V 3PN+E Wilco sockets, located on one wall to one side of the performance area,
- 10A DGPO's fitted along the perimeter of the room at nominal 3m intervals,
- 10A DGPO's fitted at the base of any columns within the room.

Consider in consultation with the operator and end user the following:

- A production lighting patch system to distribute powered circuits to outlets distributed throughout the pipe grid,
- 160 Amp 3 phase (415V) incoming supply to be provided based on the size of the area for the rehearsal space.

Communication requirements

Incoming communication services requirements to be developed based on the building/space requirements. Minimum 10 pair Cat 6 cabling connection to be installed from the building distributor to the floor distributor within the rehearsal space.

The rehearsal room shall include at minimum:

- Data outlets fitted to the perimeter of the room at nominal 3m intervals,
- Data outlets distributed throughout the pipe grid,
- A dedicated AV rack with network switch, where all local data outlets will be wired to,
- Internet access to the data switch for rehearsal room users to access,
- Wi-Fi network within the rehearsal room for users to access.

Electrical design standards and System Criteria

Item	Standards	Criteria
Supply Conditions	• Supply Authority service rules	• 400V 3-Phase nominal. • 50Hz.
Main Switchboard	• AS/NZS 61439 • AS/NZS 3000	• 25% spare space or one spare space (whichever is greatest) for each frame size excluding main switch(es). • Main busbars 125% initial load.
Distribution boards	• AS/NZS 61439 • AS/NZS 3000	• Form 2 unless stated otherwise. • 30% spare space or minimum 18 poles (whichever is greatest) for each frame size excluding local main control). • Local main control required. • Fault interrupt capacity of circuit breakers minimum 6kA. • Provide fault current limiters or use higher fault interrupt capacity circuit breakers as required. • Internal DBs: IP52 minimum.

Item	Standards	Criteria
		• External DBs: IP56 minimum.
Consumer mains	• AS/NZS 3000 • AS/NZS 3008.1	• Voltage drop: Max. 2%. • Maximum demand + 25% capacity (current carrying and voltage drop). • Fire rate where required to AS3000. • At least 100% neutral. Provide oversize neutral where harmonic currents are expected to be high.
Submains	• AS/NZS 3000 • AS/NZS 3008.1	• Voltage drop: 1%. • Maximum demand + 20% (current carrying and voltage drop). • Fire rate where required for Fire and Life Safety Services. • At least 100% neutral. Provide oversize neutral where harmonic currents are expected to be high.
Final subcircuits	• AS/NZS 3000 • AS/NZS 3008.1	• Voltage drop: Max.2%. • Power 2.5 mm² minimum. • Lighting 2.5 mm² minimum. • Max 80% utilisation to AS 3000.
Lighting	• AS/NZS 1680	• Use long life, energy saving lamps such as LEDs. Use tungsten and tungsten halogen only to approval. • Allow overall depreciation factor of 0.8 for clean, air conditioned areas, 0.7 for clean, non-air conditioned areas and 0.6 for dirty areas.
Communications	• AS/NZS 11801	• Provide Cat 6 UTP cabling. • Contain Cat 6 cable route length to <90m. • Cross power cables only at 90°. • The maximum fill of a cable tray shall not exceed 50%.
Electrical Metering and EMS system	• NCC Section J6 • Supply authority standards	• Meters and CTs shall comply with NCC and supply authority standards.

Acoustic design requirements

The acoustic outcomes will be influenced by the site location, internal design, and interface with surrounding development. The key design considerations and requirements are outlined below:

Acoustic design considerations

The acoustic outcomes will be influenced by the site location, internal design and interface with surrounding development. The key design factors include:

- Environmental noise and vibration emission,
- Internal design noise and vibration levels,
- Environmental noise intrusion,
- Building services noise and vibration control,
- Internal acoustic separation, including spatial planning and physical isolation, and
- Room acoustics (e.g. reverberation).

Departure Guidance: Acoustic design should be undertaken in the full context of its locality. Rehearsal spaces are both noise sensitive as well as noise generating. Careful design of the building envelope should aim to avoid noise disturbance both to and from neighbours.

Design criteria and management requirements

Item	Criteria and requirements
Environmental noise and vibration emission	• Minimum requirements will be according to Council consent requirements and will be dependent on surrounding or adjoining development. • The design must be based on the full operating hours of the space and maximum noise and vibration levels potentially generated by the use. • The acoustic design requirements will be heavily influenced by the proximity and sensitivity of nearby or adjoining receivers. Site location will be critical to minimising design requirements and maximising operational flexibility. • A noise monitoring system is recommended to be included to aid noise management. Where temporary or portable sound systems are used, a sound monitor is recommended in the space (e.g CESVA RS-60, NTi Audio XL2), to identify when sound levels are above allowable noise levels. Where different noise limits apply at various operating times, the device should include or support multiple time-based settings. • If a permanent sound system is installed, sound levels can be controlled by a DSP limiter. An RMS compressor/limiter with multi-band compression is recommended.
Internal background noise and vibration levels	• Criteria related to the noise and vibration in the space excluding occupant activity. • Internal background noise levels, from both environmental noise intrusion and internal plant and equipment should not exceed the lower bound design sound level range in AS/NZS 2107:2016 by more than 5 dB. Refer to Educational > Drama studios occupancy/activity in Table 1 for rehearsal space. • Internal background vibration not to exceed the maximum levels in British Standard BS 6472:2008.
Internal acoustic separation, including spatial planning and physical isolation	• Design will need to consider vibration and structure-borne noise control from dancing. A specialist structural dynamics engineer should be consulted.
Room acoustics	• Reverberation should be minimised for noise control, occupant comfort and space functional requirements.

Item	Criteria and requirements
	• For Type A (theatre) rehearsal space, a lower reverberation time is recommended in accordance with Curve 1 or 3 of Appendix A, AS/NZS2107:2016. Where the space may be used for prolonged use, the lower reverberation time is preferrable. • When Type A (theatre) is used for music rehearsal, consideration should be given to sufficient room volume and absorption to address excessive loudness. As high-level guidance, 25 m^3, per person for quiet instruments (e.g. strings, wood winds), 50 m^3 for loud instruments (such as percussion, brass and amplified instruments). Detailed assessment could be carried out as per Norwegian standard NS 8178. • For Type B (dance) rehearsal space, the reverberation time should not exceed Curve 2 (Music) of Appendix A, AS/NZS2107:2016. • Where non-absorptive wall linings are required for functional purposes, angling of walls (7 degrees off parallel) should be considered to reduce flutter echo.

Fire safety design requirements

Key fire safety design considerations and requirements are outlined below:

Rehearsal facility only

- Fire exits and egress routes are to be in accordance with the requirements of the NCC. Where temporary equipment or props are expected, management provisions are to be implemented to prevent blocking of the exits and egress routes.
- Audibility of the Occupant Warning System is to be considered. Competing sound systems are to shut down in accordance with AS1670.1-2018 clause 3.22.3.
- The placement of occupant warning speakers is to consider any sound-proofing measures within the facility.
- Visual warning devices are to be located in areas where portable sound systems may be used.
- Linings are required to meet the Fire Hazard Property requirements outlined in C1.10 of the NCC. This requirement is to be considered in conjunction with any acoustic or sound proofing linings.

Rehearsal facility proposed to operate as an entertainment venue

The use of a rehearsal facility as an Entertainment Venue should be clarified in the Design Brief, as this is likely to change the NCC Classification and fire safety requirements. If a rehearsal facility is proposed to operate as an Entertainment Venue or Assembly Building, the following shall also be considered.

- The use of staging or seating is to be identified in the early stages of design, along with proposed layouts. This applies to both temporary and permanent staging and seating. The layout of temporary staging and seating layouts will need to form part of the approvals documentation to ensure that NCC requirements are maintained during event layouts.
- The design of fire safety systems is to consider the presence of any temporary staging or seating, particularly in relation to fire system coverage, and exit signage layouts. Additionally, the size of any stage will drive differing fire safety measures in the building. Therefore, it is important to clarify this and manage future performances within the requirements of the fire strategy.
- Where the use of theatrical smoke is to be allowed for, the impact of false alarms due to a smoke detection system is to be considered. Isolation of a smoke detection system is non-

compliant (as clarified by NSW Department of Planning) and would need to be supported via a Performance Solution which outlines an alternative strategy for detection of a fire and meets the Performance Requirements of the NCC. The impact of isolating the detection system would need to consider occupant evacuation and initiation of active fire safety systems such as smoke exhaust that are required to be operated by smoke detection.

- If a smoke exhaust system is required, smoke is to be exhausted at high level and make-up air introduced at low level. Where a smoke exhaust system is required, it is recommended that it be designed on a Performance basis by a Fire Safety Engineer.

The design of an Entertainment Venue can often benefit from a Performance Based Fire Safety Strategy, carried out by a Fire Safety Engineer. Designing in accordance with the prescriptive NCC requirements, whilst possible, may prove restrictive to the space. A Performance Based design, considering the Fire Safety Strategy as a whole, can often lead to a more usable (less restrictive) outcome that considers the operational needs of a theatre.

Hydraulic design requirements

Key Hydraulic Services provisions should be considered as part of the design.

- Domestic water and sanitary drainage are to be provided to any kitchens, toilets and cleaners sinks which are part of the space.
- Where the space forms part of a building, domestic water services should be metered separately from the base building supply to allow landlord billing of water use.
- Mechanical condensate should drain to the sanitary system via a trapped tundish.
- Domestic hot water should be generated local to the space and consider the frequency of use. Where spaces are used infrequently, instantaneous electric hot water generation is preferred to avoid energy associated with heat losses. Where the space is used daily, electric storage may be more appropriate.
- Hydraulic services should not be located in the rehearsal space. Where this is not possible, they should be acoustically treated and located in a way to avoid impact on the rehearsal space during routine maintenance or repair.

Hydraulic design criteria

The Hydraulic Services design is to be based on the following design criteria.

System	Standards	Design Criteria
Domestic hot and cold Water	• NCC 2019 Amdt. 1 • AS/NZS 3500.1 – 2018 • AS/NZS 3500.4 - 2018	• Cold water average supply temp: 14°C. • Hot water storage: 60°C – 65°C. • Hot water distribution: 55°C-60°C. • Amenities (visitor and non-visitor): 43°C. • Utility rooms (kitchens, cleaners sinks): 50 to 55°C. • Max velocity: 2.4m/s externally and in ground. • Max velocity: 1.5m/s in risers, BOH spaces. • Max velocity: 0.8m/s in acoustically sensitive spaces. • Min operating pressure: 200kPa. • Max operating pressure 500kPa.

System	Standards	Design Criteria
Sanitary Plumbing and Drainage	• NCC 2019 Amdt. 1 • AS/NZS 3500.2 – 2018	• Minimum grade: 2.5% for 40-65mm, 1.65% for 80-100mm and 1% for 150mm pipelines. • Sanitary stacks design capacity: 22% to 0.33% full. • Drainage design capacity: Max 70 % full. • Velocity: 0.75m/s to 1.2m/s.
Building Rainwater Drainage	• NCC 2019 Amdt. 1 • AS/NZS 3500.3 – 2018 • Australian Rainfall and Runoff Guidelines • City of Sydney requirements	• Flat roofs, box gutters – 5min 1% AEP. • Eaves gutters – 5min 5% AEP. • Climate change allowance +10%. • Full capacity overflows to be provided to all building rainwater drainage catchment areas. • Velocity: 0.75m/s to 1.2m/s. • Siphonic drainage velocities TBC by hydraulic calculation, insulation where required to limit noise in noise sensitive areas.

Mechanical design requirements

Key mechanical design considerations and requirements are outlined below:

General mechanical requirements

- For mechanical sizing, internal gains within the space shall be based on increased metabolic rates to reflect high activity level from dancing.
- Relevant ASHRAE and CIBSE external design criteria shall be used. Consideration should be given to future climate change and resultant elevated ambient design temperatures.
- Increased outside air (50% above code minimum is recommended) in normal operation
- If system supplies >1000 l/s, economy mode shall be provided in line with NCC 2019 Section J requirements. Economy mode should be offered with smaller units to achieve energy reductions.
- Openable windows should be incorporated where possible to allow for natural ventilation in low-load scenarios when the external temperature is acceptable.
- For spaces with a floor-to-ceiling height of 4-6m, minimum air change rate of 6 air changes per hour to be achieved.
- For spaces with a floor-to-ceiling heigh >6m, minimum air change rate of 8 air changes per hour to be achieved.
- When determining airflow and mechanical equipment sizing, consideration should be given to up-lighting vs. downlighting so that the mechanical system is not oversized (a proportion of high-level lighting and equipment load will not land in the space so does not require direct air conditioning).
- Mechanical system shall be designed to meet acoustic requirements of the space.

Rehearsal Space requirements

The mechanical systems shall ensure a comfortable environment for users, who will likely be performing exhausting physical movement, in groups, for varied periods of time. Heat loads in rehearsal rooms can be quite dynamic (e.g., large groups of dancers suddenly starting an intense session) and mechanical systems should be designed to respond to this.

- The mechanical systems shall maintain an environment within the specified values during times of use:
    - Temperature: 20 to 23 degrees Celsius, with ability to widen temperature criteria depending on space use to save energy
    - Humidity: 40 to 60% (note: this will not be directly controlled but will naturally fall into this range as a result of the air conditioning)
- CO2 sensors shall increase the outside air proportion to the space in response to high CO2 levels. The mechanical equipment shall be sized to maintain internal temperatures and deliver increased outside air at high ambient temperatures.
- Mechanical system shall be variable volume, responding to temperature and CO2 levels within the space (wall-mounted temperature and CO2 sensors shall be installed at 1500mm AFFL inside the space). Sensors should be installed in areas that will be representative of the conditions inside the space.
- All ductwork to be above rigging zone OR can be wall mounted as long as it doesn't clash with other services / uses.
- Ensure access to ductwork is maintainable taking into account rigging infrastructure and associated production equipment within the space.
- Consideration should be given to performance of diffusers in heating mode, especially for spaces with high floor-to-ceilings (more than 3.2m).
- If extensive lighting and equipment is used, make allowance for mechanical system to offset expected maximum lighting and equipment loads.
- Air supply should be 'low velocity' to reduce noise, avoid drafts and avoid moving drapes / curtains.
- Diffusers to be high induction to reduce drafts in space.

Other areas

- Cleaners store to be exhausted directly to outside in line with AS1668.2 requirements
- Ventilation of toilets and change rooms to be in line with AS1668.2 requirements (change rooms may be conditioned by a small FCU/PAC if desired to provide additional comfort for occupants). It is recommended extract ventilation is 200% of code minimum to ensure odours are effectively removed from the space.

Fire engineering/ Smoke Control

- If smoke exhaust is required, all components are to be compliant with AS1668.1 requirements and Spec E2.2b of the NCC, except where deviated by a Performance Based Fire Engineering strategy developed by a Fire Safety Engineer.

Design Criteria

External design criteria	ASHRAE or CIBSE current guidance
General Ventilation	AS 1668.2:2012
Smoke Control Ventilation	AS 1668.1:2015
Battery Ventilation	AS 2676.1:2020
Refrigerant	AS 5149:2016

Departure Guidance: Early and ongoing engagement with operators and user groups or a consultant with relevant experience to advise on their behalf is required in the development of technical systems. A lack of provision may deem the space not fit for purpose. Rehearsal spaces can produce significant changes in thermal load once performers begin rehearsals that often involve physical movements. Mechanical systems can include mix-mode systems but needs to take into account ranges of comfort for the performers using the space as well as accommodate to rapid changes in thermal load.

In addition, the design should be compliant with the following codes and standards:

- 2019 National Construction Code / Building Code of Australia (BCA),
- Building Permit conditions,
- AS1668.1 (2015) – Fire and Smoke Control in Multi-Compartment Buildings (Amendment 1),
- AS1668.2 (2012) – Mechanical Ventilation in Buildings (Amendment 1 and 2),
- AS1668.4 (2012) – Natural Ventilation of Buildings,
- AS 1940 (2004) – The Storage and Handling of Combustible Liquids,
- AS/NZS 2107 (2000) – Recommended Design Sound Levels and Reverberation Times for Building Interiors,
- AS 3000 – Electrical Installations,
- AS 3500 – National Plumbing and Drainage Code,
- AS 3666 (2011) – Air-handling and Water Systems of Buildings – Microbial Control,
- AS 4254.1 (2012) – Ductwork for Air-Handling Systems in Buildings – Flexible Duct,
- AS 4254.1 (2012) – Ductwork for Air-Handling Systems in Buildings – Rigid Duct,
- AS/NZS 5601.1 (2013) – Gas Installations – General Installations,
- All other applicable Australian Standards,
- WorkCover requirements,
- OH&S Regulations,
- Safe Work Australia,
- Electricity Supply Authority requirements,
- Fire Brigade requirements,
- Australian Gas Authority requirements,
- All Local Council regulations,
- Fire Engineering Report.

Pipework Velocity and Pressure Drop

The following values shall not be exceeded:

- Pipework pressure drop: 300 Pa/m,
- Pipework velocity:

Diameter (mm)	Velocity (m/s)
25	1
50	1.1
100	1.25
150	1.5
200	2

Diameter (mm)	Velocity (m/s)
250	2.2
300	2.5

Ductwork Velocity and Pressure Drop

The following values shall not be exceeded:

Ductwork Velocity – Variable Volume Systems (Final velocity to be agreed with Acoustic Consultant depending on acoustic requirements of the space)

- Risers and plantrooms: 7.0 m/s,
- In ceiling secondary ductwork: 5.0 m/s,
- In ceiling tertiary ductwork: 3.5 m/s,
- Flexible ductwork: 2.5 m/s,
- General duct discharges: 6.0 m/s,
- Louvers: 2.5 m/s face velocity.

Ductwork Pressure Drop

- General ductwork: 0.8 Pa/m,
- Transfer ducts: 12 Pa,
- Riser take-offs: Kt £ 0.89,
- Bends: Kt £ 0.25,
- Rectangular contractions: Kt £ 0.19.

Where the total pressure loss through the fitting is defined as Pt = Kt × Pv:

- Pt = Total pressure loss through fitting (Pa),
- Kt = Loss coefficient,
- Pv = Velocity pressure (Pa).

Mechanical Equipment and Accessories Pressure Drops

The following values shall not be exceeded:

- Sound attenuators: 50 Pa,
- Louvres: 20 Pa,
- Cooling coils (airside): 150 Pa,
- Cooling coils (waterside): 35 kPa.

Document 2:

Sound Recording Studios

Description

A sound recording studio may be used by individuals or groups to record music, song and voice-over for performance, production, and digital art-forms. Sound recording studios provide artists with a comfortable, private space with technical production equipment and expertise to develop and produce their work.

Usage profile

Typical recording studio usage profiles are outlined below:

- Occupation by a user-group for a few days to a week at a time (up to 16 hours per day, 5-6 days per week).
- Occupied for a single day, occasionally with multiple users throughout the day and evening.

References

QUT Recording Studios © Arup

QUT Recording Studios © Arup

Programmatic requirements

A sound recording studio should provide a family of rooms to cater for all levels of sound from digital musicians monitoring through headphones, through to acoustic and amplified instruments. This calls for a variety of rooms of different volume, loudness and reverberance – as well as a degree of variability. Early engagement with the operator and user groups to determine the usage is necessary.

