# Creative Spaces Design Guide

PART 3K
TECHNICAL APPENDIX:
**FABRICATION SPACE: LIGHT-INDUSTRIAL**

CREATIVE VICTORIA ARUP

CITY OF MELBOURNE CITY OF SYDNEY

## We acknowledge the Traditional Owners of Country throughout Victoria and their ongoing connection to this land and water. We pay our respects to their culture and their Elders – past, present and future.

In preparing these guides, we acknowledge that First Peoples self-determination is a human right as enshrined in the United Nations Declaration on the Rights of Indigenous Peoples.

We also acknowledge that past injustices and continuing inequalities experienced by First Peoples have limited, and continue to limit, their participation in all land and resource management[1], including development of creative spaces.

Creative spaces exist on land for which sovereignty has not been ceded and, as such, development, design and operation of creative spaces should involve consultation with First Peoples and Traditional Owners. Engagement and operation must be carried out in a culturally safe manner.

Any use of First Peoples design should follow the principles outlined in the International Indigenous Design Charter[2], which stipulates that First Peoples must have opportunity to meaningfully participate in and influence design and development processes that affect their Country and community.

**Artist — Dixon Patten, Yorta Yorta and Gunnai**
*This artwork, commissioned in 2019 by the (then) Victorian Department of Jobs, Precincts and Regions is about developing the economy by working with community to create First People's employment opportunities, supporting inclusion and economic prosperity and thriving First Peoples' communities.*

*The symbolism used represents opportunities for First Peoples to achieve personal and economic prosperity and improved employment outcomes, the diversity of First Peoples' knowledge, skills and resources in community, and the connection to cultural practices and ceremonies.*

**Terminology:**
First Peoples – Throughout this document the term Victorian First Peoples is used to refer to Traditional Owners of Victoria and all other Aboriginal and Torres Strait Islander peoples who reside in this state.

Culturally-safe Spaces[3] – Culturally-safe spaces are built environments, places, areas, groups, dialogues or bodies of work that positively and proactively acknowledge, accept and provide for the inclusion of the full spectrum of diversity of participants in that space. They are empowering places of mutually-beneficial exchange, personal and collective growth, and strength-based approaches.

For First Peoples, culturally safe spaces are places where imbalances of power, primacy and status are identified and structural adjustment is made to ensure equitable conditions are achieved and maintained. Culturally safe spaces are cognisant of, and proactively provide cultural safety at all levels of operation.

1. DELWP, see Traditional Owner and Aboriginal Community Engagement Principles on page 10 https://www.delwp.vic.gov.au/__data/assets/pdf_file/0031/508099/Traditional-Owner-and-Aboriginal-Community-Engagement-Framework-compressed-2.pdf

2. The International Indigenous Design Charter, see Guiding Principles on page 8 at https://indigenousdesigncharter.com.au/international-indigenous-design-charter/

3. More information can be found via the UTS Design Index. http://www.utsdesignindex.com/researchmethod/culturally-safe-spaces/ and the Victorian Government's cultural safety framework: https://www.dhhs.vic.gov.au/publications/aboriginal-and-torres-strait-islander-cultural-safety-framework

# Contents




**Cover: AFC's 2019 film Curated AFC**
**Credit: Noel Smyth**
**Prepared by Arup for Creative Victoria, Office of the Victorian Government Architect, City of Melbourne and City of Sydney.**

# Introduction

An abundant and diverse supply of creative space is essential to support a productive cultural sector. Due consideration for the operational, spatial, and technical requirements of these creative spaces can better support the functions and meet the needs of its users, operators and the community for the long-term.

Designing and delivering creative spaces that are fit for purpose will amplify its creative potential as well as increase operational efficiency, in turn reducing costs to the owner and/or operator.

## Purpose of the technical appendices

The technical appendices to the 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, and not all aspects will be applicable or achievable for every project.

These appendices are technical in nature, relating to program, spatial requirements, structure, amenity and serviceability of space. Readers of these technical appendices 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 proposed creative space. In particular, these technical appendices should be read in conjunction with **Part 1: Making space for creativity** and **Part 2: Principles for creative spaces** of this document which provide a wider context within which creative spaces are typically conceived and delivered.

These technical appendices 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. They prioritise spaces that were identified through consultation as being in high demand and low supply. Guidance on other types of spaces are intended to be added in future iterations.

## How to use the technical appendices?

The technical appendices to the Creative Spaces Design Guides are intended to provide a preliminary technical brief prior to undertaking design work. These technical requirements include architectural, engineering and specialised design advice. The technical appendices:

— are aimed at providing 'best in class' outcomes and should be considered as a foundation for the development of detailed design briefs 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 technical appendices

The intended audience and users of these technical appendices might include (but not limited to):

— 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.

## Appendix structure

The first section titled **Key principles for designing creative spaces** provides guidance applicable equally across all space types and important considerations that need to be addressed alongside the technical framework of these appendices. These include:

— End-user and operational needs
— Project process
— Procurement
— Code compliance
— Departure guidance

The second section identifies the following technical requirements of a light fabrication space:

— Programmatic – key spaces and spatial relationships
— Spatial – key dimensions and spatial relationships
— Technical systems – specialised equipment relevant to functions of the spaces
— Universal design
— Sustainability
— Structural engineering
— Lighting
— Electrical engineering
— Acoustics
— Fire engineering
— Hydraulic engineering
— Mechanical engineering

A glossary section is included for reference.

# Key principles for designing creative spaces

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.

## Embedding good design in a creative space

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 Victorian Government Architect recognises the critical need for good design. The 'Good design - Issue 1' publication by the Office of the Victorian Government Architect identifies that:

*"Good design comes in many forms and is defined by much more than how something looks. It refines the purpose and aspiration of a project, improves how it works, creates additional benefits and elevates how people feel and behave in the final outcome. Good design creates inspiring places and greater, lasting financial value. And of course, good design also looks and feels good."*

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

— User and operational needs
— Project processes
— Efficient procurement of goods and services
— Compliance with codes and standards
— Universal design
— Sustainability
— The local, national and international arts and culture ecosystem

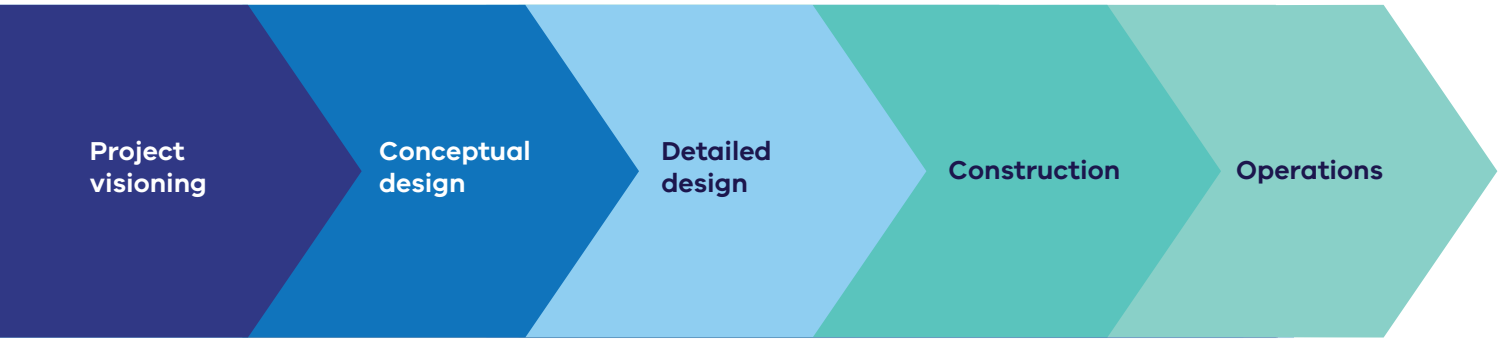
## Operational and end-user needs

Early and ongoing engagement with operators, user groups and other stakeholders is a key component in the successful delivery of creative space projects. The establishment of critical success factors with primary stakeholders lays the foundation for the development of spatial, operational and management structures. The conception 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 ecosystem.

Accordingly, defining operational and end-user needs is often the first step in a project delivery process.

## Project process

These technical appendices provide the key requirements for best practice design. However, design itself does not guarantee good project outcomes. Design of creative spaces is part of a bigger 'process' of project delivery, and these technical appendices are a tool to be deployed throughout a project process that can provide differing points of value. The diagram below outlines one possible project process.



Ultimately, the success of the technical appendix will be realised through its application throughout a design and delivery process. The appendix is intended to be used as a reference at different phases of a project, as well as serving as a tool to facilitate collaborative discussions as project details unfold during design and construction. The table below presents some examples of how the technical appendix may be of value at each phase in the project process.

**Project visioning** - Project inception phase where site is selected, vision and direction of the project is established.

| 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 with 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 requirements 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** - Project phase in which the creative space is designed fit for purpose to meet user and stakeholder needs.

| POTENTIAL USES | EXAMPLE OF USAGE |
|---|---|
| Assist a property developer to determine appropriate creative infrastructure aligned to a development vision | The technical appendix establishes 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 recognises that the technical appendix is 'best practice' and can be de-scoped 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** - Project phase in which technical documents including construction documentation is produced.

| POTENTIAL USES | EXAMPLE OF USAGE |
|---|---|
| Detailed design and engineering requirements to be used as 'basis of design' for project design team | The technical appendix provides a clear set of functional and performance design criteria that needs to be delivered unless otherwise agreed – for example: can the appropriate background noise levels be met against the nominated criteria or has the design team agreed to relax them for this project? |

**Construction** - Project phase in which the creative space is constructed on site.

| POTENTIAL USES | EXAMPLE OF USAGE |
|---|---|
| Provide a reference point for collaborative discussion between stakeholders, designers and builders as projects are being delivered | The technical appendix is 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** - Ongoing phase that includes operation and maintanence of the creative space.

| POTENTIAL USES | EXAMPLE OF USAGE |
|---|---|
| Post-occupancy validation | Has the intended functionality and performance been delivered? |
| Real world implementation of technical appendix used to provide lessons learned for future refinement of the technical appendix | Feedback, such as if aspects of the guidance prove to be persistently difficult to practically achieve, can be recorded and submitted. |

## Procurement considerations

Procurement methodologies – for both design and delivery, should be structured in a way 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 technical appendix, and each project will require its own specific procurement methodology.