A sound recording studio should include the following areas:

Recording Rooms, in addition to a **live room** an additional **two** other different sized recording rooms should be located directly adjacent for example a **drum booth** and **vocal booth,**

Control room, a central technical space that connects to all the recording spaces,

Machine room, to house recording technical equipment and racks,

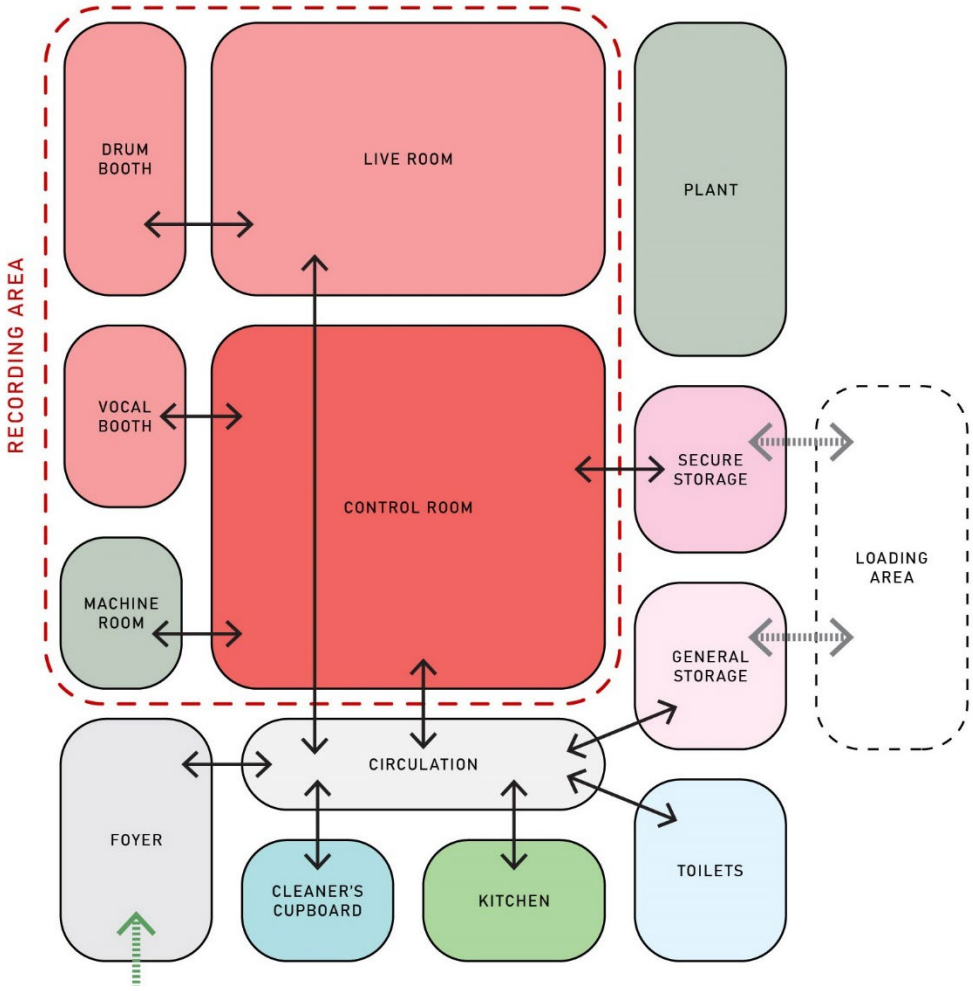
Amenities including office space, lunch or break room with basic kitchen amenity and dedicated toilet and shower amenities,

Storage areas,

Loading zones for incoming equipment and instruments,

Step-free circulation and **obstruction free access**, sized (at minimum) for a grand piano,

Inclusive and legible **wayfinding signage.**



Sound Recording Studios – Spatial adjacency diagram

Departure Guidance: The investment in the building should be commensurate to the investment in recording technology being used. All spaces above have specific functional and/or acoustic requirements that are not easily combined without having to compromise on functionality or acoustic performance.

Spatial requirements

A sound recording studio should support simultaneous users, including performers / artists, technical crew / staff, producers, support staff and observers. Minimum area of key spaces outlined below:

Early engagement with the operator and user groups to determine the usage is key to defining area requirements. The following area allowances have been provided as an early planning guide:

Live room: **50 sqm** minimum

Drum booth: **12 sqm** minimum

Iso / vocal booth: **6 sqm** minimum

Control room: **25 sqm** minimum

Machine room: **6 sqm** minimum

A minimum **clear height of 4m** should be achievable in all spaces

All walls (both internal and external), floor and ceiling build-ups are likely to be significant to meet acoustic requirements. Allowances should be made for sound attenuating walls, absorptive finishes, diffusion, and curtains.

The room size and shaping, equipment location in particular loudspeaker positions and finishes will require close co-ordination with the Acoustic Consultant, Audio-Visual Consultant and Services Engineers.

Windows between control and recording rooms should meet specific acoustic requirements, typically multiple layers of glazing with angled panes to avoid acoustic anomalies. Visibility between spaces and the control of glare will need to be managed, in coordination with the Lighting Consultant.

A sound lock may be required between the adjacent rooms to avoid sound transmission between rooms.

Live Room

The live room is a performance space that should lend a live sound quality to recordings. It needs to allow for multiple musicians tracking simultaneously, providing a well-blended sound within the room that allows for ambient (distant) mic-ing techniques in addition to close mic-ing. The acoustic response should allow the listeners to appreciate the definition and polish of the recording. This will require a complex distribution of architectural finishes providing a variety of reflection, diffusion and absorption of sound to provide a ‘neutral’ room acoustic response as well as options for a ‘live-end’ and ‘dead-end’ room acoustic.

Control Room

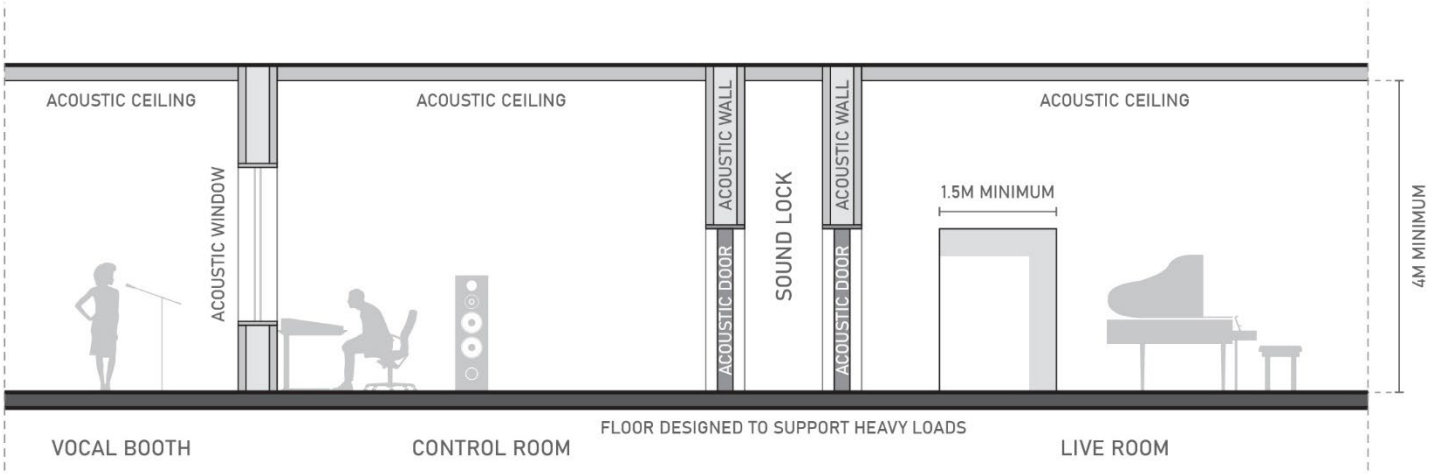
The control room is a listening space where fidelity of sound reproduction is paramount. The rooms acoustic design should be developed based on known seating and monitor positions. Generally, a control room should have a very well controlled room acoustic response that has a linear response across the frequency spectrum. This is achieved through a significant quantity of sound-absorbing treatment, with some key reflecting and diffusing surfaces carefully positioned to create spaciousness and render details of the sound.

Iso/Vocal and Drum Booths

These booths are recording spaces with more controlled (“dry”) room acoustic responses than the live room and are useful for isolating drum and vocal tracks primarily. Floors should be carpeted, with deep broadband sound absorbing treatment to walls and ceilings to achieve a low reverberation time. Doors, windows and services trunking will provide some reflections to avoid the room becoming anechoic.

Machine Room

The machine room layout should allow for equipment racks with access to the front, side and rear to install, remove and service the equipment within each rack.



Sound Recording Studios – Sectional diagram

Kitchen

A Kitchen is intended only for basic meal prep and reheating of pre-prepared meals. The kitchen should also allow for food rinsing, utensil washing and the sanitary disposal of associated wastewater. There is no need to provide an oven and stove unless specified by the operator or user groups.

A minimum clear height of 2.4m above finish floor level should be maintained in the kitchen.

Basic kitchen provisions to include: a large fridge, microwave, sink and instantaneous hot water boiler for efficient tea and coffee preparation. A reasonable amount of bench space and storage should be provided. A dishwasher may be considered.

Toilet facilities

The National Construction Code of Australia (NCC) sets out the ratio of male and female toilets to the number of occupants, and the specifications for toilets.

A minimum clear height of 2.4m above finish floor level should be maintained in the toilets.

Accessible toilets should also be provided for people with a disability. The National Construction Code of Australia (NCC) sets out the number of accessible toilets required. Layout for accessible toilets should comply with the National Construction Code of Australia (NCC) and the AS 1428 suite of Standards.

Loading zone and circulation requirements

The loading & unloading of equipment into the sound recording studios and/or the building in which the sound recording studio is housed should be carefully considered. The buildings load-in door should be a minimum of 1.8m wide by 2.4m high to allow for large items and equipment destined for

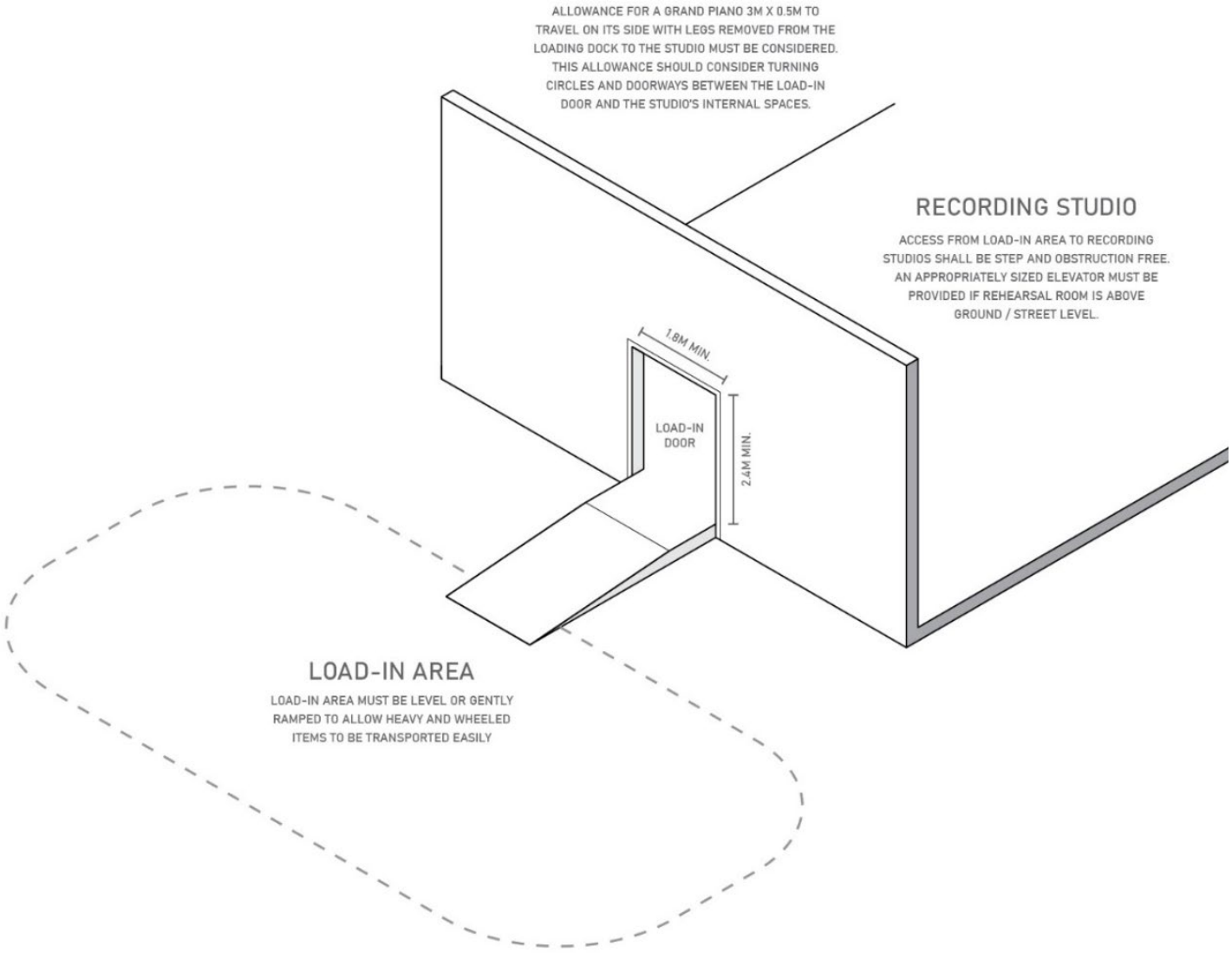
the Recording Studio. The load-in area shall be level or gently ramped to allow heavy and wheeled items to be safely transported.

Circulation paths from the load-in area to the rehearsal room should be step and obstruction free. Circulation should allow for a grand piano to travel on its side with legs removed. Doorways and accessways should be a minimum 1.8m. An appropriately sized elevator should be considered if the rehearsal room is situated above ground / street level.

Other heavy items that are likely to be used in the studio might include:

- A fully loaded chair trolley,
- A heavy road-case of technical equipment.

A dedicated loading dock is not required to support this type of space, however a loading zone sized for a large van or 3t Pantech truck should be in close proximity to a nominated ‘load-in door’.



Recording Studio Loading diagram

Storage requirements

General storage areas adjacent to the studio should be provided and will typically store:

- Loose furniture, such as chairs,

- Loose equipment, such as music stands, microphone stands,
- Instruments.

Secure storage adjacent to the studio should be provided and will typically store:

- High-value technical equipment associated with the space, such as mixing consoles, microphones, and loudspeakers,
- High-value musical instruments,
- Other high-value items belonging to users of the room.

A cleaner's cupboard should be provided with the following:

- Fitted with mop sink,
- Space to hang wet mops, and brooms,
- A limited amount of cupboard space for general cleaning products (dustpan & brush, bin liners, cleaning fluids, etc.).

Departure Guidance: Kitchen facilities and toilets are expected for both professional and non-professional user groups. A lack of storage is a typical complaint of arts and culture building operators. In the event that loading and circulation requirements cannot be met, please note the impact on the usage range (e.g. capability for a Piano to be unloaded and its travel path to a recording studio). Any departure should be discussed with key stakeholders including user groups and operators.

Structural design requirements

Key structural design requirements are outlined below:

Load allowances for the sound recording studio and surrounding areas shall consider the use of space and comply with AS1170.1:2000.

The sound recording studio floor shall be designed for minimum live loads of:

- Uniformly distributed load (UDL) of 3kPa,
- Concentrated point load, 3.5 kN over a minimum area of 300x300mm,
- Special consideration for the allowance of concentrated point loads shall be made for heavy items if they exceed the above allowances. Some heavy items to consider include:
    - A heavy road-case of technical equipment,
    - A grand piano.

Acoustic separation between the structure and the sound studio may be required and loading allowance for a secondary slab should be considered. The isolated slab thickness may vary depending on substructure and requirements specified by the acoustic engineer. Acoustic isolation pads or bearings between the primary structure and isolated slab should be specified considering both acoustic frequency and load rating require to support the secondary slab. Detailing of sound recording studio walls and their fixings into the primary structure will also need to allow for full vibration isolation.

Lighting design requirements

Key lighting design requirements are outlined below:

Lighting design considerations

- The colour temperature of the fixtures to be 3000K or 4000K and consistent throughout.
- Luminaires to be concealed where possible and with a unified glare rating (UGR) of 19 or less.
- The colour rendering (CRI) of the luminaires to be 90 or higher.
- Luminaires should have a minimum offset of 1000mm from the glazing between internal spaces, and narrow beam angle should be used so to minimize glare, reflections and maintain visibility between spaces.

Lighting controls

- All lighting should be dimmable, with smooth fading from 0-100%.
- A local control or override should be provided so that creative teams can dim or black-out the room lighting.
- Room lighting should be coordinated and controllable from the Building Management System.

Lighting design compliance

- Lighting illuminance and uniformity requirements must comply with AS 1680. A rehearsal room should have good general lighting throughout. The average horizontal illuminance level should meet 240 lux. This is indicated in AS1680.2.3 (Specific applications – educational and training facilities), Table D1 Auditoriums. The uniformity of the space should meet 0.3 as a minimum.
- Motion sensors and lighting timers should also be considered to turn off the lighting and conserve energy when room is not in use.

Emergency Lighting and Exit signs

- AS2293 and NCC Section E4 compliance emergency lighting and exit signs to be provided throughout as required.
- Consideration shall be given to incorporate integrated emergency lighting to the general lighting within the space.

Electrical design requirements

Key electrical design requirements are outlined below:

Electrical requirements

- Incoming power supply to the recording studio space and the power supply authority power metering requirements to be developed based on the incoming power supply to the building and as per local power supply authority requirements.
- A dedicated distribution board must be provided for the Sound recording studio with separately metered power and lighting as required by NCC and ESD purposes.
- A separate clean earth distribution board complete with a technical earth connection directly from the building main earth bar to be provided within the Sound recording studio to connect all specialist audio and video equipment and outlets.

- General power outlets to be provided for the user ports and cleaners' outlets as required.
- Equipment power to be provided for the small kitchenet together with spare general power outlets. Power provisions to be provided for AV racks, toilets and loading docks as required.
- Power provisions to be provided for all mechanical and hydraulic services equipment and to be coordinated with mechanical and hydraulic services installations.
- Cable reticulation to be coordinated with acoustic requirements of the floor/wall build up. To maintain the required acoustic performance based on the installation requirements, rigid conduits, flexible conduits or steel conduits are to be used.

The Recording Studio will require:

- 10A DGPO's around perimeter of each room,
- 20A supply to technical equipment racks in machine room,
- Facility panels with Single phase and three phase power outlets,
- Clean power / technical earth system for all outlets in recording studio.

Departure Guidance: As well as ensuring adequate electrical supplies, the distribution of power supplies is critical to success for recording studios; electrical supplies should be 'clean' and free from noise generated by inductive loads; design of earthing systems should avoid potential for 'earth loops' which can cause hum in sensitive equipment; power should be distributed liberally with outlets mounted to every wall between a set of doors in recording spaces and associated with all potential equipment locations.

Communications requirements

Incoming communication services requirements to be developed based on the building/space requirements. Minimum 10pair Cat 5 cabling connection to be installed from the building distributor to the floor distributor together with minimum 6 core single mode fibre optic connection to be provided within the sound recording space.

The Recording Studio will require:

- Data outlets distributed in each room, wired back to dedicated AV rack,
- AV switch in standalone AV network rack in machine room,
- Minimum 1Gbps internet connection provided to AV switch,
- Wi-Fi network provided throughout studio for users,
- Data outlets within facility panels,
- Facility panels with inter-connections fitted in each room to provide specialist AV signal types between rooms, control room and machine room patch rack,
- Data storage capacity.

Electrical design standards and System Criteria

Item	Standards	Criteria
Supply Conditions	Supply Authority service rules	• 400V 3-Phase nominal. • 50Hz.

Item	Standards	Criteria
Main Switchboard	• AS/NZS 61439 • AS/NZS 3000	• 25% spare space or one spare space (whichever is greatest) for each frame size excluding main switch(es). • Main busbars 125% initial load.
Distribution boards	• AS/NZS 61439 • AS/NZS 3000	• Form 2 unless stated otherwise. • 30% spare space or minimum 18 poles (whichever is greatest) for each frame size excluding local main control). • Local main control required. • Fault interrupt capacity of circuit breakers minimum 6kA. • Provide fault current limiters or use higher fault interrupt capacity circuit breakers as required. • Internal DBs: IP52 minimum. • External DBs: IP56 minimum.
Consumers mains	• AS/NZS 3000 • AS/NZS 3008.1	• Voltage drop: Max. 2%. • Maximum demand + 25% capacity (current carrying and voltage drop). • Fire rate where required to AS3000. • At least 100% neutral. Provide oversize neutral where harmonic currents are expected to be high.
Submains	• AS/NZS 3000 • AS/NZS 3008.1	• Voltage drop: 1%. • Maximum demand + 20% (current carrying and voltage drop). • Fire rate where required for Fire and Life Safety Services. • At least 100% neutral. Provide oversize neutral where harmonic currents are expected to be high.
Final subcircuits	• AS/NZS 3000 • AS/NZS 3008.1	• Voltage drop: Max.2%. • Power 2.5 mm² minimum. • Lighting 2.5 mm² minimum. • Max 80% utilisation to AS 3000.
Lighting	• AS/NZS 1680	• Use long life, energy saving lamps such as LEDs. Use tungsten and tungsten halogen only to approval. • Allow overall depreciation factor of 0.8 for clean, air conditioned areas, 0.7 for clean, non-air conditioned areas and 0.6 for dirty areas.
Communications	• AS/NZS 11801	• Provide Cat 6 UTP cabling. • Contain Cat 6 cable route length to <90m. • Cross power cables only at 90°.

Item	Standards	Criteria
		• The maximum fill of a cable tray shall not exceed 50%.
Electrical Metering and EMS system	• NCC Section J6 • Supply authority standards	• Meters and CTs shall comply with NCC and supply authority standards.

Acoustic design requirements

The acoustic outcomes will be influenced by the site location, internal design, and interface with surrounding development. The key design considerations and requirements are outlined below:

Acoustic design considerations

- Environmental noise and vibration emission,
- Internal design noise and vibration levels,
- Low background noise levels related to environmental noise and vibration intrusion, and building services noise and vibration control,
- Internal acoustic separation, including spatial planning and physical isolation, and
- Room acoustics.