Below are some examples of strategies that might be included within the procurement process 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 should 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 National Construction Code of Australia (NCC) and all relevant associated Australian Standards (AS).
— A building regulations consultant and an accessibility consultant should be engaged to provide comprehensive advice and compliance check throughout design and documentation.
— For a change-of-use and/or works within an existing building, the building regulations consultant is to assess the extent of upgrade required for compliance in line with Clause 62 and 64 of the Environmental Planning and Assessment (EP&A) Regulations (NSW) and Building Regulations 2018 (Victoria). This assessment should be carried out in the concept phase of a project (pre development application in NSW).
— In an existing building, 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 requisite level of upgrade.
— Part H of the NCC will apply to Class 9b spaces. In Victoria, if the space is a 'Place of Public Entertainment' (as defined in the Building Act 1993 and prescribed in the Building Regulations 2018), then part VIC Part H102 will apply. In NSW, if the space is an 'Entertainment Venue' (as described in the EP&A Regulations), then part NSW H101 of the NCC will apply.

## Departures from the technical advice in these appendices

These technical appendices articulate a set of functional and performance requirements that should be considered in the delivery of a creative space project. However, it is not always possible, or appropriate, to achieve best practice outcomes. The design should principally align with the capability and expectation of key users and stakeholders. Misalignment between design and user/stakeholder expectations may result in creative spaces:

— that are not fit-for-purpose
— that are operationally burdensome
— that don't align to their broader built environment

These technical appendices represent best practice and are intended to be a 'point of departure'. Stakeholders should be empowered to descope from these requirements where appropriate. It is crucial that users are advised by a design, architectural, engineering and consultant team who understands and can explain the implications of descoping these requirements.

**DEPARTURE GUIDANCE**

Throughout the technical appendix document, there are boxes formatted in this style. These boxes contain commentary on the potential implications of descoping against specific requirements. Please note that 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.

# Fabrication space: Light-industrial

Light fabrication spaces provide construction environments 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**

A light fabrication workshop will:
— Typically operate from 7am – 6pm
— Occasionally operate outside of normal hours.
— 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 (including text, pictogram, visual, tactile and audible options)

## Type A – Timber construction workshop area requirements

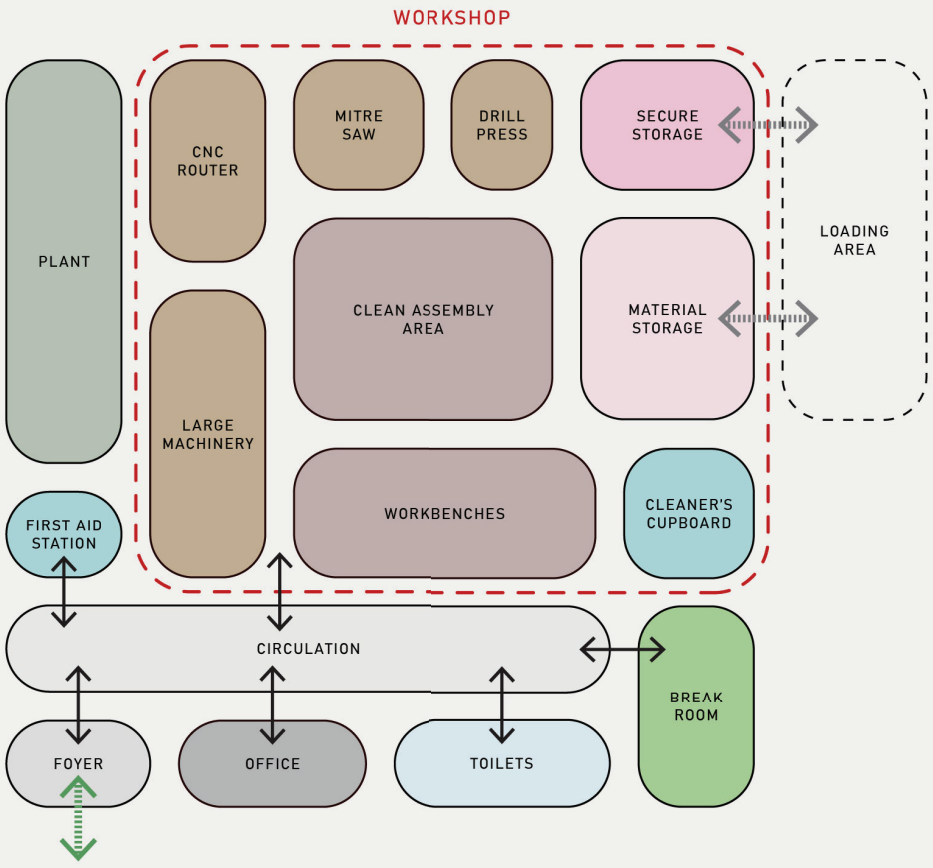
In addition to assembly and storage areas outlined above, timber construction workshops require:

— 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

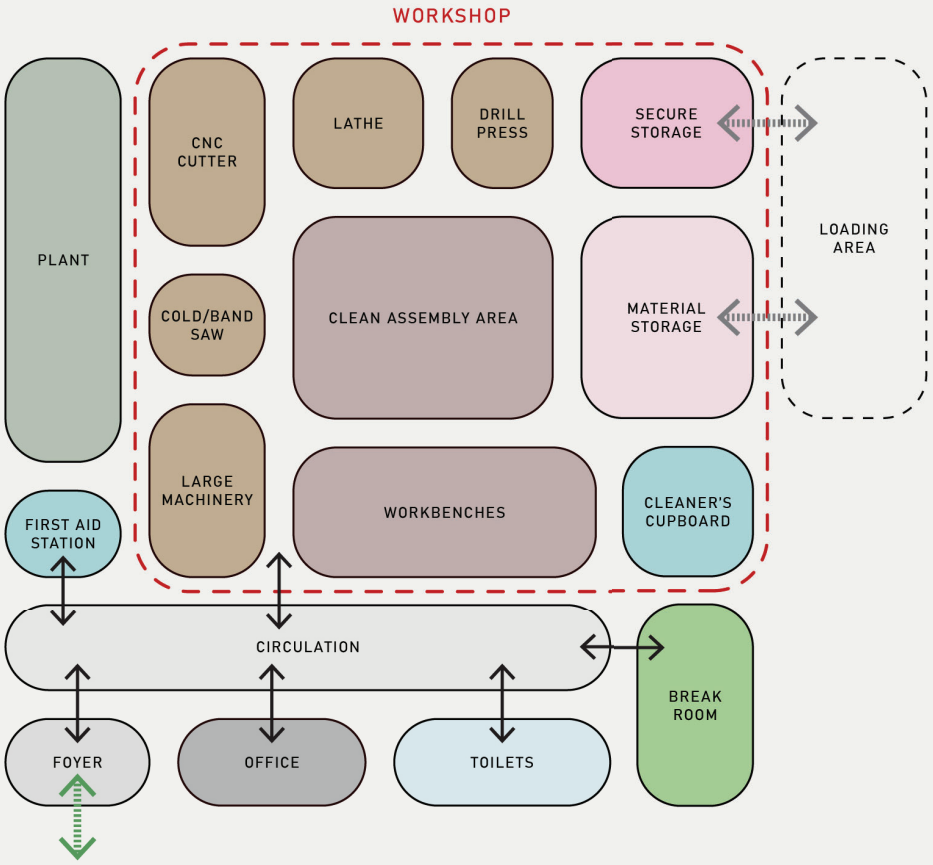
In addition to assembly and general storage areas outlined above, metal fabrication workshops require:

— 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**



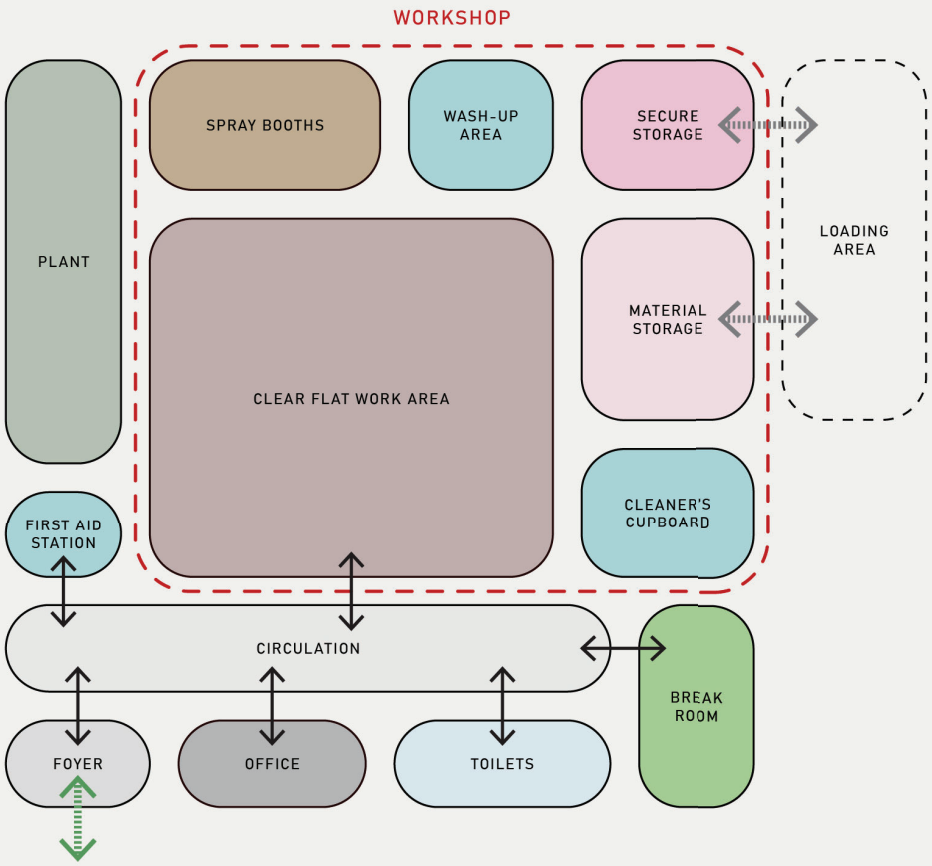
## Type C – Paint and scenic application area requirements

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 Design Requirements** section.
— For discussion with user and operators during the design phase is the following:
— Area for a spray booth.

**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.

Type C Paint and Scenic application space – Spatial adjacency diagram



# 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: **10sqm**

Kitchen and breakout room: **15sqm**

Changing rooms: **1.5 sqm per person**

Toilets: **as per NCC**

Showers: **as per NCC**

Cleaners cupboard: **2sqm**

All spatial requirements listed above denote Net Internal Area.