Departure Guidance: The criticality of good acoustic design needs to be emphasized as vital to the success of a recording studio. Building envelope design should avoid noise ingress from external noise and vibration sources; internal partitions often require heavy-weight / high performance construction so that music equipment can't be heard through control room windows; internal finishes (both absorptive and diffusing) need to result in 'flat' room response to aid critical listening.

Design criteria and management requirements

Item	Criteria and requirements
Environmental noise and vibration emission	• Minimum requirements will be according to Council consent requirements and will be dependent on surrounding or adjoining development. • The design must be based on the full operating hours of the space and maximum noise and vibration levels potentially generated by the use. • The acoustic design requirements will be heavily influenced by the proximity and sensitivity of nearby or adjoining receivers. Site location will be critical to minimising design requirements and maximising operational flexibility.
Internal background noise and vibration levels	• Criteria relate to the noise and vibration in the space excluding occupant activity. • Internal background noise levels, from both environmental noise intrusion and internal plant and equipment should not exceed:

Item	Criteria and requirements
	○ Live and control rooms: NR 20-25 (professional studio NR15). Priority should be given to achieving lowest levels in live rooms, ○ Other areas: Not to exceed the lower bound design sound level range in AS/NZS 2107:2016 by more than 5 dB, ○ Internal background vibration not to exceed the maximum levels in British Standard BS 6472:2008.
Internal acoustic separation, including spatial planning and physical isolation	• Isolated constructions will be required between live rooms and control room to provide minimum noise transfer between spaces. The extent of separation is dependent on acceptable noise transfer between spaces. Where glazing is required, such as between control room and live room, a higher level of sound transfer is expected. • Sound locks should be provided for all doorways to live and control rooms. • Masonry recommended for live rooms for low frequency noise control.
Room acoustics	• Control rooms shall be designed in accordance with: ○ EBU Tech 3276 2nd Edition, ○ Dolby 5.1-Channel Music Production Guidelines Issue 2, ○ Requirements relate to finishes, layout and room shaping and will require close coordination with the architect. • For live rooms: room acoustics will be dependent on the type of music to be recorded. For general guidance, the reverberation time should not exceed Curve 2 (Music) of Appendix A, AS/NZS2107:2016. A combination of absorption, diffusion and reflective surfaces will be required.

Fire safety design requirements

Key fire safety design considerations and requirements are outlined below:

- Fire exits and egress routes are to be in accordance with the requirements of the NCC. Where temporary equipment or props are expected, management provisions are to be implemented to prevent blocking of the exits and egress routes.
- Fire safety systems are to be provided in accordance with the requirements of the NCC.
- Audibility of the Occupant Warning System is to be considered. Competing sound systems are to shut down in accordance with AS1670.1-2018 clause 3.22.3. The placement of occupant warning speakers is to consider any sound-proofing measures within the facility. Visual warning devices are to be located in areas where portable sound systems may be used.
- Linings are required to meet the Fire Hazard Property requirements outlined in C1.10 of the NCC. This requirement is to be considered in conjunction with any acoustic or sound proofing linings.

Hydraulic design requirements

Key hydraulic design considerations and requirements are outlined below:

- Domestic water and sanitary drainage to be provided to any kitchens, toilets and cleaner's sinks which are part of the space.
- Where the space forms part of a building, domestic water services should be metered separately from the base building supply to allow landlord billing of water use.
- Mechanical condensate should drain to the sanitary system via a trapped tundish.
- Domestic hot water should be generated local to the space and consider the frequency of use. Where spaces are used infrequently, instantaneous electric hot water generation is preferred to avoid energy associated with heat losses. Where the space is used daily, electric storage may be more appropriate.
- Hydraulic services should not be located in the studio space to avoid risk of damage to equipment from water leaks and the associated acoustic nuisance from live services.

Hydraulic design criteria

The Hydraulic Services design is to be based on the following design criteria.

System	Standards	Design Criteria
Domestic hot and cold Water	• BCA 2019 Amdt. 1 • AS/NZS 3500.1 – 2018 • AS/NZS 3500.4 - 2018	• Cold water average supply temp: 14°C. • Hot water storage: 60°C – 65°C. • Hot water distribution: 55°C-60°C. • Amenities (visitor and non visitor): 43°C. • Utility rooms (kitchens, cleaners sinks): 50 to 55°C. • Max velocity: 2.4m/s externally and in ground. • Max velocity: 1.5m/s in risers, BOH spaces. • Max velocity: 0.8m/s in acoustically sensitive spaces. • Min operating pressure: 200kPa. • Max operating pressure 500kPa.
Sanitary Plumbing and Drainage	• BCA 2019 Amdt. 1 • AS/NZS 3500.2 – 2018	• Minimum grade: 2.5% for 40-65mm, 1.65% for 80-100mm and 1% for 150mm pipelines. • Sanitary stacks design capacity: 22% to 0.33% full. • Drainage design capacity: Max 70 % full. • Velocity: 0.75m/s to 1.2m/s.
Building Rainwater Drainage	• BCA 2019 Amdt. 1 • AS/NZS 3500.3 – 2018 • Australian Rainfall and Runoff Guidelines • City of Sydney requirements	• Flat roofs, box gutters – 5min 1% AEP. • Eaves gutters – 5min 5% AEP. • Climate change allowance +10%. • Full capacity overflows to be provided to all building rainwater drainage catchment areas. • Velocity: 0.75m/s to 1.2m/s. • Siphonic drainage velocities TBC by hydraulic calculation, insulation where required to limit noise in noise sensitive areas.

Mechanical design requirements

General mechanical requirements

- Relevant ASHRAE and CIBSE external design criteria shall be used. Consideration should be given to future climate change and resultant elevated ambient design temperatures.
- Increased outside air (50% above code minimum is recommended) in normal operation
- CO2 sensors shall increase the outside air proportion to the space in response to high CO2 levels. The mechanical equipment shall be sized to maintain internal temperatures and deliver increased outside air at high ambient temperatures.
- Mechanical system shall be variable volume, responding to temperature and CO2 levels within the space (wall-mounted temperature and CO2 sensors shall be installed at 1500mm AFFL inside the space). Sensors should be installed in areas that will be representative of the conditions within the space.
- If system supplies >1000 l/s, economy mode shall be provided in line with NCC 2019 Section J requirements. Economy mode should be offered with smaller units to achieve energy reductions.

Recording studios

- For recording studios, the following criteria applies:
    - Temperature: 20 to 24 degrees Celsius, with ability to modify temperature criteria,
    - Humidity: 40 to 60% (note: this will not be directly controlled but will naturally fall into this range as a result of the air conditioning).
- The HVAC system will need to accommodate the typical heat-loads generated by technical equipment in the space – particularly in the machine room (to be coordinated during the design phase by the project's design and engineering specialists).
- Air conditioning system to provide comfortable conditions to occupants within recording studios. Due to size of studios, select appropriate air-off temperatures for cooling and heating to ensure optimum comfort in the studios (for high-level air supply, suggest minimum air-off in cooling of 14degC in small studios <10sqm).
- Consider displacement ventilation if sufficient floor void for enhanced acoustic performance and occupant comfort. Appropriate supply air temperatures with low dT should be selected to prevent occupant discomfort.
- Close coordination with Acoustic Consultant to ensure HVAC system meets noise criteria. Review NC requirements of room and select appropriate equipment and provide acoustic treatment to meet target NC requirements.
- Fans should be selected to operate at lower turndowns to minimise noise regeneration
- Diffusers should be selected to reduce regenerated noise.

Departure Guidance: Climate control in recording studios needs to address operating temperatures of sensitive and high-cost equipment, and elimination of potential for condensation. Tight tolerance control of conditions should be maintained in spaces that might house high value instrument such as pianos (including storage areas) which are particularly vulnerable to rapid changes in temperatures and humidity levels.

Storage rooms

- Storage rooms which house high value equipment and instruments may require humidity control, requirements to be confirmed by operators and user groups. Humidity and temperature sensors may be required to be redundant to ensure room conditions deviate minimally. Rooms requiring close control of conditions should be located internally and not against the façade or adjacent to unconditioned spaces. They should be served by dedicated units and utilise code minimum outside air to reduce temperature deviations (refer AS1668.2).

- Major stakeholders to confirm plant redundancy requirements, temperature & RH conditions and maximum temperature/RH fluctuations allowed within the storage rooms. Refer AICCM (Australian Institute for the Conservation of Cultural Material) guidance as a baseline. Suggesting starting point is as follows:
    - Short term fluctuations of no greater than 4ºC for ≤24 hours duration within the total temperature range of 15-25 ºC,
    - RH to be maintained 45-55% for the majority of the time for Sydney's temperate climate. Short term, ±5% fluctuations ≤24 hours duration into the outer limits of the total RH ranges (i.e. can swing 40-60% RH for ≤24 hours).
- AV/rack rooms/equipment shall be provided with sufficient cooling and/or ventilation to offset the loads and maintain the equipment at manufacturers' recommended temperatures.
- The main stakeholders are to advise significant equipment loads in line with their technical requirements.
- Rooms should be provided with outside air in line with AS1668.2, or battery ventilation in line with AS2676 if housing any type of batteries.
- If actively cooled by an air conditioning unit, the unit shall be dedicated and be provisioned in a duty/standby arrangement if required by the owner/operator of the space.
- If the unit is a direct expansion (DX) unit, design and installation is to be in line with AS5149.

Other areas

- Toilets and storerooms are to be ventilated in line with AS1668.2. It is recommended extract ventilation is 200% of code minimum to ensure odours are effectively removed from the space.

Fire engineering/ Smoke control

- If any smoke control is required, this should be in line with AS1668.1.

Design Criteria

External design criteria	ASHRAE or CIBSE current guidance
General Ventilation	AS 1668.2:2012
Smoke Control Ventilation	AS 1668.1:2015
Battery Ventilation	AS 2676.1:2020
Refrigerant	AS 5149:2016

In addition, the design should be compliant with the following codes and standards:

- 2019 National Construction Code / Building Code of Australia (BCA),
- Building Permit conditions,
- AS1668.1 (2015) – Fire and Smoke Control in Multi-Compartment Buildings (Amendment 1),
- AS1668.2 (2012) – Mechanical Ventilation in Buildings (Amendment 1 and 2),
- AS1668.4 (2012) – Natural Ventilation of Buildings,
- AS 1940 (2004) – The Storage and Handling of Combustible Liquids,
- AS/NZS 2107 (2000) – Recommended Design Sound Levels and Reverberation Times for Building Interiors,
- AS 3000 – Electrical Installations,
- AS 3500 – National Plumbing and Drainage Code,
- AS 3666 (2011) – Air-handling and Water Systems of Buildings – Microbial Control,
- AS 4254.1 (2012) – Ductwork for Air-Handling Systems in Buildings – Flexible Duct,
- AS 4254.1 (2012) – Ductwork for Air-Handling Systems in Buildings – Rigid Duct,
- AS/NZS 5601.1 (2013) – Gas Installations – General Installations,

- All other applicable Australian Standards,
- WorkCover requirements,
- OH&S Regulations,
- Safe Work Australia,
- Electricity Supply Authority requirements,
- Fire Brigade requirements,
- Australian Gas Authority requirements,
- All Local Council regulations,
- Fire Engineering Report.

Pipework Velocity and Pressure Drop

The following values shall not be exceeded:

- Pipework pressure drop: 300 Pa/m,
- Pipework velocity:

Diameter (mm)	Velocity (m/s)
25	1
50	1.1
100	1.25
150	1.5
200	2
250	2.2
300	2.5

Ductwork Velocity and Pressure Drop

The following values shall not be exceeded:

Ductwork Velocity - Variable Volume Systems (Final velocity to be agreed with Acoustic Consultant depending on acoustic requirements of the space)

- Risers and plantrooms: 7.0 m/s,
- In ceiling secondary ductwork: 4.0 m/s,
- In ceiling tertiary ductwork: 2.5 m/s,
- Flexible ductwork: 2.0 m/s,
- General duct discharges: 6.0 m/s,
- Louvers: 2.5 m/s face velocity.

Ductwork Pressure Drop

- General ductwork: 0.8 Pa/m,
- Transfer ducts: 12 Pa,
- Riser take-offs: Kt £ 0.89,
- Bends: Kt £ 0.25,
- Rectangular contractions: Kt £ 0.19.

Where the total pressure loss through the fitting is defined as Pt = Kt × Pv:

- Pt = Total pressure loss through fitting (Pa),
- Kt = Loss coefficient,
- Pv = Velocity pressure (Pa).

Mechanical Equipment and Accessories Pressure Drops

The following values shall not be exceeded:

- Sound attenuators: 50 Pa,
- Louvres: 20 Pa,
- Cooling coils (airside): 150 Pa,
- Cooling coils (waterside): 35 kPa.

Document 3:

Small Multi-use Theatre

Description

A small multi-use theatre is flexible in nature and should be capable of presenting a wide array of artforms.

The multi-use theatre should be equipped to present professional work while minimising capital and operating costs. Capacity will generally cater for less than 200 patrons in flexible seating systems which allow multiple stage and seating configurations. In addition to operating as a performance venue, the space can be used as rehearsal space and more general public uses, for example dance or performance classes, play-reading, meditation, and yoga groups. The theatre has several support spaces situated within the front of house and back of house areas.

Usage profile

User-groups typically prefer to restrict access to the space for the duration of their booking. Engagement with the operator to understand expectations should consider this prior to design. For example, where a user is likely to book the theatre for a period of multiple weeks, they generally occupy the performance space and back of house areas in its entirety thus making it difficult for the space to be used by any other user.

Theatre spaces have a particular pattern of standard usage profiles:

- A production of a performance
    - The production will “bump-in” or “load in” for a period of days. Over this period production and creative teams will construct prefabricated sets and scenic elements, rig, focus and plot production lighting, video, and audio systems. Typically, this occurs from 8am to 11pm each day on weekdays and weekends.
    - The production will commence a period of technical and dress rehearsals for a number of days. Typically, this occurs from 9am to 11pm every day (weekdays and/or weekends).
    - The production will open to a public audience for a period of days to weeks. This is referred to as the productions season. The demand on the space reduces to a period of 1-2 hours prior and post a performance time. Typically, performances are held in the evening with occasional mid-morning or afternoon performances called matinees. If a production typically attracts an audience for a morning or afternoon performance the usage profile may change with a majority of day-time performances.
    - At the conclusion of the season, the production team will “bump out’ or “load out” overnight or for a period of days to reset the theatre back to its standard configuration or empty state. This period can run over a full 24 hour period.

- A single user-group may hire the venue for a single day or a few days at a time for a small-scale event, corporate function or performance requiring minimal technical requirements.
- Sporadic rehearsals or classes requiring only a few hours of time per day and multiple user groups in a single day.

References

Esme Timbery Creative Practice Lab © Arup

Lewis Center for the Arts, Princeton University © Arup

Programmatic requirements

Key programmatic requirements of a small multi-use theatre are outlined below:

Access Requirements

User friendly and controllable access for user groups should be provided from the building exterior. Areas should be zoned to control access between Back of House (BOH) and FOH areas.

Stage and Seating

The stage and seating have a direct relationship. Seating systems should be flexible and highly configurable to provide a high-quality space for small scale performances. Seating system storage should be planned in the development of seating and stage configurations.

Back of House (BOH)

Back of House (BOH) spaces are secure areas incorporating artist support, technical spaces and management. They include the following spaces:

Control positions for technical crew to operate the production systems. This could be a standalone room or temporary positions incorporated into the audience seating area, side or rear of the stage area or a combination of the above,

Technical Equipment Rooms or Rack Rooms house power, data, audio and video distribution and centralised equipment associated with specialist systems,

Dressing rooms providing desks with mirrors, costume rail and full-length mirror,

Kitchen/Green Room with a basic kitchen for performers to pre-heat meals and lounge area to gather before, during and after a performance,

Laundry Area to support costume maintenance including washing, drying and ironing,

Amenities including dedicated toilets and shower,

Storage areas,

Loading zone that services the theatre to support multiple deliveries of scenic elements, technical equipment, food, and beverage. The load-in area or dock should be located immediately adjacent to the stage and/or backstage area. If the loading zone is to be shared by other occupants of the building its ability to handle surges in capacity should be carefully assessed,

Step-free circulation and **obstruction free access**, sized (at minimum) for a grand piano or elevated work platform from the building exterior,

Sound & Light Locks (SLL's) separating the BOH areas from the theatre and FOH spaces,

Wayfinding signage that is inclusive and legible.

Front of House (FOH)

Front of house areas are common publicly accessible areas that support the function of the theatre by providing gathering spaces, information, ticketing purchasing and control. They include the following key spaces:

Foyer is the primary node point for audiences to gather and connect with all spaces they access. The foyer must have direct access to the outside and be the main entrance point for the audience into the main building,

Information/Box Office area provides a location where staff can easily meet and assist audience members with ticket sales and information,

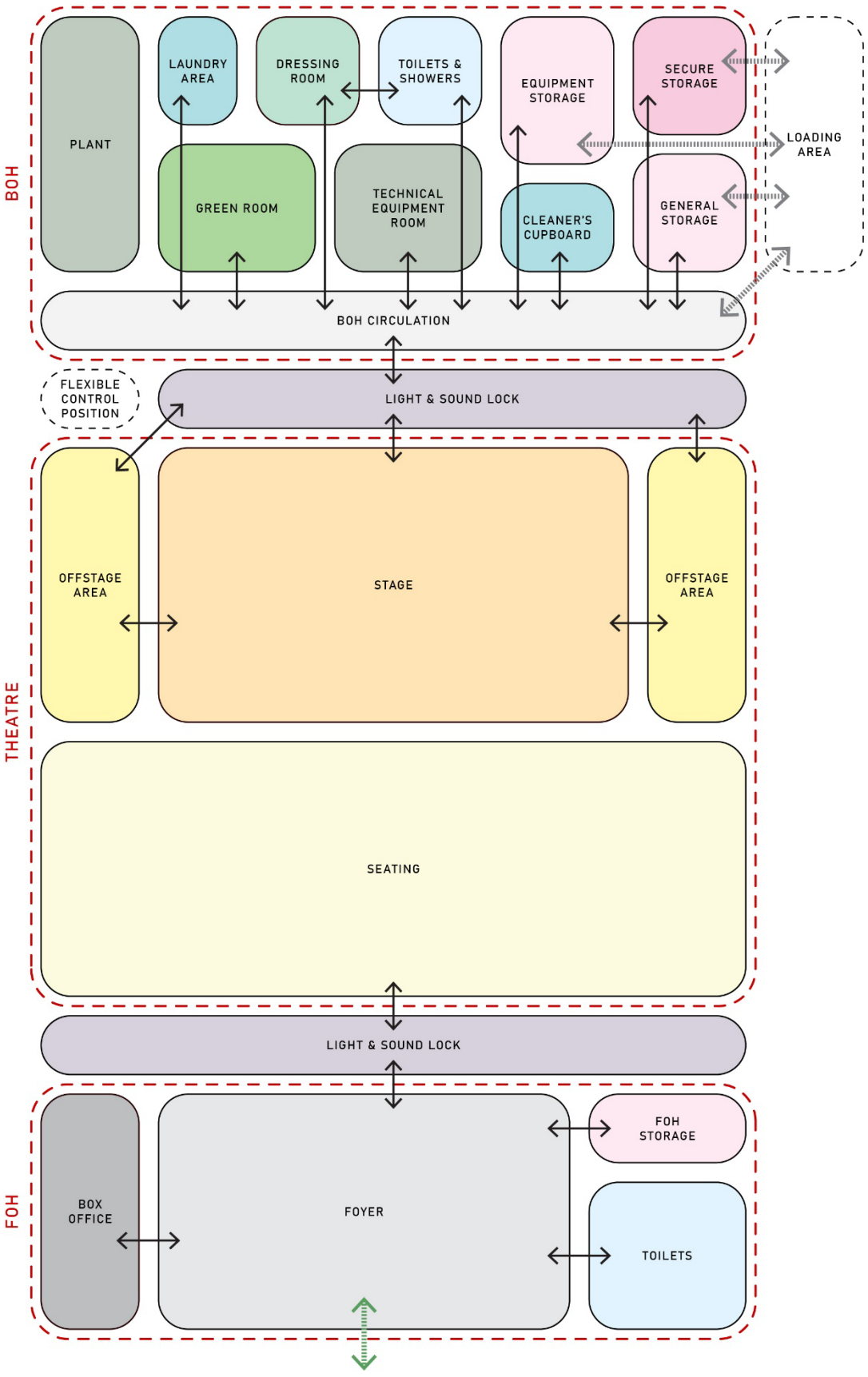
Bar and refreshment area within the foyer for use before and after a performance,

Storage Areas adjacent to the foyer,

Toilets adjacent to the foyer,

Sound & Light Locks (SLL's) separating the theatre from the FOH areas,

Wayfinding signage that is inclusive and legible.