It is important that all spaces above are designed to be inclusive, allowing opportunity to participate regardless of someone's personal identity or circumstances. Finishes, fittings and furniture should also accommodate a wide range of user needs - including good visual contrast of key surfaces and features, avoidance of finishes that will cause confusion (e.g. heavy patterns, glare, reflections)

**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.
— Safe access to materials for a range of people and accessibility requirements

A cleaner's cupboard should be provided adjacent to or within the light fabrication space that has:
— Mop sink
— Area to hang wet mops and brooms

Cupboard to store general cleaning products securely and safely (dustpan and 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 AFFL should be maintained.

**Kitchen and break room**
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 AFFL should be maintained in the kitchen. It is noted that there should be dual height surface tops in kitchenette areas allowing users of various heights (e.g. very tall or short stature, and people who may be seated, such as wheelchair users) to access facilities safely and independently. For seated users, 760mm height countertops from FFL, or adjustable units, are recommended.

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 break room should be equipped with tables and chairs for staff to sit and eat meals. A small respite room can also be provided for religious requirements (e.g. praying), or as a sensory break (e.g. for neurodivergent people).

**Toilets, showers and changing facilities**
A minimum clear height of 2.4m AFFL should be maintained in the toilet facilities

The 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 ten 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. 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 NCC and the AS 1428 suite of Standards.

It is recommended that both gendered and gender-neutral facilities be provided to accommodate cultural preferences and non-binary gender identity.

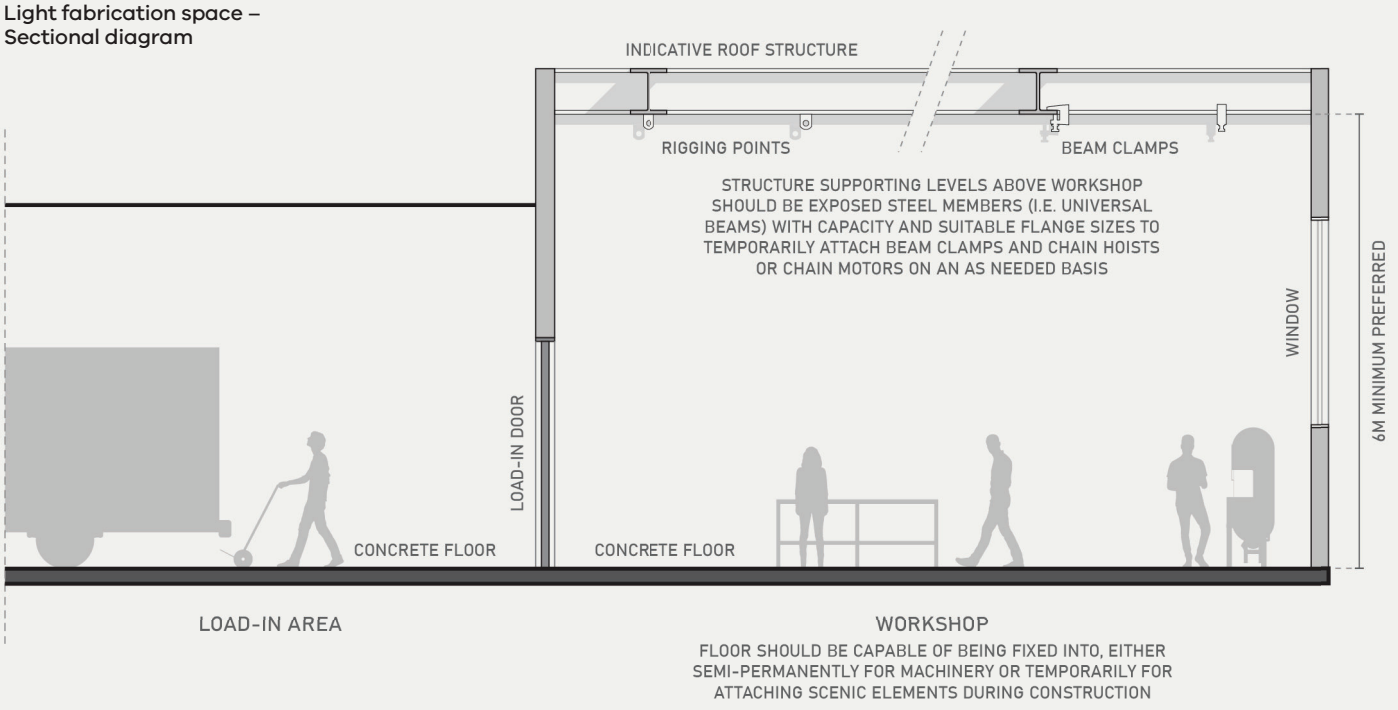
**First aid station**
A first aid station should be provided with first aid kit, eye wash station and other key requirements identified by operators and users in their operational risk management assessment.

**Floor loading requirements**
The floor should be of concrete construction and/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

**Light fabrication space – Sectional diagram**



**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.

**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 and 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 stage. Sufficient floor load ratings, storage areas, access paths, etc. will need to be assessed to inform a successful design.

It will also be important to consider technical spaces in relation to universal design. This may include rethinking technical roles and their associated spaces, and automating / remotely controlling activities (which may reduce some of the historic need for heavy lifting and work at height). For example, for an accessible lighting grid, consider moving-head lights to minimise the work that needs to be done at height, and automate or motorise as many features as possible. On the grid itself, consider whether wheelchair access can be provided with wider, level routes.