MULTI-USE THEATRE

Small Multi-use Theatre – Spatial adjacency diagram

Departure Guidance: Theatres are complex facilities with a wide range of spaces each with their own unique functional requirements. Whilst some of these can be consolidated into fewer spaces this can attract operational and building performance compromises. For instance, laundry facilities in dressing rooms can be disturbing; FOH storage can be shared with BOH storage but this will create operational inefficiencies; sound / light locks from BOH can be removed but require management to avoid disturbance from BOH activities to the stage.

Spatial requirements

The desired maximum seating allowance should be discussed with the end user and theatre consultant to find the balance between an intimate, adaptable performance space, and adequate ticket sales. In addition to the maximum audience capacity, the theatre will need to accommodate an additional 30+ people including cast, crew, technical and front of house staff. Minimum key spaces are outlined below:

Stage and Seating – Design requirements

Early engagement with the operator and user groups to determine the usage is key to defining area requirements. The following area allowances have been provided as an early planning guide:

Stage/Performance area: a minimum **10m wide x 10m** deep flat floor stage with a minimum offstage area of **2.5m wide x 10m deep** for performers and stage crew in multiple configurations. It is expected the location of the stage may shift in response to the seating arrangement,

Stage height: a minimum **5m AFFL** (above finished floor level) to the underside of the technical grid throughout including over seating areas, however a mezzanine arrangement could be considered along the rear / sides of the space,

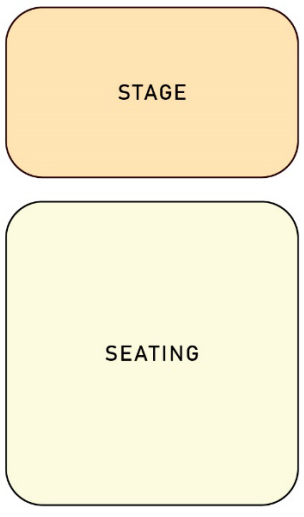
Technical Grid: Infrastructure for rigging Scenery, Lighting, Audio and Video equipment,

Services zone allowance should be considered above the technical grid (rigging Infrastructure),

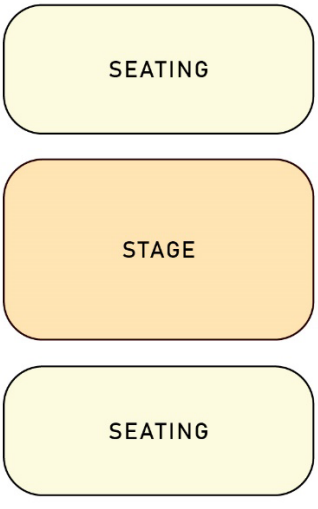
Production Systems,

Seating systems that are highly configurable. The following diagrams indicate examples of typical configurations. Early planning should allow 1.5sqm per person.

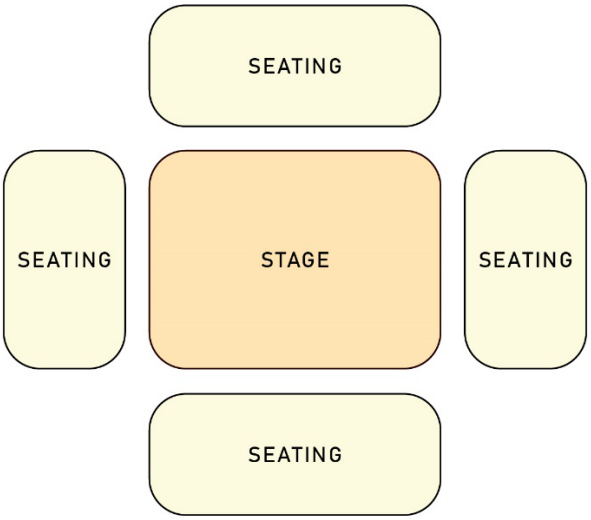
Examples of flexible seating configuration:



End stage - Seating layout



Transverse – Seating layout



In the Round – Seating layout

Stage floor

Construction and finish

Typical construction incorporates plywood sheets on joists finished with a black painted replaceable sacrificial floor that can be fixed into as needed by the users. Stage floor construction should consider floor traps for temporary cabling.

Load Requirements

The floor requires a minimum working load of 7.5kPa however should be specified to safely support the load of the designated height access equipment, seating system, and other heavy items in consultation with the end-users during the design phase.

Additional items that are likely to be used in the space might include:

- A fully loaded chair trolley.
- A heavy road-case of technical equipment (nominal 120kg maximum distributed over four castors).
- A heavy trolley supporting multiple rolls of dance floor / Tarkett (nominal 300kg distributed over four castors).
- Heavy scenic elements such as stage decks and scenery.
- A height access machine, such as a small electric scissor lift, or more likely a 1-person upright lift.
- Retractable seating bank units (possibly in excess of 500kg distributed over multiple castors, etc.).

Wall and Ceiling

Wall and ceiling finishes should be resilient, painted black and wherever possible with the capacity to be fixed into.

Technical Grid

The multi-use theatre should be fitted with overhead rigging infrastructure to support the temporary installation of production equipment and scenery. The technical grid should span the entire stage and seating zone to provide rigging capability in multiple configurations. This may be presented as a distribution of rigging points or a pipe grid system. Services zone should be nominated above the rigging infrastructure and integrated with production system cabling containment and facility panels. Please see Technical System and Structural design requirements.

Audience Seating Systems

The multi-use theatre should consider a seating system to efficiently transition between various seating and stage configurations. Careful assessment of audience sightlines and equally technical equipment sightlines in relation to stage and seating requirements must be carefully assessed.

A portable and/or retractable seating system should be considered. These systems provide load-rated platforms with code required safety elements (steps, handrails, aisles, etc.) that are relatively quick and easy to deploy with limited staff.

The storage of seating systems when not deployed should be carefully considered and integrated in the design development of seating configurations.

Selection of suitable theatre-style seating must be carefully considered and coordinated withing the overall seating system design. Selection of seats must consider architecture, comfort, sizing, code requirements, acoustic criteria, transport & storage, flexibility, cost.

Wheelchair seating spaces and accessible circulation pathway that comply with AS 1428.1 should be provided. Number of wheelchair seating spaces to be provided is set out in the NCC.

Total number of seating	Number of wheelchair seating spaces	Grouping and location
Up to 150	3 spaces	1 single space and 1 group of 2 spaces
151 to 800	3 spaces; plus 1 additional space for each additional 50 seats or part thereof in excess of 150 seats	Not less than 1 single space; and not less than 1 group of 2 spaces; and not more than 5 spaces in any other group.

The NCC specifies theatre auditorium seating. NSW Part H101 will apply.

Back of House areas (BOH) – Design requirements

The Back of House (BOH) space should remain separated, secure, and controllable at all times. User friendly access for cast and crew should be provided while still ensuring security within the building and between the BOH and FOH areas.

Early engagement with the operator and user groups to determine the usage is key to defining area requirements. The following area allowances have been provided as an early planning guide:

Dressing Rooms**: 4 m² per person**

Toilets**:** As per **NCC**

Showers: As per **NCC**

Kitchen: **10m²**

General Storage: **15m²**

Technical Equipment Storage: **20m²**

Secure Storage: **10m²**

Cleaners Cupboard: **2m²**

Control Room: **20m²**

Technical Equipment Room (Rack Room): **15m²**

Laundry Area: **5m²**

All spatial requirements listed above denote Net Internal Area.

Dressing Rooms

A minimum of two dressing rooms should be provided capable of accommodating a minimum of four people. Each dressing room should allow a clear space of no less than 4m² for each occupant and a minimum clear height of 2.4m.

Dressing rooms should be equipped with clothing racks, full length mirror, table with mirror, lockers for storing clothing and personal belongings. Lockers should be well ventilated, accessible, and secure. There should also be a clear space of at least 1800 mm between rows of lockers facing each other and at least 900 mm between lockers and a seat or wall.

Dressing room layout should comply with accessibility standards and best practice, the National Construction Code of Australia (NCC) and the AS 1428 suite of Standards.

Toilets

The ratio of male and female toilets to the number of occupants, and the specifications for toilets should comply with accessibility standards and best practice, the National Construction Code of Australia (NCC) and the AS 1428 suite of Standards. A minimum clear height of 2.4m above finish floor level should be maintained.

Showers

Provide a minimum of two shower cubicles. Showers should have a floor area of not less than $1.8m^{2.}$ Showers should comply with accessibility standards and best practice, the National Construction Code of Australia (NCC) and the AS 1428 suite of Standards. A minimum clear height of 2.4m above finish floor level should be maintained.

Kitchen

A Kitchen is intended only for basic meal prep and reheating of pre-prepared meals. The kitchen should also allow for food rinsing, utensil washing and the sanitary disposal of associated wastewater. There is no need to provide oven and stove unless specified by the operator or user groups.

A minimum clear height of 2.4m above finish floor level should be maintained in the kitchen.

Basic kitchen provisions to include: a large fridge, microwave, sink and instantaneous hot water boiler for efficient tea and coffee preparation. A reasonable amount of bench space and storage should be provided. A dishwasher may be considered.

Storage requirements

General storage must be provided within or adjacent to the theatre, and may be used for:

- Height access machinery and/or ladder storage,
- Loose furniture, especially loose seating and temporary production desks,
- A location to store the seating system when not in use.

Technical Equipment storage must be provided within or adjacent to the theatre, and may be used for:

- Lighting equipment,
- Audio equipment,
- Video equipment,
- Staging equipment,
- Loose cabling.

Secure storage must be provided adjacent to the theatre and within the BOH areas and dressing rooms for:

- High-value technical equipment and tools,
- Critical show props,
- Personal items of cast and crew.

A cleaner's cupboard should be provided adjacent to the theatre and the BOH area:

- Fitted with a mop sink,
- Space to hang wet mops,
- A limited amount of storage for general cleaning products (dustpan & brush, bin liners, cleaning fluids, etc.).

Departure Guidance: Storage is a commonly overlooked facility in creative spaces design, sometimes sacrificed to allow area for other functional requirements. The saying 'you can never have too much storage' is true and failure to do so can have an impact on the safety and operation of a facility.

Control Room

One primary control room should be provided with a clear line of sight to the stage in one or more of the standard seating configurations. In addition, infrastructure should be provided to support temporary control positions for each nominated seating and stage configuration.

Technical Equipment Room (Rack Room)

Technical Equipment Room or Rack Room should be provided to house power, data, audio, and video distribution. It should be easily accessible from control rooms and back of house circulation without disrupting the performance.

Laundry Area

The laundry area is to support costume maintenance. It should provide a washing machine, dryer, workspace for minor repairs and ironing.

Loading zone and circulation

The loading zone that services the theatre is required to support multiple deliveries of scenic elements, technical equipment, food, and beverage. The load-in area or dock should ideally sit immediately adjacent to the stage and/or backstage area. If the loading zone is to be shared by other occupants of the building its ability to handle surges in capacity needs to be carefully assessed.

The loading zone should be sized to accept a medium rigid flatbed truck, a large van and/or a 3T Pantech. Dock levellers and/or an overhead crane should be considered depending on loading area arrangement. Dock design should ensure vehicles accessing the dock do not impede traffic or pedestrian flow. If forklift or similar loading plant is to be used, space around the parked truck to allow manoeuvring when loading / unloading should be included.

The loading circulation path from the loading zone to the theatre and FOH area needs to be carefully designed. It should be step free to allow heavy over-sized wheeled loads to be easily transported to and from the theatre. Direction changes and turning circles and clearances must be assessed.

If there is a building level change between the dock and the theatre a goods lift must be incorporated into the building design, sized to accommodate typically large and heavy loads associated with the theatre.

Loading zone exhaust ventilation should be provided in line with AS1668.2 code requirements. If the loading dock is within the building and close to other occupied areas, appropriate consideration should be made to reduce risk of nearby occupants.

Front of House areas (FOH) – Design requirements

Early engagement with the operator and user groups to determine the usage is key to defining area requirements. The following area allowances have been provided as an early planning guide:

Foyer**:** allow minimum of **1m^2 per person**

Toilets**:** As per **NCC**

Bar and Refreshment Area: **20m^2**

Box Office and Information Area: **5m^2**

Storage Area: **10m^2**

Sound & Light Locks (SLL's) separating the theatre from the FOH spaces.

Wayfinding signage that is inclusive and legible.

All spatial requirements listed above denote Net Internal Area.

Foyer

The foyer is the primary node point for audiences to gather and connect with all spaces they access. The foyer must have direct access to the outside and be the main entrance point for the audience into the main building.

Departure Guidance: A foyer space with an allowance of 1m^2 per person is a starting point for design and will evolve as the design process develops. Inadequate foyer space can result in poor patron experience and loss of food & beverage revenue generating opportunities.

Toilets

The ratio of male and female toilets to the number of occupants, and the specifications for toilets should comply with accessibility standards and best practice, the National Construction Code of Australia (NCC) and the AS 1428 suite of Standards. However, good practice for theatres would increase the number of female toilets by 50-100% to accommodate transient loads associated with intermissions.

Bar and Refreshment Area

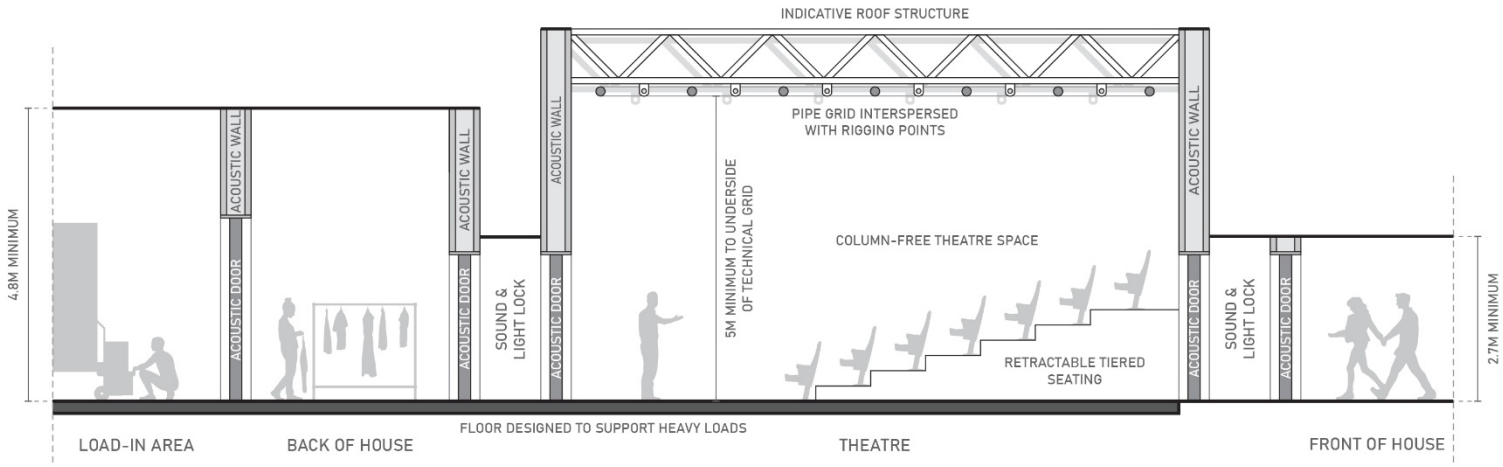
The Bar and Refreshment area should have sufficient space to accommodate performance interval queues without obstructing circulation routes around the Foyer. Shelf or table space should be provided to allow pre-ordered drinks to be prepared for the interval.

Box Office/Information Area

The Box Office area provides a location where staff can easily meet and assist audience members with ticket sales and information. It should be clearly visible, located in the foyer close to the main audience entry point.

Storage requirements

General storage must be provided within a suitably accessible location throughout the foyer. It may be used for portable barriers, merchandise, cleaning equipment, and similar resources to support front of house operations.



Multi-use theatre – Sectional diagram

Departure Guidance: All amenities listed are expected for both professional and non-professional user groups. If loading or circulation requirements cannot be met, this may result in operational inefficiencies and complexities that render the space not fit-for purpose and thus less desirable for users.

Technical System design requirements

Early engagement with the operator and user groups to determine the usage is key to defining technical system requirements. The overall design and capacity of the infrastructure or systems should be determined during design.

Technical Grid

Overhead rigging infrastructure should be provided above the whole theatre space to support the rigging of production equipment such as lighting fixtures, video projectors, LED walls, loudspeakers, curtains, and scenic elements brought in for a particular production. These systems will be reconfigured regularly as per each individual user's requirements. The overhead rigging infrastructure should include a pipe grid and consider rigging strong points for additional capacity and flexibility.

Pipe Grid

A pipe grid suspended from the structure above to allow for efficient rigging of permanent and temporary lighting or equipment. Key design requirements include:

- arrangement of 48.4mm OD steel pipe,
- nominal 1.5m - 2m spacing in two directions,
- capable of supporting (at minimum):
    - 50 kg per lineal meter,
    - 100 kg point loads.

Rigging Strong Points

Rigging strong points to host a series of hoisting equipment (e.g. chain-motor or chain block) that is subsequently connected to either suspended objects or a production truss arrangement. The truss can be used to support a range of production equipment for example lighting fixtures, video projectors, LED walls, loudspeakers, curtains and scenic elements. Key design requirements for rigging points are outlined below:

- Rigging points may be presented as lugs fitted directly to building trusses or ceiling slabs.
- Rigging points should be capable of individually supporting up to 500kg. Simultaneous loading of multiple points to support a distributed load will be required pending detailed design.

Building Structure

Preferably, any building structure within the theatre space should expose steel members (such as universal beams and steel trusses) that can provide temporary rigging support for point loads via temporary means (such as beam clamps and spansets).

Please refer to Structural design requirements.

Pipe Grid Example © Arup

Production Lighting

The production lighting system should enable the suspension of temporary lighting fixtures and associated temporary cabling to operate or control the fixtures via a system of dimmable and non-dimmable channels to create a distinctive look for each performance. The overall design and capacity of the infrastructure or systems is to be determined during the design phase in consultation with the operator, end-users and theatre consultant. Minimum requirements outlined below

<u>Stage Lighting Power and Control</u>

- Stage Lighting Dimmers: 72 x 2.4KW,
- Stage Lighting Non-Dim Circuits: 24 x 10A non dim,
- DMX Universes: 2.

<u>Stage Lighting Outlets and Data Network</u>

The number and distribution of lighting power outlets should be determined in consultation with the operator, end user and theatre consultant early in the design phase. For initial planning purposes a

minimum of 120 patch circuits distributed evenly throughout the technical grid and 20 patch circuits distributed at floor stage level returning to the technical equipment room (rack room) should be provided.

An ethernet based DMX lighting control network should be distributed from lighting control positions, dimmer room, technical grid, stage left, stage right, upstage wall and auditorium returning to the technical equipment (rack room). Distribution should be determined in consultation with the operator, end user and theatre consultant early in the design phase.

Integration with Architectural Lighting

Production lighting systems should integrate and have control over architectural lighting including house and aisle lighting.

A white and blue work light system controllable from control positions and stage should be provided. Please refer to lighting design requirements for further detail.

Production Audio

The sound reinforcement system will include infrastructure overhead and at floor level to support temporary loudspeaker installation and control. Connections to the audio playback system will be managed via multi-core audio cables linked to wall and floor facility panels. The cabling infrastructure should be located at nominated control positions, technical grid, stage left, stage right, upstage wall and auditorium and return to the technical equipment room (rack room). Distribution should be determined in consultation with the operator, end user and theatre consultant early in the design phase.

Production Video

The production video system should include infrastructure overhead and at floor level to support temporary video installation and control. The cabling infrastructure should be located at nominated control positions, technical grid, stage left, stage right, upstage wall and auditorium. Connections to analogue or digital switching device to distribute and process the video signal from video cameras will be managed via cable linked to the wall and floor facility panels and return to the technical equipment room (rack room). Distribution should be determined in consultation with the operator, end user and theatre consultant early in the design phase.

Production Communications

The production communication system should include infrastructure to support a minimum of two channel industry standard communication system. Infrastructure should be provided at nominated control positions and evenly distributed at stage level. Distribution should be determined in consultation with the operator, end user and theatre consultant early in the design phase.

Production Infrastructure

Facility panels will be required, mounted to various ceiling, rigging infrastructure, wall, and floor locations to interconnect the Production Lighting, Audio and Video signal and power cabling. Facility panels provide an identifiable connection point for analogue and/or digital signal cables between various systems and locations within the room. The cabling will merge at a central point within the Technical Equipment Room or Rack Room that houses power, data, audio, and video distribution. Distribution should be determined in consultation with the operator, end user and theatre consultant early in the design phase.