Consideration of partially sighted people, and deaf people who lip read or use sign language, will also be important as part of an universal technical space design. Consideration will need to be given to the legibility of visual information, whilst maintaining the ambience; this may include designing technology interfaces that can help to communicate information to staff / performers that allow adjustment to personal requirements; or a suitable minimum lux level that will balance needs in the back of house areas.

# Universal design considerations

Universal design acknowledges human diversity and difference through design that is user-centred and responsive to people's needs, enabling people to participate equally, confidently and independently.

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.

The key principles and goals of universal design are outlined below.:

- **Equitable use:** creating welcoming and accommodating spaces that offer equality in experience for different users, regardless of personal circumstance or identity
- **Flexibility in use:** creating spaces that can offer choice in use and adapt to future changes and requirements and reasonable adjustments based on user needs.
- **Simple and intuitive:** creating spaces that are intuitive to use
- **Appropriate size and space:** providing appropriate size and space for approach, circulation and use
- **Perceptible information:** effectively communicating information to all users, considering the needs of users and the constraints that the environment may place on communication

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

| |
|---|
| The access provisions of the 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 |

It is recommended that universal design considerations extend beyond compliance with codes and should respond to other areas including but not limited to:

- Provision of different sanitary facilities (i.e. accessible, ambulant accessible, gendered and non-gendered facilities)
- Provision of reflection and prayer rooms; these areas should be designed to be calm avoiding bold patterns which can be confusing for some neurodiverse users
- Equitable circulation around spaces by providing circulation paths of at least 1500mm (1800mm preferred) clear of obstructions from furniture or any door swings
- Step free vertical transportation across exhibition spaces
- Inclusive wayfinding consider all users with a particular focus on blind or partially sighted users, those where English may not be a first language, wayfinding should be simple and intuitive allowing all to navigate spaces successfully.
- Egress for all – considerations for an evacuation strategy that allows everyone to evacuate in a safe and equitable manner
- Inclusive presentation of information providing options for visual, audible and tactile means

# Sustainability considerations

Every industry is able to influence emissions and its own sustainability performance.

Sustainability and climate change are increasingly front of mind for the general public and inform and impact consumer decisions. Effective sustainability approaches should apply systems thinking by considering the project holistically from its conception (e.g. "do we need to create something new, or will repurposing something we already have suffice?") to its end-of-life.

Sustainability considerations for a fabrication space are arranged within key themes below:

**Greenhouse gas emissions**
Victoria has a goal of being net zero by 2050. Fabrication spaces should aim to reduce greenhouse gas emissions to support this goal:

— Understand and quantify Scope 1, 2 and 3 greenhouse gas emissions for the space over its lifetime, including a clear definition of the emissions reporting boundary for the space in line with Climate Active or other credible guidance.
— Develop emissions reductions targets, targeting net zero emissions that are in line with or more ambitious than Victoria's emissions reduction targets

**Energy usage**
Reducing energy usage and selecting a low emissions source of energy can significantly reduce greenhouse gas emissions. Potential sustainable energy strategies include:

— Using energy efficient appliances with an Energy Rating label, economy mode
— Obtaining an energy rating for the space or meet energy rating requirements if rating is not available (NABERS Tenancy Energy Rating, Green Star)
— Exceeding National Construction Code Section J Energy Efficiency requirements
— Monitoring energy usage through use of on-site energy metering where possible
— Ensuring 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

If space is to be leased within a broader commercial building context, ensure landlord has an energy rating for the base building:

- NABERS Base Building or NABERS Whole Building targeting 4.5 stars (without green power) for existing buildings and 5 stars (without green power) for new buildings, and/or
- Green Star Buildings v1 rating (minimum targets for new and existing building may be informed by Property Council of Australia guidance), and/or
- A reasonable equivalent rating

Evaluate the applicability of using data centres, cloud storage and other means as an alternative to in-house comms. or IT rooms. Where these options are deemed feasible, evaluate their operational energy approach using the energy hierarchy below.

**Energy source**

— Minimise natural gas usage, replacing gas with electricity for cooking and heating wherever possible.
— Strategic energy procurement for the operation of creative spaces should be considered by applying the energy hierarchy outlined below when selecting a provider. Selection of energy source can contribute to ratings such as NABERS and Green Star and should be considered in concert with energy efficiency measures.

**Energy hierarchy**

| HIERARCHY | ENERGY MEASURE |
|---|---|
| 1 | **Sustainable energy production**<br>— Renewable energy from sun, wind, waves, tides or rainfall, geothermal<br>— Bio-energy from combustion of biomass<br>— Includes off-site renewable energy generation, Power Purchase Agreements (PPAs) and other renewable energy options from energy suppliers |
| 2 | **Low carbon generation** energy sources or generation that makes use of carbon capture and storage to reduce emissions from generation |
| 3 | **Offsetting** emissions from energy usage using certified additional emissions offsets |

**Water management**
Reduction of water usage overall and use of non-potable water sources where possible contribute to sustainability performance and may contribute to sustainability ratings for the space.