Paging Systems Infrastructure

Paging systems should allow areas to link or act separately as needed including:

- Front of house paging, electronic signage and interactive systems for visitor information, orientation and latecomers video monitors with control from stage management and front-of-house staff,

- Back-of-house paging, audio and video show relay for staff, technicians and performer coordination. The system should be zoned to allow announcements from the stage manager to artists and technical crew in all back of house areas including dressing rooms and green room and to front of house foyer areas.

Overhead Access

Production equipment (e.g. loudspeakers, lighting fixtures, scenic elements, etc.) rigged above the performance area could be accessed via:

- A suitable platform ladder,
- Lightweight portable scaffold tower, or
- Height access machinery, such as a vertical lift or scissor lift.

Height access requirements should be assessed in consultation with the end-users during the design phase to determine the method of height access required. The assessment will need to consider: the operational impact, the risk profile, user needs and use-cases, frequency of use, adequate floor loading criteria, storage areas, access paths, etc. to inform a successful design.

Departure Guidance: The technical provisions listed are fundamental to the successful operation of a Small-multi-use theatre space. Early engagement with the operator and user groups to determine the usage is key to defining technical system requirements. The overall design and capacity of the infrastructure or systems should be determined during design. Under-scoping technical systems can result in operational inefficiencies, loss of creative potential and impact reputation. Over-scoping can result in a building with unrealised technical capacity, or worse, a building that cannot be maintained and supported.

Additional code compliance requirements

- The design and operation of the Entertainment Venue is to be in accordance with Schedule 3a of the EP&A Regulations.
- Part NSW H101 of the NCC will apply.
- If a multi-use theatre was proposed in an existing building, the extent of building and services upgrades required for compliance should be considered pre-Development Application. Input from a BCA Consultant will be required. Input from a Fire Safety Engineer may be of benefit, to define the extent of upgrades on a performance-basis.

Structural design requirements

Key structural design requirements are outlined below:

The Load allowances for the multi-use theatre and adjacent spaces shall consider the use of space and comply with AS1170.1:2000.

In the permanent condition, the theatre floor space shall be specifically designed for:

- Uniformly designed load (UDL), 5 kPa generally, 7.5kPa in stage area,
- Concentrated point load, 3.6 kN generally, 4.5kN in stage area.

Additional allowances should also be made for the self-weight of the retractable seating (if applicable), including stacking arrangement and concentrated point loads. These point loads should be limited to the concentrated loads specified above and should be obtained from the proprietary seating specification.

Special consideration for the allowance of concentrated point loads shall be made for scenery and production equipment. Some heavy items that are likely to be used in the space might include:

- A fully loaded chair trolley,
- A heavy road-case of technical equipment,
- A heavy trolley supporting multiple rolls of dance floor / Tarkett,
- Heavy scenic elements such as stage decks, flattage, etc.
- Retractable seating (as mentioned above),
- Concentrated loads from temporary platform/stage legs.

The theatre should also have the capacity to support concentrated and uniformly distributed loads for temporary equipment (e.g. elevated work platforms (EWPs), to facilitate access to the overhead structure for operation and maintenance as well as installation of heavy scenery. The loading capacity of the travel paths for the temporary equipment should also be considered in the design and floors should be designed to facilitate these temporary loads. The equipment and the procedure implemented for overhead operation should also be carefully selected to ensure the floor is not damaged.

Overhead rigging suggested allowances

The theatre shall be fitted with overhead rigging infrastructure to support the installation of production equipment or scenery. Overhead rigging infrastructure may also be used for hanging temporary AV and presentation equipment (projection screens, loudspeakers, theatrical lighting, curtains, etc.) Overhead infrastructure may take the form of rigging points or a pipe grid. Catwalks may also be required over the theatre at high-level for circulation and access. Sides of catwalks facing the stage area require pipes which lighting fixtures may be mounted to. Loads should be considered in balustrade design loading.

Suggested allowances:

<u>Rigging Points</u>

- Nominal 3m - 6m centres with a 5kN load capacity per point.
- A defined limit to the number of rigging points that are coincidently loaded should be discussed and agreed with the end user to avoid excessive loading requirements for the overhead structure.
- Rigging to structure is only to occur at agreed rigging point locations.

<u>Pipe Grid</u>

- Typically, 2kN point load at 2m grid, or 0.5 kPa UDL.

<u>Catwalks:</u>

- 2 .8 kPa LL allowance for people + additional 1kN/m for theatre equipment.

Overhead rigging infrastructure should be supported from the floor or roof structure above the rehearsal room. This floor/roof shall be designed considering the hanging loads from the rigging equipment, including any dynamic load factors associated with the equipment loads which are provided by the product manufacturer. Any items supported from the rigging system that are sensitive to vibration (e.g. lighting, sound) or have specific performance requirements, should be specified for consideration in the design of overhead rigging support structure.

The overhead rigging is frequently supported using chain hoists, clamps and other rigging hardware (as described in technical systems requirements). Exposed steel members (such as universal beams) are an effective support for rigging points. The possibilities for clamping to beams may be

Departure Guidance: A building that does not have adequate floor or ceiling / roof loading capacity could significantly impact the functionality of spaces; ceiling / roof loading should allow for the rigging equipment and / or connections for aerial performances; floors should allow loads such as large set constructions; floor should also allow for the concentrated loads of elevated work platforms to allow access to rigging points.

limited if fire treatment is required on the beam. These steel members can be secondary members attached to the primary structure, or direct attachment to the primary structure may be appropriate.

Vibration Performance Criteria:

The impact of rhythmic activities such as dancing, both on stage and in the audience, whether seated or standing, shall be considered in the design of the theatre and adjacent spaces. Large repeating loads due to dancing or other types of high energy movement are applied to the structure which can generate structural vibration that may cause complaints or concern to the occupants. Due to the architectural constraints of the space, namely the column free structural arrangement, suspended floors can have relatively low frequencies. This means that people can move (dance, stomp, jump etc) at the same frequency as the structure, causing large movements. There may be areas in the structure where the theatre is adjacent to or supports spaces with more sensitive usages increasing the potential to transfer structural vibrations between floors and spaces. Careful consideration into whether vibrations within the theatre and transferred vibrations into other spaces through the building will cause concern to occupants. Expected vibrations levels can be predicted using published loading and acceptability criteria from international codes and standards, including AISC Design Guide 11 and ISructE.

Lighting design requirements

Key lighting design requirements are outlined below:

Numerous lighting systems will be required within the theatre, including:

- General work light,
- House lights,
- Aisle lights, step lights, and row identifiers,
- Backstage blue lighting system,
- Emergency lighting,
- Production lighting systems (separate/standalone from the Architectural lighting systems).

Lighting design considerations

- All work lighting, house lighting and blue lighting to be efficient LED DALI dimmable.
- The colour temperature of the work lighting and house lighting fixtures to be 4000K or 3000K and consistent throughout.
- The colour rendering (CRI) of the work lighting and house lighting luminaires to be 90 or higher.
- House and aisle light systems will need to be flexible, to ensure that required coverage can be met when the theatre is operated in a non-standard configuration.
- If a projection box is included in the theatre, care is needed to limit spill light to / from the projection box.
- Aisle lighting should be at each step and produce a contrast between step and riser. Aisle lights, step lights and row identifiers should be concealed from the stage and audience so not to produce glare. The aisle lights should illuminate steps in a way that does not distract in a darkened room.

- Backstage blue lighting should be provided in the wings/ backstage areas. A monochromatic blue hue is to be used to provide light during a performance but minimize the likelihood of being seen by the audience.

Lighting control

- Architectural lighting systems such as house lights will need to interface with the Production lighting control system. Local overrides and interconnections will be required such that a lighting technician can take control of the house lights during performance mode. Panic buttons, etc. should need to be provided for in case of emergency.
- Lighting control panels to be provided BOH, at theatre entry and at the theatre control box, with care taken to minimise spill light from the lighting control panel.

Lighting design compliance

- The theatre work lights should have good general lighting throughout. The average horizontal illuminance level should meet 320 lux average. This is indicated in AS1680.2.4 (Industrial tasks and processes), Table E1 – moderate visual tasks. The uniformity of the space should meet 0.3 as a minimum.
- The theatre house lighting should provide good general lighting throughout auditorium. The average horizontal illuminance level should meet 240 lux average with ability to dim. This is indicated in AS1680.2.3 (Specific applications – education and training facilities), Table D1.

Emergency Lighting and Exit signs

- AS2293 and NCC Section E4 compliance emergency lighting and exit signs to be provided throughout as required.
- Consideration shall be given to incorporate integrated emergency lighting to the general lighting within the space.
- Exit signs to have capability of using minimum brightness allowable for exit signs to eliminate glare and light spill during a black out.

Electrical design requirements

Key electrical design requirements are outlined below:

Electrical requirements

- Incoming power supply to the small multi use theatre space and the power supply authority power metering requirements to be developed based on the incoming power supply to the building and as per local power supply authority requirements.
- A dedicated distribution board must be provided for the theatre with separately metered power and lighting as required by NCC and ESD purposes.
- A separate clean earth distribution board complete with a technical earth connection directly from the building main earth bar to be provided within the theatre to connect all specialist audio and video equipment and outlets.
- General power outlets to be provided for the user ports and cleaners' outlets as required.
- Separately metered power supply to be provided for the Bar space as required.
- Power provisions to be provided for Foyer, AV racks, toilets and loading docks as required.
- Power provisions to be provided for all mechanical and hydraulic services equipment and to be coordinated with mechanical and hydraulic services installations.
- Cable reticulation to be coordinated with acoustic requirements of the floor/wall build up. To maintain the required acoustic performance based on the installation requirements, rigid conduits or flexible conduits or steel conduits to be used.

The theatre will require:

- Minimum 200A per phase for stage lighting dimmers,
- Minimum 100A per phase at stage level,
- 7 of 40A 415V 3PN+E Wilco outlets located at the nominated lighting patch bay location,
- 1 of 40A 415V 3PN+E Wilco outlet in the BOH area adjacent to the stage,
- 10A DGPO's distributed along the perimeter of the venue, and any mezzanine,
- Technical earth / clean power system for typical audio circuits,
- Separate distribution board for the Bar. (min.100A 415V supply).

BOH will require:

- Power provisions for office space for 2 people,
- Power provisions for the small backstage kitchenette,
- Power provisions for Laundry Area.

Departure Guidance: As well as ensuring adequate electrical supplies, the distribution of power supplies is critical to success for a theatre space. Electrical supplies should be 'clean' and free from noise generated by inductive loads; design of earthing systems should avoid potential for 'earth loops' which can cause hum in sensitive equipment; power should be distributed liberally with outlets mounted to every wall and associated with all potential equipment locations.

Communications requirements

Incoming communication services requirements to be developed based on the building/space requirements. Minimum 10pair Cat 5 cabling connection to be installed from the building distributor to the floor distributor together with minimum 6 core single mode fibre optic connection.

The theatre will require:

- A dedicated AV rack and switch,
- Data outlets distributed throughout the venue,
- A production lighting patch system between the pipe grid overhead and a nominated patch bay location,
- Specialty technical system interconnections between typical control location and stage / back-stage,
- Building wide comms, paging and relay systems,
- Internet connection to the AV rack / switch,
- WI-FI network connection provisions.

Back stage will require:

- Data provisions for office space for 2 people,
- Wi-Fi network connection provisions.

Electrical design standards and System Criteria

Item	Standards	Criteria
Supply Conditions	• Supply Authority service rules	• 400V 3-Phase nominal. • 50Hz.
Main Switchboard	• AS/NZS 61439 • AS/NZS 3000	• 25% spare space or one spare space (whichever is greatest) for each frame size excluding main switch(es). • Main busbars 125% initial load.
Distribution boards	• AS/NZS 61439 • AS/NZS 3000	• Form 2 unless stated otherwise. • 30% spare space or minimum 18 poles (whichever is greatest) for each frame size excluding local main control). • Local main control required. • Fault interrupt capacity of circuit breakers minimum 6kA. • Provide fault current limiters or use higher fault interrupt capacity circuit breakers as required. • Internal DBs: IP52 minimum. • External DBs: IP56 minimum.
Consumers mains	• AS/NZS 3000 • AS/NZS 3008.1	• Voltage drop: Max. 2%. • Maximum demand + 25% capacity (current carrying and voltage drop). • Fire rate where required to AS3000. • At least 100% neutral. Provide oversize neutral where harmonic currents are expected to be high.
Submains	• AS/NZS 3000 • AS/NZS 3008.1	• Voltage drop: 1%. • Maximum demand + 20% (current carrying and voltage drop). • Fire rate where required for Fire and Life Safety Services. • At least 100% neutral. Provide oversize neutral where harmonic currents are expected to be high.
Final subcircuits	• AS/NZS 3000 • AS/NZS 3008.1	• Voltage drop: Max.2%. • Power 2.5 mm² minimum. • Lighting 2.5 mm² minimum. • Max 80% utilisation to AS 3000.
Lighting	• AS/NZS 1680	• Use long life, energy saving lamps such as LEDs. Use tungsten and tungsten halogen only to approval. • Allow overall depreciation factor of 0.8 for clean, air conditioned areas, 0.7 for clean, non-air conditioned areas and 0.6 for dirty areas.
Communications	• AS/NZS 11801	• Provide Cat 6 UTP cabling. • Contain Cat 6 cable route length to <90m. • Cross power cables only at 90°.

Item	Standards	Criteria
		• The maximum fill of a cable tray shall not exceed 50%.
Electrical Metering and EMS system	• NCC Section J6 • Supply authority standards	• Meters and CTs shall comply with NCC and supply authority standards.

Acoustic design requirements

The acoustic outcomes will be influenced by the site location, internal design, and interface with surrounding development. The key design considerations and requirements are outlined below:

Acoustic design considerations

The acoustic outcomes will be influenced by the site location, internal design, and interface with surrounding development. The key design factors include:

- Environmental noise and vibration emission
- Internal design noise and vibration levels
- Low background noise levels, related to environmental noise and vibration intrusion and building services noise and vibration control
- Internal acoustic separation, including spatial planning and physical isolation, and
- Room acoustics

Departure Guidance: The criticality of good acoustic design needs to be emphasized as vital to the success of a theatre space. Building envelope design should avoid noise ingress from external noise and vibration sources; internal partitions often require heavy-weight / high performance construction so that performance sounds from the theatre space cannot be heard through foyer or BOH doors; internal finishes (both absorptive and diffusing) need to result in 'flat' room response to aid critical listening.

Design criteria and management requirements

Item	Criteria and requirements
Environmental noise and vibration emission	• Minimum requirements will be according to Council consent requirements and will be dependent on surrounding or adjoining development. • The design must be based on the full operating hours of the space and maximum noise and vibration levels potentially generated by the use. • The acoustic design requirements will be heavily influenced by the proximity and sensitivity of nearby or adjoining receivers. Site location will be critical to minimising design requirements and maximising operational flexibility.

Item	Criteria and requirements

Internal background noise and vibration levels	• Criteria relate to the noise and vibration in the space excluding occupant activity.
	• Internal background noise levels, from both environmental noise intrusion and internal plant and equipment should not exceed:
	  ○ Performance space: NR 25.
	  ○ Other areas: Not to exceed the lower bound design sound level range in AS/NZS 2107:2016 by more than 5 dB.
	• Internal background vibration not to exceed the maximum levels in British Standard BS 6472:2008.

Internal acoustic separation, including spatial planning and physical isolation	• Acoustic separation will be required between performance space and adjoining ancillary spaces, such as back-of-house and foyer. The primary objective of internal partitions is to minimise disruption of external activities on performance. • Sound locks at entries to performance space are recommended.

Room acoustics	• Design recommendations based on use for dance, drama, and amplified/world music:
	  ○ Reverberation time not to exceed Curve 1 in Appendix A of AS/NZS2107:2016. Reverberation time at 125 Hz not to exceed mid-frequency RT by more than 0.2 seconds.
	  ○ Vocal intelligibility: minimum D50 of 0.5.
	  ○ Loudness G = 0 to 10.
	  ○ Room volume 4-5 m3 per person.
	  ○ Background noise not to exceed NR 25.
	• Note that a higher RT would be required for non-amplified along with variable acoustic treatment. Target criteria would be dependent on desired musical style and therefore expert advice is recommended for such usage.

Fire safety design requirements

The design of a theatre can often benefit from a Performance Based Fire Safety Strategy, carried out by a Fire Safety Engineer. Designing in accordance with the prescriptive NCC requirements, whilst possible, may prove restrictive to the space. A Performance Based design, considering the Fire Safety Strategy as a whole, can often lead to a more usable (less restrictive) outcome that considers the operational needs of a theatre.

- Fire exits and egress routes are to be sized and located in accordance with the prescriptive requirements of the NCC or be considered as part of a Fire Safety Strategy by a Fire Safety Engineer. Where temporary equipment or props are expected, management provisions are to be implemented to prevent blocking of the exits and egress routes.
- The theatre compartmentation strategy is to meet the prescriptive requirements of the NCC or be considered as part of a Fire Safety Strategy by a Fire Safety Engineer. Latching requirements for fire rated doors may create unwanted noise during performances and is to be considered by the design team where proposed within close proximity to a performance space. If a sound lock/lobby is not provided and auditorium doors are required to achieve both acoustic and fire rating performance this should be identified early, as such doors typically have longer lead times for procurement than standard fire doors.

- The stage and seating arrangement is to be identified in the early stages of design. This applies to both permanent and temporary arrangements. The layout or parameters of temporary staging or seating layouts will need to form part of the approvals documentation to ensure that NCC requirements are maintained during temporary event layouts.
- Fire safety systems are to be provided in accordance with the requirements of the NCC or considered as part of a Fire Safety Strategy by a Fire Safety Engineer. The design of fire safety systems is to consider the presence of any temporary staging, seating, or possible stage props in relation to fire systems coverage. If retractable seating is proposed, it is to be confirmed in the early stages of design if compliant sprinkler coverage can be achieved. If full coverage cannot be achieved, a Performance Solution will be required to meet the Performance Requirements of the NCC.
- Audibility of the Occupant Warning System is to be considered. Competing sound systems are to shut down in accordance with AS1670.1-2018 clause 3.22.3. The placement of occupant warning speakers is to consider any sound-proofing measures within the facility. Visual warning devices are to be located in areas where portable sound systems may be used.
- Linings are required to meet the Fire Hazard Property requirements outlined in C1.10 of the NCC. This requirement is to be considered in conjunction with any acoustic or sound proofing linings.
- Where the use of theatrical smoke is to be allowed for, the possibility of false alarms due to a smoke detection system is to be considered. Isolation of a smoke detection system is non-compliant (as clarified by NSW Department of Planning) and would need to be supported via a Performance Solution which outlines an alternative strategy for detection of a fire and meets the Performance Requirements of the NCC. The impact of isolation the detection system would need to consider occupant evacuation and initiation of active fire safety systems such as smoke exhaust that are required to be operated by smoke detection.
- If a smoke exhaust system is required, smoke is to be exhausted at high level and make-up air introduced at low level. It is recommended that a smoke exhaust system is designed on a Performance Basis with consideration to the wider Fire Safety Strategy and theatre operational needs (e.g., consideration of any sprinkler shortfalls, proposed detection isolations, compartmentation strategy).

Hydraulic design requirements

Key Hydraulic Services provisions should be considered as part of the design are outlined below.

- Domestic water and sanitary drainage are to be provided to any kitchens, toilets and cleaners sinks which are part of the space.
- Where the space forms part of a building, domestic water services should be metered separately from the base building supply to allow landlord billing of water use.
- Mechanical condensate should drain to the sanitary system via a trapped tundish.
- Domestic hot water should be generated local to the space and consider the frequency of use. Where spaces are used infrequently, instantaneous electric hot water generation is preferred to avoid energy associated with heat losses. Where the space is used daily, electric storage may be more appropriate.
- Hydraulic services should not be located in the theatre space to avoid risk of damage to equipment from water leaks and the associated acoustic nuisance from live services. Where this is not possible, they should be acoustically treated and located in a way to avoid impact on the theatre space during routine maintenance or repair.

Hydraulic design criteria

The Hydraulic Services design is to be based on the following design criteria.

System	Standards	Design Criteria
Domestic hot and cold Water	• BCA 2019 Amdt. 1 • AS/NZS 3500.1 – 2018 • AS/NZS 3500.4 - 2018	• Cold water average supply temp: 14°C. • Hot water storage: 60°C – 65°C. • Hot water distribution: 55°C-60°C. • Amenities (visitor and non visitor): 43°C. • Utility rooms (kitchens, cleaners sinks): 50 to 55°C. • Max velocity: 2.4m/s externally and in ground. • Max velocity: 1.5m/s in risers, BOH spaces. • Max velocity: 0.8m/s in acoustically sensitive spaces. • Min operating pressure: 200kPa. • Max operating pressure 500kPa.
Sanitary Plumbing and Drainage	• BCA 2019 Amdt. 1 • AS/NZS 3500.2 – 2018 • Sydney Water Trade Waste Guidelines	• Minimum grade: 2.5% for 40-65mm, 1.65% for 80-100mm and 1% for 150mm pipelines. • Sanitary stacks design capacity: 22% to 0.33% full. • Drainage design capacity: Max 70 % full. • Velocity: 0.75m/s to 1.2m/s.
Building Rainwater Drainage	• BCA 2019 Amdt. 1 • AS/NZS 3500.3 – 2018 • Australian Rainfall and Runoff Guidelines • City of Sydney requirements	• Flat roofs, box gutters – 5min 1% AEP. • Eaves gutters – 5min 5% AEP. • Climate change allowance +10%. • Full capacity overflows to be provided to all building rainwater drainage catchment areas. • Velocity: 0.75m/s to 1.2m/s. • Siphonic drainage velocities TBC by hydraulic calculation, insulation where required to limit noise in noise sensitive areas.

Mechanical design requirements

Key mechanical design considerations and requirements are outlined below:

General mechanical requirements

- Separate mechanical systems shall be provided to serve the theatre, backstage area, tech crew control area (if required), dressing rooms, green room and office areas. Each system shall be activated as required to avoid unnecessary energy usage. Operation of these systems should be either programmed (for the larger spaces) or based on occupancy sensing (for small offices, dressing rooms etc.).
- For mechanical sizing, internal gains within the dressing rooms, green room and theatre space shall be based on increased metabolic rates to reflect high activity level from performance.
- Relevant ASHRAE and CIBSE external design criteria shall be used. Consideration should be given to future climate change and resultant elevated ambient design temperatures.
- Increased outside air (50% above code minimum is recommended) in normal operation
- CO2 sensors shall increase the outside air proportion to the space in response to high CO2 levels. The mechanical equipment shall be sized to maintain internal temperatures and deliver increased outside air at high ambient temperatures.
- Mechanical system shall be variable volume, responding to temperature and CO2 levels within the space (wall-mounted temperature and CO2 sensors shall be installed at 1500mm

AFFL inside the space). Sensors should be installed in areas that will be representative of the conditions inside the space.

- If system supplies >1000 l/s, economy mode shall be provided in line with NCC 2019 Section J requirements. Economy mode should be offered with smaller units to achieve energy reductions.
- For spaces with a floor-to-ceiling height of 4-6m, minimum air change rate of 6 air changes per hour to be achieved.
- For spaces with a floor-to-ceiling heigh >6m, minimum air change rate of 8 air changes per hour to be achieved.
- When determining airflow and mechanical equipment sizing, consideration should be given to up-lighting vs. downlighting so that the mechanical system is not oversized (a proportion of high-level lighting and equipment load will not land in the space so does not require direct air conditioning).

Departure Guidance: Early and ongoing engagement with operators and user groups or a consultant with relevant experience to advise on their behalf is required in the development of technical systems. A lack of provision may deem the space not fit-for-purpose. Theatre spaces can produce significant changes in thermal load once performers begin their performances which often involve physical movements. Mechanical systems can include mix-mode systems but need to take into account ranges of comfort for the performers, audience and staff as well as accommodate rapid changes in thermal load.

Theatre

The mechanical systems shall ensure a comfortable environment for the production team to work, and for audiences who attend. Heat loads in theatres can be quite dynamic (e.g. significant technical systems that generate a lot of heat operating intensely for the duration of a show, post-interval performance commencement) and mechanical systems should be designed to respond to this.

- The mechanical systems serving the theatre shall maintain an environment within the specified values during times of use:
    - Temperature: 20 to 23 degrees Celsius, with ability to widen temperature criteria depending on space use to save energy,
    - Humidity: 40 to 60% (note: this will not be directly controlled but will naturally fall into this range as a result of the air conditioning).
- Mechanical system shall be designed to meet acoustic requirements of the space. Coordinate mechanical systems with Acoustic Consultant to meet specific noise criteria for the Theatre.
- All ductwork to be above rigging zone OR can be wall mounted as long as it isn't covered by drapes, doesn't clash with other services / uses and airflow can be delivered to performers on stage and occupants seated in theatre.
- Ensure access to ductwork is maintainable taking into account lighting and equipment rigging within the space.
- Consideration should be given to performance of diffusers in heating mode, especially for spaces with high floor-to-ceilings (more than 3.2m).
- If extensive lighting and equipment is used, make allowance for mechanical system to offset expected maximum lighting and equipment loads.
- Make provision for a purge mode for return air to bypass AHU and discharge directly to atmosphere (in the event of use of smoke machines or similar).
- Air supply should be 'low velocity' to reduce noise, avoid drafts and avoid moving drapes / curtains.
- Diffusers to be high induction to reduce drafts in space.
- Tech crew control area to be provided with outside air 50% above AS1668.2 code requirements and, if within an enclosed room, a dedicated air conditioning unit.

Other Areas

- Ventilation of toilets and change rooms to be in line with AS1668.2 requirements (change rooms may be conditioned by a small FCU/PAC if desired to provide additional comfort for occupants). It is recommended extract ventilation is 200% of code minimum to ensure odours are effectively removed from the space.
- Bar area and any kitchenette shall have dedicated exhaust and be appropriately sized to capture fumes from small-scale food reheat, dishwasher, microwave and other heat-emitting appliances. Provide sufficient ventilation based on size and usage of the bar/kitchenette.
- Cleaners store (if required) to be exhausted directly to outside in line with AS1668.2 requirements.

Fire engineering/ Smoke control

- If smoke exhaust is required, all components are to be compliant with AS1668.1 requirements and Spec E2.2b of the NCC, except where deviated by a Performance Base Fire Engineering strategy developed by a Fire Safety Engineer.

Design Criteria

External design criteria	ASHRAE or CIBSE current guidance
General Ventilation	AS 1668.2:2012
Smoke Control Ventilation	AS 1668.1:2015
Battery Ventilation	AS 2676.1:2020
Refrigerant	AS 5149:2016

In addition, the design should be compliant with the following codes and standards:

- 2019 National Construction Code / Building Code of Australia (BCA),
- Building Permit conditions,
- AS1668.1 (2015) – Fire and Smoke Control in Multi-Compartment Buildings (Amendment 1),
- AS1668.2 (2012) – Mechanical Ventilation in Buildings (Amendment 1 and 2),
- AS1668.4 (2012) – Natural Ventilation of Buildings,
- AS 1940 (2004) – The Storage and Handling of Combustible Liquids,
- AS/NZS 2107 (2000) – Recommended Design Sound Levels and Reverberation Times for Building Interiors,
- AS 3000 – Electrical Installations,
- AS 3500 – National Plumbing and Drainage Code,
- AS 3666 (2011) – Air-handling and Water Systems of Buildings – Microbial Control,
- AS 4254.1 (2012) – Ductwork for Air-Handling Systems in Buildings – Flexible Duct,
- AS 4254.1 (2012) – Ductwork for Air-Handling Systems in Buildings – Rigid Duct,
- AS/NZS 5601.1 (2013) – Gas Installations – General Installations,
- All other applicable Australian Standards,
- WorkCover requirements,
- OH&S Regulations,
- Safe Work Australia,
- Electricity Supply Authority requirements,
- Fire Brigade requirements,
- Australian Gas Authority requirements,
- All Local Council regulations,
- Fire Engineering Report.

Pipework Velocity and Pressure Drop

The following values shall not be exceeded:

- Pipework pressure drop: 300 Pa/m,
- Pipework velocity:

Diameter (mm)	Velocity (m/s)
25	1
50	1.1
100	1.25
150	1.5
200	2
250	2.2
300	2.5

Ductwork Velocity and Pressure Drop

The following values shall not be exceeded:

Ductwork Velocity – Variable Volume Systems (Final velocity to be agreed with Acoustic Consultant depending on acoustic requirements of the space)

- Risers and plantrooms: 7.0 m/s,
- In ceiling secondary ductwork: 5.0 m/s,
- In ceiling tertiary ductwork: 3.5 m/s,
- Flexible ductwork: 2.5 m/s,
- General duct discharges: 6.0 m/s,
- Louvers: 2.5 m/s face velocity.

Ductwork Pressure Drop

- General ductwork: 0.8 Pa/m,
- Transfer ducts: 12 Pa,
- Riser take-offs: Kt £ 0.89,
- Bends: Kt £ 0.25,
- Rectangular contractions: Kt £ 0.19.

Where the total pressure loss through the fitting is defined as Pt = Kt × Pv

- Pt = Total pressure loss through fitting (Pa),
- Kt = Loss coefficient,
- Pv = Velocity pressure (Pa).

Mechanical Equipment and Accessories Pressure drops

The following values shall not be exceeded:

- Sound attenuators: 50 Pa,
- Louvres: 20 Pa,
- Cooling coils (airside): 150 Pa,
- Cooling coils (waterside): 35 kPa.

Document 4:

Fabrication Space: Light-Industrial

Description

A light fabrication space provides a construction environment for use by artists, designers, creatives, construction and technical personnel to fabricate scenery, props and artworks at a variety of scales.

The general requirements of a light fabrication workshop are identified below with provisions for timber construction, metal fabrication, paint and scenic application.

Type A – Timber Construction

A fabrication space that can be used to work with timber. This space may need to accommodate equipment including, but not limited to, air compressor, table saw, electric sander, table router, drill press, thicknesser, wood lathe, mitre saw and jointer.

Type B – Metal fabrication

A fabrication space that can be used to work with metal. This space may need to accommodate equipment including, but not limited to, air compressor, grinders, wire wheel, welders, drill press, oxyacetylene torch, hydraulic press, anvil and linisher.

Type C – Paint and Scenic application

A fabrication space that can be used to work with paint including industrial grade paints. This space should be fitted with an air compressor, an industrial grade paint sink and wash-up area. Provisions for a spray booth should be considered.

Usage Profile

Light fabrication workshops typically:

- Operate from 7am – 6pm typically.
- will occasionally operate outside of normal hours.
- will often need to support the loading / unloading of large vehicles outside of normal hours (including early in the morning, late at night, and on weekends).

The context of a workshop and its adjacency to other buildings / occupants / etc will need to be carefully considered at the planning stage. Constraints on operations, especially noise constraints

and limited hours of operation, run the risk of a workshop that is not fit for purpose to support key functions.

References

Powerhouse Ultimo Workshop © City of Sydney

Powerhouse Ultimo Workshop © City of Sydney

Programmatic requirements

Common to Type A, B and C

A light fabrication workshop should provide at minimum the following common areas across all typologies:

Construction/Fabrication area in which machinery and workstations are located,

Machinery area clearance as required for machinery type,

Assembly area that is clear of obstructions, and adequately sized to assemble large and complex elements,

Office area,

Kitchen and break room,

Loading facilities for incoming materials and equipment and outgoing scenery and artwork,

Amenities including office space, lunch or break room with basic kitchen amenity and dedicated toilet and shower amenities,

Storage areas,

First-aid station,

Step-free circulation between workstations and machinery,

Wayfinding signage that is inclusive and legible.

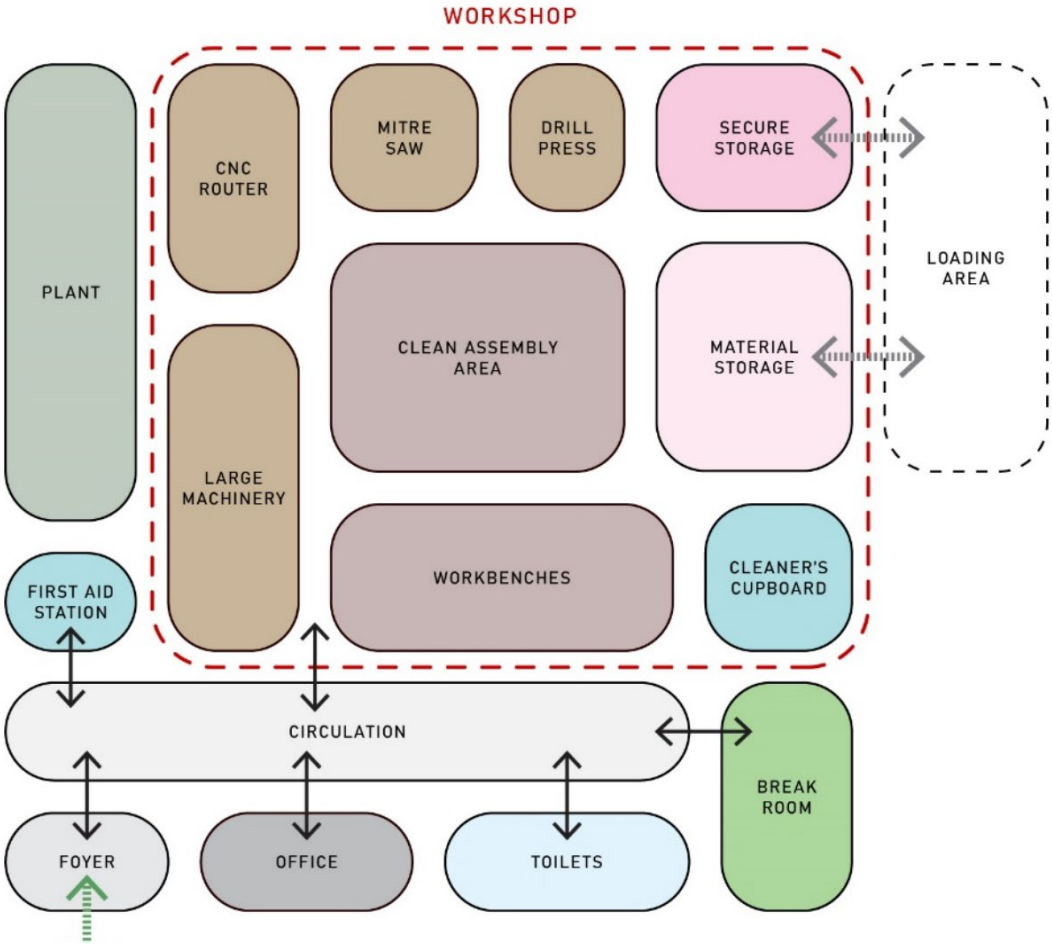
Type A – timber construction workshop area requirements

In addition to assembly and storage areas outlined above, timber construction workshops require:

- Storage for incoming timber sheet goods,
- Storage for long-length timber goods,
- Area for large machinery, such as a table or panel saw,
- Area for a sliding-compound mitre saw, including wings and clearance either side to lay a 6m stick of timber,
- Area for a drill press including wings and clearance either side,
- Workbenches for construction and joinery tasks.

For discussion with user and operators during the design phase is the following:

- Area for a bandsaw, planer, jointer - depending on the user requirement,
- Area for a CNC router bed.



Type A Timber Construction fabrication space – Spatial adjacency diagram

Type B – Metal fabrication workshop area requirements

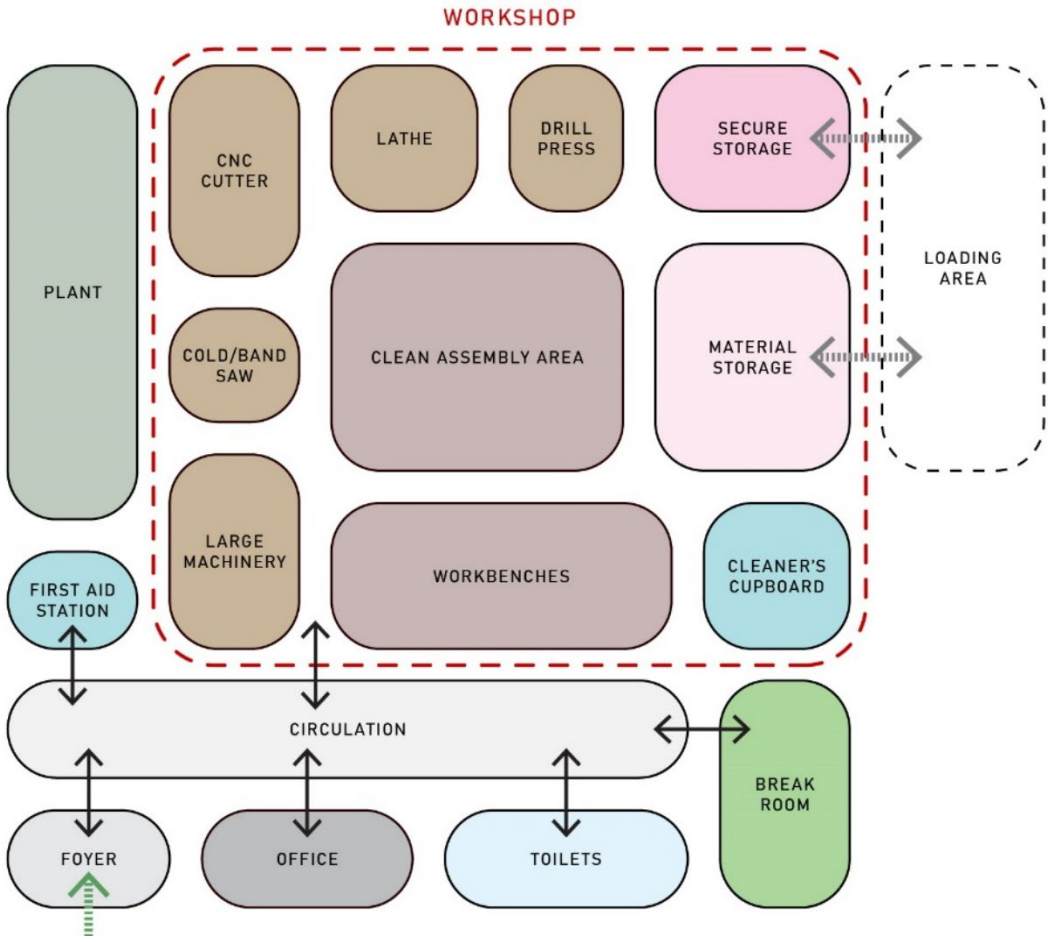
In addition to assembly and general storage areas outlined above, metal fabrication workshops require:

- Storage for incoming metal sheet-goods,
- Storage for incoming long length metal supplies,

- Area for a cold-saw or metal bandsaw, with wings and clearance either side to lay down a 6m length of metal,
- Area for a drill press including wings and clearance either side,
- Area for Metal fabrication workbenches for securing work while welding.

For discussion with user and operators during the design phase is the following:

- Area for a CNC plasma or laser cutter bed,
- Area for a lathe.



Type B Metal fabrication space – Spatial adjacency diagram

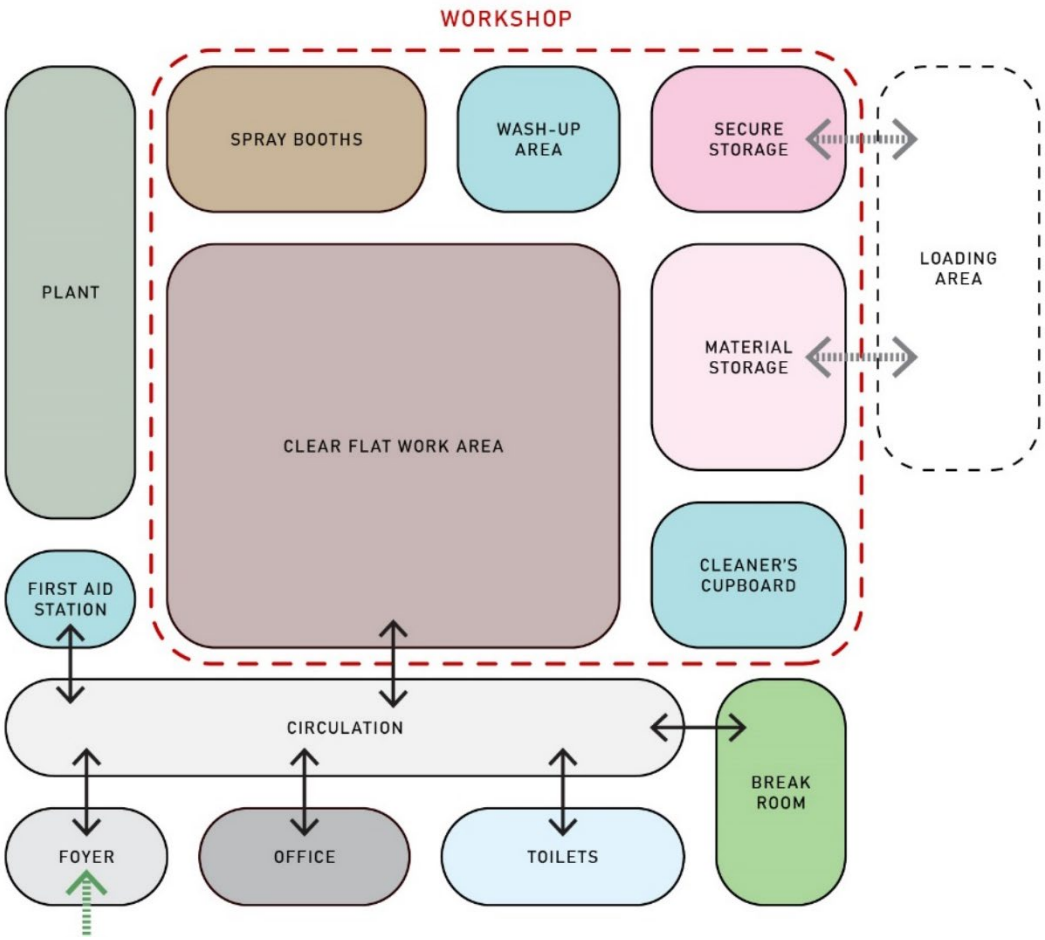
Type C – Paint and scenic application area requirements

In addition to assembly and general storage areas outlined above, metal fabrication workshops require:

- A clear flat area free of obstructions to layout cloths/drapes, flats and large scenic elements for painting,
- Area for industrial grade paint sink and wash-up area. Please refer to Hydraulic engineering.