Water management in fabrication spaces should consider:
— Use of efficient fixtures and fittings with a WELS rating
— Monitoring water usage through on-site metering
— If space is to be leased within a broader commercial building context, ensure landlord has a water rating for the base building:
  - NABERS Office Water 4 star for new buildings, and/or
  - A Green Star Buildings v1 rating that includes achievement against Water Use credit, and/or
  - A reasonable equivalent rating
— 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**
Waste is a source of greenhouse gas emissions and its disposal can result in costs for fabrication spaces. Management of waste can result in both emissions and cost reductions and can improve operational efficiency. Waste includes single use items, food waste, waste associated with the fit out of the space and waste associated with the processes undertaken in the space (e.g. in the assembly space, workshops or studios)

Waste management in fabrication spaces should consider:
— Application of circular economy principles in line with the Victorian DELWP's Recycling Victoria A new economy Plan:
  - Design to last, repair and recycle
  - Use products to create more value
  - Recycle more resources
  - Reduce harm from waste and pollution
— 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 Fabrication space. This can be achieved through achievement of or alignment with Green Star Buildings v1 Operational Waste and Upfront Carbon Emissions credits
— Minimising 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. For a fabrication space, hazardous waste may include waste disposal into sewer may require special permitting.
— Setting targets to maximise diversion of waste from landfill and aligning with Victoria's target of 80% diversion by 2030. Strategies may include the following and should be captured in an Operational Waste Management Plan:
  - Have separate collection for multiple waste streams, including organics waste, and adequate space to accommodate these waste streams
  - Have specific waste recycling or disposal options identified for non-standard materials used in fabrication processes
  - Educate staff on waste sorting
  - Provide signage and nudge mechanisms for staff, visitors and clients to promote waste sorting
— Implementing a sustainable procurement policy that guides procurement decisions during operation with the aim of reducing waste overall, reducing hazardous waste, increasing reuse and recyclability, and integrating circular economy and whole of life principles into procurement evaluation

If space is to be leased within a broader building context, ensure landlord has a waste rating for the base building:
— NABERS Waste, and/or
— A Green Star Buildings v1 rating that includes achievement against Operational Waste credit, and/or
— A reasonable equivalent rating

**Fabrication resources**
Fabrication is by its nature resource-intensive and can generate excessive waste and greenhouse gases. A strategic approach to planning fabrication can result in operational efficiency and reduce the emissions and waste associated with fabrication processes.

Transportation of materials and fabricated products can be emissions-intensive and may be addressed through:
— Minimising the weight and footprint of shipped items through strategic selection of items and efficient packaging
— Selecting reduced-environmental impact transport options (e.g. ground or sea transport, as opposed to air transport)
— Strategic planning of transportation of materials and fabricated products to maximise efficiency of transportation, minimise travel legs and transportation distances

Principles for material selection and usage should be required for users of the fabrication spaces:
— Select materials for durability, reusability and recyclability. Ensure that adequate disposal options are available for materials that cannot be reused and allowing achievement of landfill diversion targets outlined above.
— Select materials for reduced environmental impact, aligning with materials selection criteria outlined in Green Star Buildings v1 Exposure to Toxins credit.
— Ensure strategic and collaborative design of products or artworks and procurement of materials to reduce materials wastage, minimise any excess in ordering materials and maximise reuse and sharing opportunities.

# Structural design requirements

Load allowances for the industrial fabrication space should 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 should 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 350sqmm 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 should incorporate the localised loading from these cranes if applicable.

Allowances should 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 should be 4000K or 3000K and consistent throughout. In Type C – Scenic workshop, tunable 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 should be concealed where possible and have a Unified Glare Rating (UGR) of 19 or lower. The Colour Rendering Index (CRI) of the luminaires should 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. Preprogrammed 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):

**Emergency lighting and exit signs**
— AS2293 and NCC Section E4 compliance emergency lighting and exit signs should be provided throughout as required.
— Consideration should be given to incorporate integrated emergency lighting into the general lighting within the space.

| TYPE | EXAMPLE OF TASKS PERFORMED | TASK ILLUMINANCE TARGET |
|---|---|---|
| **DIFFICULT VISUAL TASKS** | | |
| **A - Timber construction workshop** | Woodworking, sawmills and timber processing<br>Fine bench and machine work, fine sanding, finishing, veneering<br>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** | | |
| **A - Timber construction workshop** | Wood machining and assembly: machining, sanding and assembly of components<br>Cabinet making: veneer pressing<br>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<br>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 |