For discussion with user and operators during the design phase is the following:

- Area for a spray booth.



Type C Paint and Scenic application space – Spatial adjacency diagram

Departure Guidance: The configuration of adjacencies should be developed to suit the specific needs of each project. Key issues to consider are load-in and materials handling, hazardous goods handling, isolation and management of fumes and particulates, and storage. A work area that doesn't have direct access to key functional spaces can be inefficient and can introduce operational health and safety risks.

Spatial requirements

For all three types of fabrication space, a suitable floor area to support the needs of the workshop is inextricably linked to the type and size of work that the space can be used for.

Early engagement with operators and end users is essential as the type of work will dictate the number of staff simultaneously using the space, type and size of area for:

Machinery,

Fabrication/Construction area,

Assembly area,

Storage and **Loading requirements** for the type and quantity of raw materials,

Clear height of 6.5m is preferred throughout the space. Occasional columns are acceptable if coordinated with the overall flow and layout of the space. Columns should be avoided within the assembly areas.

The following area allowances have been provided as an early planning guide:

Office: **10m^2**

Kitchen and Breakout Room: **15m^2**

Changing Rooms**: 1.5 m^2 per person**

Toilets**:** As per **NCC**

Showers: As per **NCC**

Cleaners Cupboard: **2m^2**

All spatial requirements listed above denote Net Internal Area.

Machinery

Close consultation with operators, end users and consultants should inform the type and layout of machinery to create an efficient and safe work environment.

Fabrication/ Construction

Close consultation with operators, end users and consultants should inform the number, type and layout of work benches and other work surfaces to create an efficient and safe work environment.

Assembly Area

The assembly area should be column free with a typical construction of plywood sheets that can be fixed into as needed by the users. The assembly area should be fitted with overhead rigging infrastructure to support the assembly of large and complex items.

Storage requirements

Storage areas for incoming materials and supplies, including up to 8m lengths of materials, 1200mm x 3600mm sheet goods, heavy items, large and/or over-sized item should be provided. The operators and end-users should inform the number, type and area of storage required.

In addition to material storage the following areas should be considered:

- Secure storage areas for tools, consumables, etc.
- Paint and solvent storage
- Forklift storage when not in use, including a charging station.
- Ladders, pallet jack, and other height access and manual handling item storage

Cleaner's cupboard must be provided adjacent to or within the light fabrication space

- Mop sink
- Area to hang wet mops, and brooms

Cupboard to store general cleaning products securely and safely (dustpan & brush, bin liners, cleaning fluids, etc.)

Office

The office should support 1-2 people with sufficient area for two desks, storage, print and copy facilities. Considerations for a large format plotter with the capability to print A0 sheets should be considered. A minimum clear height of 2.4m above finish floor level should be maintained.

Kitchen and Breakroom

The Kitchen is intended only for basic meal prep and reheating of pre-prepared meals. No need to provide an oven and stove top. The kitchen should also allow for food rinsing, utensil washing and the sanitary disposal of associated wastewater.

A minimum clear height of 2.4m above finish floor level should be maintained in the kitchen.

Basic kitchen provision – including a large fridge, microwave, sink and instantaneous hot water boiler for efficient tea and coffee preparation should be provided. A reasonable amount of bench space and some storage should also be provided. Dishwasher may be considered.

The breakroom should be equipped with tables and chairs for staff to sit and eat meals.

Toilets, showers and changing facilities

A minimum clear height of 2.4m above finish floor level should be maintained in the toilet facilities

The National Construction Code of Australia (NCC) sets out the ratio of male and female toilets to the number of occupants, and the specifications for toilets. Provide at least one shower cubicle for every 10 occupants. Showers should have a floor area of not less than 1.8 sqm.

Changing facilities should be provided. The changing room should allow a clear space of no less than 1.5 sqm for each occupant changing at any time. Change rooms should be equipped with lockers for storing clothing and personal belongings. Lockers should be well ventilated, accessible, and secure. There should also be a clear space of at least 1800 mm between rows of lockers facing each other and at least 900 mm between lockers and a seat or wall.

Accessible toilets, showers and changing facilities should also be provided for people with a disability. The National Construction Code of Australia (NCC) sets out the number of accessible toilets, accessible showers and accessible changing facilities required. Layout for accessible toilets, showers and changing facilities should comply with the National Construction Code of Australia (NCC) and the AS 1428 suite of Standards.

First Aid Station

A first aid station should be provided with first aid kit, eye wash station and other key requirements identified by operators and users in their operational risk management assessment.

Floor loading requirements

The floor should be of concrete construction and and/or rated to accept the wheel load of truck or forklift. The floor should have a sacrificial layer of timber with the capacity to be fixed into, either semi-permanently for machinery or temporarily for attaching scenic elements during construction. Refer to structural design requirements for floor load requirements. The slip resistance of the floor surface should be compliant with Australian Standards.

Overhead rigging requirements and access

The assembly and metal fabrication areas should be fitted with overhead rigging infrastructure to support the assembly of large and/or complex items. This may be presented as a distribution of rigging strong points or a beam clamp system. Please refer to Technical Requirements.

The building structure supporting levels above the workshop should be of exposed steel members (such as universal beams) with capacity and suitable flange sizes to temporarily attach beam clamps and chain hoists or chain motors on an as needs basis. This provides suitable point loading for lifting loads, distributed throughout the space wherever structure exists. A services zone should be incorporated above the clear height requirement, including allowance for rigging infrastructure

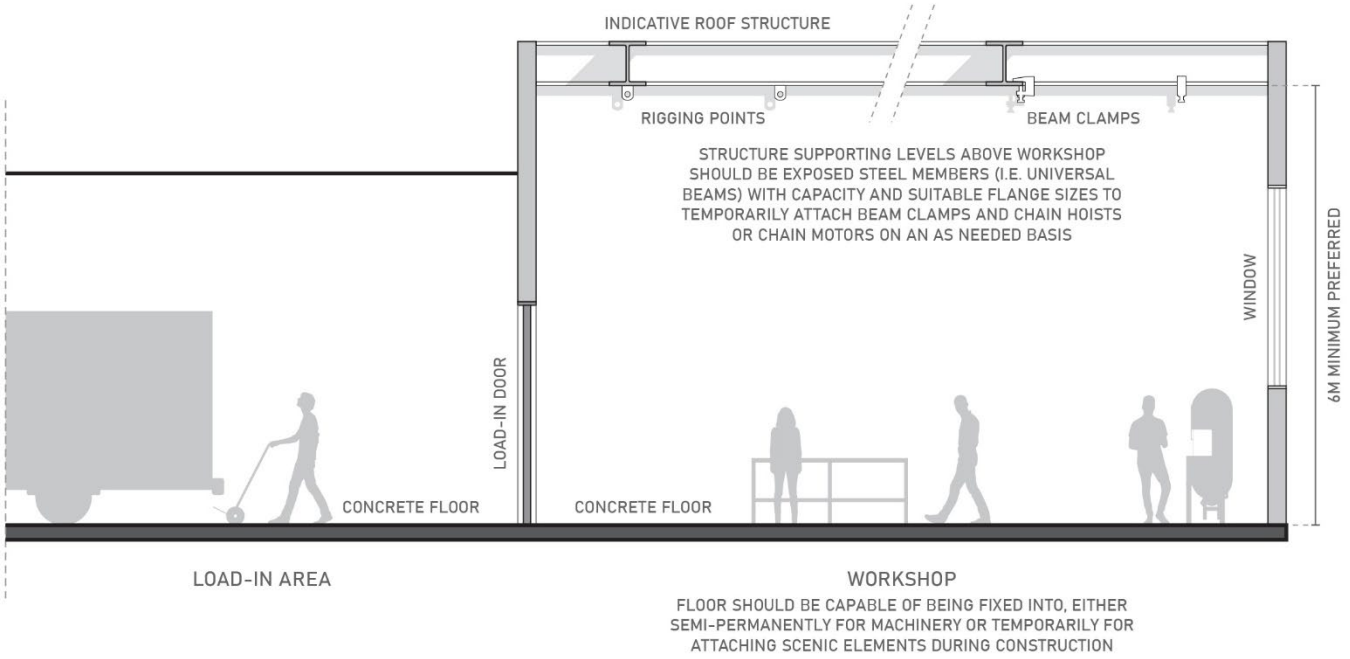
Loading zone and circulation requirements

Preferably the workshop is located at street level and adjacent to a vehicle entryway immediately off the street.

A loading door should be provided, of a size capable of accepting a Heavy Rigid flatbed truck directly into the loading area, adjacent or attached to the workshop. This loading area needs to accommodate the footprint of the truck, plus the footprint, clearance and turning circle of a forklift side-loading the truck.

The loading zone should be flat and level with the workshop floor. Alternatively, the workshop could be raised from the street level and a dock-leveller installed for truck loading/ unloading.

A hoist should be installed over the truck loading area.



Light fabrication space – Sectional diagram

Departure Guidance: Fabrication facilities may require the handling of objects of significant size and weight – both as raw materials as well as finished goods. Access to loading areas should take into consideration at grade and direct 'line-of-sight' movement of goods, floor loading capacity for trolleys, pallet jacks and forklifts, and overhead monorails and gantries. The inability to effectively move and maneuver materials can introduce inefficiencies and occupational health and safety risks.

Additional code compliance requirements

- The extent of on-site storage should be identified at the early stages of design so that the Classification of the space can be correctly determined.
- Work Health & Safety requirements are to be considered in the design of fabrication facilities.
- A Dangerous Goods consultant may be required to assess the presence of Dangerous Goods within a facility.

Technical requirements

Early engagement with the operator and user groups to determine the usage is key to defining technical system requirements. The overall design and capacity of the infrastructure or systems should be determined during design.

Distributed Compressed Air

Compressed airlines should be distributed throughout the Assembly, Fabrication/Construction and Machinery areas.

Rigging Systems

Rigging strong points host a series of hoisting equipment (e.g. chain-motor or chain block) that will subsequently connect to either suspended scenery or art works in both construction and assembly and phases.

Key design requirements outlined below

- Rigging points may be presented as lugs fitted directly to building trusses or ceiling slabs.
- Rigging points should be capable of individually supporting up to 500kg. Simultaneous loading of multiple points to support a distributed load will be required pending detailed design and well-defined use cases for rigging scenarios in consultation with a theatre consultant, operator and end-users.

Please refer to Structural design requirements.

Overhead Access

This area could be accessed via:

- A suitable platform ladder,
- Lightweight portable scaffold tower,
- Height access machinery, such as a vertical lift or scissor lift.

An assessment by the end-user group of the type of height access required, the operational impact, the risk profile, etc. needs to be completed during the design. Sufficient floor load ratings, storage areas, access paths, etc. will need to be assessed to inform a successful design.

Structural design requirements

Load allowances for the industrial fabrication space shall consider the use of space and comply with AS1170.1:2000.

The following load allowances should be considered for rigging infrastructure outlined in Technical Systems requirements.

Rigging Points

- Nominal 3m – 6m centres with a 5kN load capacity per point,
- A defined limit to the number of rigging points that are coincidently loaded should be discussed and agreed with the end user to avoid excessive loading requirements for the overhead structure.
- Rigging to structure is only to occur at agreed rigging point locations.

Generally, the floor shall be designed for:

- 5kPa uniformly distributed load,
- In storage areas, 4kPa for each metre of storage height, but not less than 10kPa,
- Concentration point load of 31kN over a minimum area of 350mm2 for forklift, heavy machinery etc.

Due to the use of space, a concrete floor slab is recommended for the fabrication spaces and a sacrificial topping slab should be considered in the design.

Monorail or similar free-standing cranes may also be required in the space to move heavy machinery. The lifting capacity of the monorail is to be agreed in the design development stage. The design of the high-level structure shall incorporate the localised loading from these cranes if applicable.

Allowances shall also be made to the high-level structure of the fabrication space to accommodate hanging loads for chain hoists, motors etc. Introduction of secondary steel members may be required if fixing to the primary structure is not appropriate. Rigging points of up to 10kN for chain hoists, clamps etc should also be accounted for in the design of the roof structure. Distribution of these

hanging loads and the maximum coincident loads should be reviewed and agreed to avoid excessive loading requirements to the floor / roof structure above the space.

Lighting design requirements

Key lighting design requirements are outlined below:

- The fabrication space should have good general lighting throughout. The average general horizontal illuminance level should meet 600 lux as a base illuminance level. Please see table below for illuminance level target per space type. The general uniformity of the space should meet 0.3 as a minimum.
- Fixtures with indirect or diffuse light sources should be used where possible and care taken to avoid interreflections on metallic finishes.
- Good natural light throughout is preferred. Control of natural light with blinds / shutters / drapes should be provided on all windows and glass surfaces.
- Motion sensors and lighting timers should also be considered to turn off the lighting and conserve energy when room is not in use.
- The colour temperature of the fixtures to be 4000K or 3000K and consistent throughout. In Type C – Scenic workshop tuneable white lighting is required, such that paint finishes can be applied under the same lighting conditions as may be used in a theatre for example.
- LED point sources to be concealed where possible and with a unified glare rating (UGR) of 19 or less. The colour rendering (CRI) of the luminaires to be 90 or higher.
- All lighting should be dimmable, with smooth fading from 0-100%.
- Room lighting should be coordinated and controllable from the Building Management System.
- A local control or over-ride should be provided so the user has control over room. A panic button should be incorporated to instantaneously activate room lighting in an emergency.
- Certain industrial environments require luminaires to be protected against explosion. Please refer to as AS/NZS 60079 series for specific information.
- Task lighting will be required in multiple locations throughout the workshop space. Preprogramed lighting Scenes should be provided with different illuminance levels based on the type of activity being undertaken.

Illuminance levels and task examples from AS 1680.2.4 (Industrial tasks and processes):

Type	Example of tasks performed	Task illuminance target
Difficult Visual Tasks		
A - Timber construction workshop	Woodworking, sawmills and timber processing. Fine bench and machine work, fine sanding, finishing, veneering. Grading and inspection.	600 lux
B - Metal fabrication workshop	Sheet metal benchwork, scribing, inspection.	600 lux
C - Scenic workshop	Extra-fine painting, spraying and finishing.	600 lux
Difficult to moderate visual tasks		

Type	Example of tasks performed	Task illuminance target
A - Timber construction workshop	Wood machining and assembly: machining, sanding and assembly of components. Cabinet making: veneer pressing. Upholstery: filling and covering, mattress making, assembly.	400 lux
B - Metal fabrication workshop	N/A	N/A
C - Scenic workshop	Fine painting, spraying and finishing.	400 lux
Moderate visual tasks		
A - Timber construction workshop	Woodworking, sawmills and timber processing. Sizing, planing, rough sanding, medium machine and bench work, gluing.	320 lux
B - Metal fabrication workshop	Welding and soldering.	320 lux
C - Scenic workshop	N/A	N/A

Emergency Lighting and Exit signs

- AS2293 and NCC Section E4 compliance emergency lighting and exit signs to be provided throughout as required.
- Consideration shall be given to incorporate integrated emergency lighting to the general lighting within the space.

Electrical design requirements

Key electrical design requirements are outlined below:

Electrical requirements

- Incoming power supply to the industrial fabrication space and the power supply authority power metering requirements to be provided based on the incoming power supply to the building and as per local power supply authority requirements.
- A dedicated distribution board must be provided for the fabrication space with separately metered power and lighting as required by NCC and ESD purposes.
- General power outlets to be provided for the user ports and cleaners' outlets around the perimeter.
- Equipment power to be provided for all kitchen equipment together with spare general power outlets within the kitchen bench. Power provisions to be provided for toilets and loading docks as required.
- Power provisions to be provided for all mechanical and hydraulic services equipment and to be coordinated with mechanical and hydraulic services installations.

The fabrication space/workshop will require:

- Various 3-phase outlets for certain machines (with or without neutral, different current ratings, depending on machine),
- Overhead suspended GPO's, above benches and typical work areas,
- GPOs around perimeter and attached to columns throughout the room,
- GPOs at specific tool and machinery locations,
- Power for dust extractors in wood workshop spaces.

Departure Guidance: A detailed assessment of all plant required in the fabrication space should be undertaken to establish total electrical load requirements including fabrication machinery as well as ancillary systems such as extraction systems. Necessary upgrades to incoming power supplies and distribution boards should be weighed up against the operational impacts of not being able to allow concurrent operation of multiple pieces of plant.

Communications requirements

Incoming communication services requirements to be developed based on the building/space requirements. Minimum 10pair Cat 5 cabling connection to be installed from the building distributor to the floor distributor within the fabrication space.

The fabrication space/workshop will require:

- Data and switch with internet connection at the office,
- Some data outlets may be needed within the general workshop space (e.g., if CNC is required then data connection to office will be required).

Electrical design standards and System Criteria

Item	Standards	Criteria
Supply Conditions	• Supply Authority service rules	• 400V 3-Phase nominal. • 50Hz.
Main Switchboard	• AS/NZS 61439 • AS/NZS 3000	• 25% spare space or one spare space (whichever is greatest) for each frame size excluding main switch(es). • Main busbars 125% initial load.
Distribution boards	• AS/NZS 61439 • AS/NZS 3000	• Form 2 unless stated otherwise. • 30% spare space or minimum 18 poles (whichever is greatest) for each frame size excluding local main control). • Local main control required. • Fault interrupt capacity of circuit breakers minimum 6kA. • Provide fault current limiters or use higher fault interrupt capacity circuit breakers as required. • Internal DBs: IP52 minimum. • External DBs: IP56 minimum.
Consumers mains	• AS/NZS 3000	• Voltage drop: Max. 2%.

Item	Standards	Criteria
	• AS/NZS 3008.1	• Maximum demand + 25% capacity (current carrying and voltage drop). • Fire rate where required to AS3000. • At least 100% neutral. Provide oversize neutral where harmonic currents are expected to be high.
Submains	• AS/NZS 3000 • AS/NZS 3008.1	• Voltage drop: 1%. • Maximum demand + 20% (current carrying and voltage drop). • Fire rate where required for Fire and Life Safety Services. • At least 100% neutral. Provide oversize neutral where harmonic currents are expected to be high.
Final subcircuits	• AS/NZS 3000 • AS/NZS 3008.1	• Voltage drop: Max.2%. • Power 2.5 mm² minimum. • Lighting 2.5 mm² minimum. • Max 80% utilisation to AS 3000.
Lighting	• AS/NZS 1680	• Use long life, energy saving lamps such as LEDs. Use tungsten and tungsten halogen only to approval. • Allow overall depreciation factor of 0.8 for clean, air conditioned areas, 0.7 for clean, non-air conditioned areas and 0.6 for dirty areas.
Communications	• AS/NZS 11801	• Provide Cat 6 UTP cabling. • Contain Cat 6 cable route length to <90m. • Cross power cables only at 90°. • The maximum fill of a cable tray shall not exceed 50%.
Electrical Metering and EMS system	• NCC Section J6 • Supply authority standards	• Meters and CTs shall comply with NCC and supply authority standards.

Acoustic design requirements

Acoustic design considerations

The acoustic outcomes will be influenced by the site location, internal design and interface with surrounding development. The key design factors include:

- Environmental noise and vibration emission,
- Internal design noise and vibration levels,
- Environmental noise intrusion,
- Building services noise and vibration control,

- Internal acoustic separation, including spatial planning and physical isolation, and
- Room acoustics (e.g. reverberation).

Departure Guidance: Noise emissions from fabrication spaces are typically subject to their own council guidelines. Careful evaluation of typical and maximum noise levels for fabrication plant should be developed to inform what noise mitigation measures might be required to avoid noise impacts to neighbours. Typical noise mitigation approaches may introduce operational impacts i.e. a workshop may need to operate whilst loading dock doors are open meaning that the loading dock door is not a suitable noise mitigation mechanism.

Design criteria and management requirements

Item	Criteria and requirements
Environmental noise and vibration emission	• Minimum requirements will be according to Council consent requirements and will be dependent on surrounding or adjoining development. Due regard must be given to any requirements or expectations for natural ventilation. • The design must be based on the full operating hours of the space and maximum noise and vibration levels potentially generated by the use. Activities may include use of welders, grinders, saws, compressors, etc. • Consideration must be given to noise generated by the use of loading docks, which should allow for use late at night and early in the morning to coordinate with load-in times at performance spaces. • The acoustic design requirements will be heavily influenced by the proximity and sensitivity of nearby or adjoining receivers. Site location will be critical to minimising design requirements and maximising operational flexibility.
Internal background noise and vibration levels	• Criteria relate to the noise and vibration in the space excluding occupant activity. • Internal background noise levels, from both environmental noise intrusion and internal plant and equipment should not exceed the lower bound design sound level range in AS/NZS 2107:2016 by more than 5 dB. This would typically be assessed with any operable windows closed. • Internal background vibration not to exceed the maximum levels in British Standard BS 6472:2008.
Internal acoustic separation, including spatial planning and physical isolation	• Vibration and structure borne noise from equipment and activities within the workshop must be factored into the building design and siting.
Room acoustics	Reverberation should be minimised for noise control, occupant comfort and space functional requirements. In the absence of specific recommendations in AS/NZS2107:2016, reverberation times should not exceed Curve 2 in Appendix A.

Fire safety design requirements

Key fire safety design requirements are outlined below:

- Fire exits and egress routes are to be in accordance with the requirements of the NCC. Where temporary equipment or props are expected, management provisions are to be implemented to prevent blocking of the exits and egress routes.
- Fire safety systems are to be provided in accordance with the requirements of the NCC. Smoke detection is generally unsuitable for fabrication spaces, due to the heightened likelihood of false alarm. An alternative means of detection is to be provided in areas prone to false alarm.
- Sprinkler systems are generally recommended within fabrication facilities. Their inclusion within a facility is to be considered on a case-by-case basis in line with the requirements of the NCC.
- A Dangerous Goods Consultant is to be engaged to assess hazards associated with the presence of Dangerous Goods. Any Fire Engineering Performance Solutions are to consider the ignition sources and goods present within a facility.
- Audibility of the Occupant Warning System is to be considered. Competing sound systems are to shut down in accordance with AS1670.1-2018 clause 3.22.3. The placement of occupant warning speakers is to consider any sound-proofing measures within the facility. Visual warning devices are to be located in areas where portable sound systems may be used.
- Linings are required to meet the Fire Hazard Property requirements outlined in C1.10 of the NCC. This requirement is to be considered in conjunction with any acoustic or sound proofing linings.

Hydraulic design requirements

- Domestic water and sanitary drainage are to be provided to any kitchens, toilets and cleaners sinks which are part of the space.
- Where the space forms part of a building, domestic water services should be metered separately from the base building supply to allow landlord billing of water use.
- Mechanical condensate should drain to the sanitary system via a trapped tundish.
- Domestic hot water should be generated local to the space and consider the frequency of use. Where spaces are used infrequently, instantaneous electric hot water generation is preferred to avoid energy associated with heat losses. Where the space is used daily, electric storage may be more appropriate.
- Wastewater pre-treatment is to be provided to paint wash up areas in accordance with Sydney Waters trade waste guidelines and should typically be a paint or oil separation device.
- A compressed air system with centralised air compressor is to be installed to provide compressed air for pneumatic air tools.
- Facilities should be made available for oxy - acetylene welding equipment to be stationed within the space to undertake welding work.

Hydraulic design criteria

The Hydraulic Services design is to be based on the following design criteria.

System	Standards	Design Criteria
Domestic hot and cold Water	• BCA 2019 Amdt. 1	• Cold water average supply temp: 14°C. • Hot water storage: 60°C – 65°C.

System	Standards	Design Criteria
	• AS/NZS 3500.1 – 2018 • AS/NZS 3500.4 - 2018	• Hot water distribution: 55°C-60°C. • Amenities (visitor and non visitor): 43°C. • Utility rooms (kitchens, cleaners sinks): 50 to 55°C. • Max velocity: 2.4m/s externally and in ground. • Max velocity: 1.5m/s in risers, BOH spaces. • Max velocity: 0.8m/s in acoustically sensitive spaces. • Min operating pressure: 200kPa. • Max operating pressure 500kPa.
Sanitary Plumbing and Drainage, and trade waste	• BCA 2019 Amdt. 1 • AS/NZS 3500.2 – 2018 • Sydney Water Trade Waste Guidelines	• Minimum grade: 2.5% for 40-65mm, 1.65% for 80-100mm and 1% for 150mm pipelines. • Sanitary stacks design capacity: 22% to 0.33% full. • Drainage design capacity: Max 70 % full. • Velocity: 0.75m/s to 1.2m/s.
Building Rainwater Drainage	• BCA 2019 Amdt. 1 • AS/NZS 3500.3 – 2018 • Australian Rainfall and Runoff Guidelines • City of Sydney requirements	• Flat roofs, box gutters – 5min 1% AEP. • Eaves gutters – 5min 5% AEP. • Climate change allowance +10%. • Full capacity overflows to be provided to all building rainwater drainage catchment areas. • Velocity: 0.75m/s to 1.2m/s. • Siphonic drainage velocities to be confirmed by hydraulic calculation, insulation where required to limit noise in noise sensitive areas.

Mechanical design requirements

Key mechanical design considerations and requirements are outlined below:

General mechanical requirements

- Separate mechanical systems shall be provided to serve the Timber Construction, Metal Fabrication and Paint/Scenic Application areas. Each system shall be activated as required to avoid unnecessary energy usage. Operation of these systems should be either programmed (for the larger spaces) or based on occupancy sensing (for small offices etc). For workshop spaces, general exhaust is recommended over air conditioning as it is expected the workshop will have access to large openable doors and windows to facilitate working in natural light and aid in dilution of hazardous airborne particles/chemicals.
- If mechanical extract is provided, it is recommended that local heating is provided in winter to temper the space. Electric radiant heaters at high level are recommended for this application. Any heating/cooling provided must be in line with NCC Section J requirements.
- If provided with active air conditioning:
    - Appropriate filtration should be provided based on the materials which are expected to be used in the space.
    - CO2 sensors shall increase the outside air proportion to the space in response to high CO2 levels. The mechanical equipment shall be sized to maintain internal temperatures and deliver increased outside air at high ambient temperatures.

    - Mechanical system shall be variable volume, responding to temperature and CO2 levels within the space (wall-mounted temperature and CO2 sensors shall be installed at 1500mm AFFL inside the space). Sensors should be installed in areas that will be representative of the conditions inside the space.
    - If system supplies >1000 l/s, economy mode shall be provided in line with NCC 2019 Section J requirements. Economy mode should be offered with smaller units to achieve energy reductions.
    - Increased outside air (50% above code minimum is recommended) in normal operation (This is recommended to be delivered via openable windows).
- Relevant ASHRAE and CIBSE external design criteria shall be used. Consideration should be given to future climate change and resultant elevated ambient design temperatures.
- Consider pressure gradient within the fabrication spaces to ensure the air path is from clean to dirty to prevent contamination of clean spaces.

Departure Guidance: design of mechanical systems to achieve minimum safe levels of emissions, gases, airborne particulate etc. should not be compromised. Careful attention should be paid to the types of emissions being generated by all items of fabrication plant and appropriate mitigation measures be put in place including isolated booths, fume cupboards / hoods, and extraction systems etc.

Workshop Spaces – Type A, B and C

- For workshop spaces, general exhaust is recommended over air conditioning as it is expected the workshop will have access to large openable doors and windows to facilitate working in natural light and aid in dilution of hazardous airborne particles/chemicals.
- For spaces with a floor-to-ceiling height of 4-6m, minimum air change rate of 6 air changes per hour to be achieved.
- For spaces with a floor-to-ceiling heigh >6m, minimum air change rate of 8 air changes per hour to be achieved.
- All ductwork to be above rigging zone OR can be wall mounted as long as it doesn't clash with other services.
- Sufficient makeup air shall be provided at regular spacing within the space. This air shall generally be filtered and delivered at a range of low and high level to ensure particles are adequately removed from the space.
- For mechanical sizing, internal gains within each space shall be based on increased metabolic rates to reflect high activity level within workshop.
- For areas within the workshop with significant sources of wood dust, metal filings, fumes, exhaust and the like, installation of a Nederman Arm (or similar moveable extraction arm) is required to directly remove particles from the space. The system should be centralized for redundancy and energy efficiency.
- If an air compressor is to be used, design is to be in accordance with the relevant standards and an extract system will be installed adjacent to keep the area clean.

Timber workshop Area – Type A

- The woodworking area is to be acoustically sealed from other spaces. Provide acoustic makeup air paths to provide sufficient ventilation to this area.
- For the woodworking area, provide a dedicated dust extraction system (Nederman or similar) which safely operates with high temperature wood dust.

Painting area – Type C

- For areas with paint, provide flammable storage cabinets. Dangerous Goods Consultant should be engaged to review the materials to be stored and advise the size of cabinets for storage.

- If a painting booth is provided, this should be provided with a dedicated extract system.
- If highly toxic/flammable materials such as paint, glue, epoxies, etc. is to be used, provide fume cupboards with appropriate extract.

Assembly Space – Type A, B and C

- The clean assembly space should be appropriately separated from other spaces and the exhaust rate in this space should be such that particles from the other fabrication spaces do not enter this space.

Storage areas

- Provide ventilation in line with AS1668.2 and if storing any batteries, or other flammable materials, provide ventilation in line with relevant code requirements. Extract systems shall not be combined unless permitted in AS1668.2.

Support Spaces (Small Office, Break Room)

- Office is to be provided with air conditioning, with internal temperature controlled to 21-24 degrees Celsius. Humidity will be uncontrolled but will generally be in the range of 40-60% RH.
- The break room is to be provided with air conditioning, with internal temperature controlled to 21-24 degrees Celsius. Humidity will be uncontrolled but will generally be in the range of 40-60% RH. Provide sufficient ventilation based on size and usage of the break room, with local extract provided to capture fumes from small-scale food reheat, dishwasher, microwave and other heat-emitting appliances.

Other Areas

- Ventilation of toilets and change rooms to be in line with AS1668.2 requirements (change rooms may be conditioned by a small FCU/PAC if desired to provide additional comfort for occupants). It is recommended extract ventilation is 200% of code minimum to ensure odours are effectively removed from the space.
- Cleaners store (if required) to be exhausted directly to outside in line with AS1668.2 requirements.
- Rooms should be provided with outside air in line with AS1668.2, or battery ventilation in line with AS2676 if housing any type of batteries.

Fire engineering/ Smoke Control

- If smoke exhaust is required, all components are to be compliant with AS1668.1 requirements. Smoke exhaust strategy to be agreed with Fire Engineer.

Design Criteria

External design criteria	ASHRAE or CIBSE current guidance
General Ventilation	AS 1668.2:2012
Smoke Control Ventilation	AS 1668.1:2015
Battery Ventilation	AS 2676.1:2020
Refrigerant	AS 5149:2016
Storage and Handling of Flammable and Combustible Liquids	AS1940

Fume Cupboard	AS2243.8/2243.9
Compressed Air	AS1210, AS1271, AS3873, AS3788, AS3892, AS4041, AS4343

In addition, the design should be compliant with the following codes and standards:

- 2019 National Construction Code / Building Code of Australia (BCA),
- Building Permit conditions,
- AS1668.1 (2015) – Fire and Smoke Control in Multi-Compartment Buildings (Amendment 1),
- AS1668.2 (2012) – Mechanical Ventilation in Buildings (Amendment 1 and 2),
- AS1668.4 (2012) – Natural Ventilation of Buildings,
- AS 1940 (2004) – The Storage and Handling of Combustible Liquids,
- AS/NZS 2107 (2000) – Recommended Design Sound Levels and Reverberation Times for Building Interiors,
- AS 3000 – Electrical Installations,
- AS 3500 – National Plumbing and Drainage Code,
- AS 3666 (2011) – Air-handling and Water Systems of Buildings – Microbial Control,
- AS 4254.1 (2012) – Ductwork for Air-Handling Systems in Buildings – Flexible Duct,
- AS 4254.1 (2012) – Ductwork for Air-Handling Systems in Buildings – Rigid Duct,
- AS/NZS 5601.1 (2013) – Gas Installations – General Installations,
- All other applicable Australian Standards,
- WorkCover requirements,
- OH&S Regulations,
- Safe Work Australia,
- Electricity Supply Authority requirements,
- Fire Brigade requirements,
- Australian Gas Authority requirements,
- All Local Council regulations,
- Fire Engineering Report.

Pipework Velocity and Pressure Drop

The following values shall not be exceeded:

- Pipework pressure drop: 300 Pa/m,
- Pipework velocity:

Diameter (mm)	Velocity (m/s)
25	1
50	1.1
100	1.25
150	1.5
200	2
250	2.2
300	2.5

Ductwork Velocity and Pressure Drop

The following values shall not be exceeded:

Ductwork Velocity – Variable Volume Systems (Final velocity to be agreed with Acoustic Consultant depending on acoustic requirements of the space)

- Risers and plantrooms: 7.0 m/s,
- In ceiling secondary ductwork: 5.0 m/s,
- In ceiling tertiary ductwork: 3.5 m/s,
- Flexible ductwork: 2.5 m/s,
- General duct discharges: 6.0 m/s,
- Louvers: 2.5 m/s face velocity.

Ductwork Pressure Drop

- General ductwork: 0.8 Pa/m,
- Transfer ducts: 12 Pa,
- Riser take-offs: Kt £ 0.89,
- Bends: Kt £ 0.25,
- Rectangular contractions: Kt £ 0.19.

Where the total pressure loss through the fitting is defined as Pt = Kt × Pv:

- Pt = Total pressure loss through fitting (Pa),
- Kt = Loss coefficient,
- Pv = Velocity pressure (Pa).

Mechanical Equipment and Accessories Pressure Drops

The following values shall not be exceeded:

- Sound attenuators: 50 Pa,
- Louvres: 20 Pa,
- Cooling coils (airside): 150 Pa,
- Cooling coils (waterside): 35 kPa.

Glossary

Access To Premises Standard · The Disability (Access to Premises – Buildings) Standards 2010 (Premises Standards) is legislation under the Disability Discrimination Act 1992. The purpose of the Disability Standards for Access to Premises is to make sure: people with disability and their family members, carers and friends, have equal access to public buildings; and building certifiers, developers and managers fulfil their responsibilities to people with disability under the Disability Discrimination Act 1992.

AFFL · Above Finish Floor Level.

AISC· American Institute of Steel Construction.

Amdt · Amendment.

Amp · Ampere.

AS · Australian Standards are published documents setting out specifications and procedures designed to ensure products, services and systems are safe, reliable and consistently perform the way they are intended to. They establish a minimum set of requirements which define quality and safety criteria. Standards Australia develops internationally aligned Australian Standards.

AS/NZS · Australian/New Zealand Standards. Joint standards developed by Standards Australia and Standards New Zealand.

ASHRAE · American Society of Heating, Refrigerating and Air-Conditioning Engineers.

AV· Audio Visual.

back of house (BOH) · A term used to refer to the support spaces for the stage, most often immediately adjacent to the stage. This includes dressing rooms, storage rooms, loading dock. This term can also be used to refer to the rear of the auditorium.

BCA · Prior to the creation of the NCC, building was regulated by the Building Code of Australia (BCA), and had been since 1992. The BCA was the first collection of nationally-consistent building regulations. The BCA was superseded by NCC.

catwalk · A steel structure over the stage, audience area, or both, used by stage personnel to cross from one side of the house to the other, often used to support lighting instruments.

CISBE · Chartered Institution of Building Services Engineers.

CNC · Computer Numerical Control router.

control room · The dedicated zone or room from which the lighting, sound and AV equipment is operated during a performance.

CT· A Current Transformers.

DB · Distribution Boards.

dB(A) · The unit generally used for measuring environmental, traffic or industrial noise is the A-weighted sound pressure level in decibels, denoted dB(A). The weighting is based on the frequency response of the human ear and has been found to correlate well with human subjective reactions to various sounds.

It is worth noting that an increase or decrease of approximately 10 dB corresponds to a subjective doubling or halving of the loudness of a noise, and a change of 2 to 3 dB is subjectively barely perceptible.

DCP · Development Control Plans. DCPs provide detailed planning and design guidelines to support the planning controls in the Local Environmental Plan.

DDA · Disability Discrimination Act.

decibel · Measure of loudness of sound (pressure) level. For convenience, this is calculated on a logarithmic measurement scale.

DGPO · Double General Power Outlets.

DMX · *(Digital Multiplex)* is a standard for digital communication networks that are commonly used to control stage lighting and effects.

DSP · Digital Signal Processer.

DX · Direct Expansion.

EP&A Regulations · Environmental Planning and Assessment Regulation. The EP&A Regulation contains key operational provisions for the NSW planning system.

ESD · Ecologically Sustainable Development.

FCU/PAC· Fan Coil Unit/Packaged Air Conditioning Unit.

fire curtain · A non-flammable, vertical travel curtain immediately behind the proscenium, contained in the smoke pocket, used to protect the audience from possible smoke and fire originating from the stage. It is typically rated for 30 minutes of protection.

frequency · The subjective equivalent of frequency in music is pitch. Higher frequency sounds have a higher pitch. The unit of frequency is the Hertz (Hz). Human hearing ranges approximately from 20 Hz to 20 kHz. For design purposes, the octave bands between 63 Hz to 8 kHz are generally used.

front of house (FOH) · A term typically used to collectively refer to the support areas immediately adjacent to the auditorium. This includes the lobbies, restrooms, cloak check, gift shop and box office.

GPO · General Power Outlets.

Green Star · A Green Star rating provides independent verification that a building or community project is sustainable. Undertaking voluntary Green Star certification demonstrates leadership, innovation, environmental stewardship and social responsibility.

Hz · Hertz.

IP · Ingress Protection rating.

ISructE · Institution of Structural Engineers.

l/s · Litres per Second.

LED · Light Emitting Diode.

Loudness · Loudness provides for an exciting and dramatic aural experience and allows the musical director maximum dynamic range. The loudness of sound varies throughout an auditorium, and is equated to the distance from the stage to a listener.

m · Metres.

m/s · Metres per Second.

m^2 · Square metre.

NABERS · National Australian Built Environment Rating System (NABERS). NABERS is a simple, reliable sustainability rating for the built environment. This helps building owners to understand their building's performance versus other similar buildings, providing a benchmark for progress.

National Construction Code (NCC) · The National Construction Code is Australia's primary set of technical design and construction provisions for buildings. As a performance-based code, it sets the minimum required level for the safety, health, amenity, accessibility and sustainability of certain buildings. The Australian Building Codes Board, on behalf of the Australian Government and each State and Territory government, produces and maintains the National Construction Code.

noise criteria (NC) · The Noise Criteria (NC) curves are commonly used to define building services noise limits. The NC value of a noise is obtained by plotting the octave band spectrum on the set of standard curves. The highest value curve which is reached by the spectrum is the NC value. Shown below is a plant noise spectrum that is equivalent to NC 40.

OH&S regulations · The Occupational Health and Safety (OH&S) Regulations build on the OHS Act. They set out how to fulfil duties and obligations, and particular processes that support the Occupational Health and Safety Act.

preferred noise criteria (PNC) · A set of curves, similar in principle to NC curves, but considered to correlate better to subjective acceptability in very low noise areas such as music auditoria.

reverberation · The principal, subjective acoustic quality perceived by the majority of listeners in an auditorium is reverberation. This is most commonly experienced at the end of stop chords as the sustained sound that rings in the space. Reverberance assists the sustain of musical instruments and the blending of the orchestra sections. It also contributes to the feeling of envelopment, i.e. that the sound comes from all around you.

RMS Compressor · Root Mean Squared compressor.

Sqm · Square metre.

typical noise levels · Some typical noise levels are given below:

Noise Level dB(A)	Example
130	Threshold of pain
120	Jet aircraft take-off at 300 ft
110	Chain saw at 3 ft
100	Inside disco
90	Heavy trucks at 15 ft
80	Sidewalk of busy street
70	Loud radio (in typical domestic room)
60	Office or restaurant
50	Domestic fan heater at 3 ft

Noise Level dB(A)	Example
40	Living room
30	Movie Theatre
20	Remote countryside on still night
10	Sound insulated test chamber
0	Threshold of hearing

UDL · Uniformly Designed Load. A uniform distributed load is a force that is applied evenly over the distance of a support.

UTP · Unshielded Twisted Pair Cabling.

WELS · Water Efficiency Labelling and Standards (WELS). WELS is Australia's water efficiency labelling scheme that requires certain products to be registered and labelled with their water efficiency.

wings · Areas on stage left and right of the proscenium opening edge not in direct view of the audience. The wings are used as a space for actors or scenery waiting to go on stage.