# 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, for ESD purposes and for subleasing (if required)
— 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<br>— 50Hz |
| **Main switchboard** | AS/NZS 61439<br>AS/NZS 3000 | — 25% spare space or one spare space (whichever is greatest) for each frame size excluding main switch(es)<br>— Main busbars 125% initial load |
| **Distribution boards** | AS/NZS 61439<br>AS/NZS 3000 | — Form 2 unless stated otherwise<br>— 30% spare space or minimum 18 poles (whichever is greatest) for each frame size excluding local main control)<br>— Local main control required<br>— Fault interrupt capacity of circuit breakers minimum 6kA<br>— Provide fault current limiters or use higher fault interrupt capacity circuit breakers as required<br>— Internal DBs: IP52 min.<br>— External DBs: IP56 min. |
| **Consumers mains** | AS/NZS 3000<br>AS/NZS 3008.1 | — Voltage drop: max. 2%<br>— Max. demand: + 25% capacity (current carrying and voltage drop)<br>— Fire rate where required to AS3000<br>— At least 100% neutral; provide oversize neutral where harmonic currents are expected to be high |
| **Submains** | AS/NZS 3000<br>AS/NZS 3008.1 | — Voltage drop: 1%<br>— Max. demand: + 20% (current carrying and voltage drop)<br>— Fire rate where required for Fire and Life Safety Services<br>— At least 100% neutral; provide oversize neutral where harmonic currents are expected to be high |
| **Final subcircuits** | AS/NZS 3000<br>AS/NZS 3008.1 | — Voltage drop: max. 2%<br>— Power 2.5mm² min.<br>— Lighting 2.5mm² min.<br>— 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<br>— 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<br>— Contain Cat 6 cable route length to <90m<br>— Cross power cables only at 90°<br>— Max. fill of a cable tray should not exceed 50% |
| **Electrical metering and EMS system** | NCC Section J6<br>Supply authority standards | — Meters and CTs should 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
— 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. In noisy environments, visual warning devices may be required to comply with AS 1670.1-2018.
— 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<br>AS/NZS 3500.1 – 2018<br>AS/NZS 3500.4 - 2018 | — Cold water average supply temp: 14°C<br>— Hot water storage: 60°C to 65°C<br>— Hot water distribution: 55°C to 60°C<br>— Amenities (visitor and non visitor): 43°C<br>— Utility rooms (kitchens, cleaners sinks): 50°C to 55°C<br>— Max. velocity: 2.4m/s externally and in ground<br>— Max. velocity: 1.5m/s in risers, BOH spaces<br>— Max. velocity: 0.8m/s in acoustically sensitive spaces<br>— Min. operating pressure: 200kPa<br>— Max. operating pressure: 500kPa |
| **Sanitary plumbing and drainage, and trade waste** | BCA 2019 Amdt. 1<br>AS/NZS 3500.2 – 2018<br>Sydney Water Trade Waste Guidelines | — Min. grade: 2.5% for 40-65mm, 1.65% for 80-100mm and 1% for 150mm pipelines<br>— Sanitary stacks design capacity: 22% to 33% full<br>— Drainage design capacity: max. 70% full<br>— Velocity: 0.75m/s to 1.2m/s |
| **Building rainwater drainage** | BCA 2019 Amdt. 1<br>AS/NZS 3500.3 – 2018<br>Australian Rainfall and Runoff Guidelines<br>City of Sydney requirements | — Flat roofs, box gutters: 5min 1% AEP<br>— Eaves gutters: 5min 5% AEP<br>— Climate change allowance: +10%<br>— Full capacity overflows to be provided to all building rainwater drainage catchment areas<br>— Velocity: 0.75m/s to 1.2m/s<br>— 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 should be provided to serve the timber construction, metal fabrication and paint/scenic application areas. Each system should 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.
  - $CO_2$ sensors should increase the outside air proportion to the space in response to high $CO_2$ levels. Mechanical equipment should be sized to maintain internal temperatures and deliver increased outside air at high ambient temperatures.
  - Wall-mounted temperature and $CO_2$ sensors should be installed at 1500mm AFFL inside the space and in areas that will be representative of the conditions inside the space.
  - Mechanical system should be variable volume and respond to temperature and $CO_2$ levels within the space.
  - If system supplies >1000 l/s, economy mode should 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 should 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 – Types 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 should be achieved.
— For spaces with >6m floor-to-ceiling height, minimum air change rate of 8 air changes per hour should be achieved.
— All ductwork should be above rigging zone OR can be wall mounted if it does not clash with other services.
— Sufficient makeup air should be provided at regular spacing within the space. This air should 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 should 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 centralised for redundancy and energy efficiency.
— If an air compressor is to be used, design should be in accordance with the relevant standards and an extract system should be installed adjacent to keep the area clean.

**Timber workshop area – Type A**

— The woodworking area should 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 – Types 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 should not be combined unless permitted in AS1668.2.

**Support spaces (small office, break room)**

— Office should be provided with air conditioning, with internal temperature controlled to 21°C to 24°C. Humidity will be uncontrolled but will generally be in the range of 40-60% RH.
— The break room should be provided with air conditioning, with internal temperature controlled to 21°C to 24°C. 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 should 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 should be compliant with AS1668.1 requirements. Smoke exhaust strategy should 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 should 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 should 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 plant rooms: 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
— Louvres: 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 should 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**
Current Transformer

**DB**
Distribution Board

**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, a standard for digital communication networks that are commonly used to control stage lighting and effects

**DSP**
Digital Signal Processor

**DX**
Direct Expansion
**EP&A Regulations**
Environmental Planning and Assessment Regulation. The EP&A Regulation contains key operational provisions of any local or state planning system.

**ESD**
Environmentally Sustainable Design

**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

**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 100m |
| 110 | Chain saw at 1m |
| 100 | Inside disco |
| 90 | Heavy trucks at 5m |
| 80 | Sidewalk of busy street |
| 70 | Loud radio (in typical domestic room) |
| 60 | Office or restaurant |
| 50 | Domestic fan heater at 1m |
| 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 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.

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Level 31, 121 Exhibition Street
Melbourne 3000

Developed by: Arup Australia Pty Limited, Sydney



If you would like to receive this publication in an accessible format, contact us on:
T: 03 8683 3100
E: creative.places@creative.vic.gov.au
ISBN: 978-1-76090-511-8
creative.vic.gov.au