Mechanical Services

Design Standard

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TAFE NSW would like to pay our respect and acknowledge Aboriginal and Torres Strait Islander Peoples as the Traditional Custodians of the Land, Rivers and Sea. We acknowledge and pay our respect to the Elders; past, present and emerging of all Nations.

TAFE NSW Granville Electrotechnology Workshop

Rev	Issue date	Issue	Amendments since previous issue
P1	18 March 2022	Draft 1	n/a
P2	11 April 2022	Draft 2	Ongoing development
P3	29 April 2022	Draft 3	Ongoing development
A	20 May 2022	Final 1	Updates and Inclusions from Workshops
B	10 June 2022	Final 2	Updates from final presentation and comments
C	11 November 2022	Final 3	Updates as per comments
D	06 December 2022	Final 4	Updates as per comments

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The project team retains responsibility for the coordination, design, procurement, and delivery of mechanical services which will include taking all reasonable steps to make sure that the mechanical services design, and selection complies with all applicable Australian Standards required by the NCC, WHS Legislation, Statutory planning approval processes, TAFE NSW Procedures & Policies, and all other relevant statutory requirements.

TAFE NSW Wetherill Park

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Introduction

1 Introduction

1.1 Overview

This document forms part of the TAFE NSW Design Book and is to be read in conjunction with all other relevant TAFE NSW Design Standards, policies and procedures.

This Design Standard provides specific guidelines for the planning, design, operation and maintenance of mechanical services design within built environment projects across TAFE NSW.

This Design Standard applies to a variety of physical environments including but not limited to new buildings, refurbishments, or a cluster of learning areas or spaces within existing or new buildings.

1 Introduction

1.2 Audience

The table below broadly defines the diverse audience this Design Standard is written for and the roles they play through the design, selection and delivery process.

Table 1 Who should use this Design Standard?

Group	Members	Group's Roles/ Standard Applications
Consultants	▪ Architects ▪ Interior Designers ▪ Engineers ▪ Project Managers	▪ Guidance tool to design team ▪ Outline TAFE NSW technical requirements
TAFE NSW Project Team	▪ Program Managers ▪ Design Managers ▪ Strategic Planning ▪ Procurement ▪ Facility Management ▪ Sustainability ▪ Logistics ▪ Systems Group	▪ Assist with project design brief preparation ▪ Provide technical outline to manage project ▪ Outline space specific expectations ▪ Outline TAFE NSW technical requirements
TAFE NSW Operations & End Users	▪ Teaching Staff ▪ Education Planning & Services Delivery ▪ Student Experience Group ▪ Product Group ▪ Change Management ▪ Student support groups ▪ Industry Partners	▪ Outline space specific technical expectations ▪ Assist to understand and properly utilise/operate the installed systems
Contractors	▪ Construction Contractors	▪ Outline TAFE NSW technical requirements ▪ Assist with preparation of TAFE NSW quotes, and plant selection/suggestions
Suppliers	▪ Mechanical system suppliers ▪ Mechanical system manufacturers	▪ Outline TAFE NSW technical requirements ▪ Assist with preparation of TAFE NSW quotes, and plant selection/suggestions

1 Introduction

1.3 Standards & Documents

The following standards and documents, as relevant to the project, should be read in conjunction with this Design Standard when designing, documenting & delivering mechanical services. This list is not exhaustive and other documents may apply.

1.3.1 External Requirements

Statutory Requirements

The planning, design, installation and operation must incorporate the relevant requirements as stipulated by the following Statutory Authority bodies:

- National Construction Code/Building Code of Australia (NCC), version in force for the specific project
- State Environmental Planning and Assessment Legislation
- All Commonwealth, State and Local Government Legislation
- Any conditions of consent identified through the statutory approvals process
- Fire & Rescue NSW
- Australian Communication Authority
- Principal Certifying Authority (person qualified to conduct a Certification of Crown Building Works)
- Work Health and Safety Act
- Safe Work NSW Authority Requirements
- Disability Discrimination Act
- Disability (Access to Premises - Buildings) Standards
- Disability Standards for Education
- NSW Anti-Discrimination Act
- The Australian Dangerous Goods Code. ADG Code
- Any other authority having jurisdiction

External Certification Schemes

- Green Building Council of Australia (Green Star) and other recognised certification schemes (e.g. GECA, etc)

NSW Government Policies

- Workplace Design Principles (NSW Department of Planning, Industry and Environment)
- Local Council regulations having project specific jurisdiction
- NSW Climate Change Policy Framework
- Better Placed - Design objectives for NSW (Government Architects NSW)
- NSW Government Resource Efficiency Policy (GREP)
- NSW Government Net Zero Plan Stage 1 2020-2030

1 Introduction

1.3 Standards & Documents

1.3.2 TAFE NSW Requirements

TAFE NSW Design Standards

- Any other Design Standards relevant to the project

TAFE NSW Policies

- Environmental Sustainability Policy
- Reconciliation Action Plan
- Diversity and Inclusion Policy
- Work Health and Safety Policy
- Disability Inclusion Action Plan and Implementation Guide

1 Introduction

1.3 Standards & Documents

1.3.3 Standards

Australian Standards

Code Standards	Description
AS/NZS 1668.1	The use of ventilation and air conditioning in buildings Part 1: Fire and smoke control in buildings
AS 1668.2	The use of ventilation and air conditioning in buildings Part 2: Mechanical ventilation in buildings
AS 1170.4	Structural design actions Earthquake actions in Australia
AS 1324.1	Air Filters for Use in General Ventilation and Air-conditioning, Part 1
AS 1657	Fixed platforms walkways stairways and ladders - Design construction and installation
AS 1668.4 Pt 4	Natural ventilation of buildings
AS 1682.1	Fire smoke and air dampers
AS 1940	The Storage and handling of Flammable and combustible liquids
AS 2676.1	Installation, maintenance, testing and replacement of secondary batteries in buildings Vented cells
AS 2676.2	Guide to the installation maintenance testing and replacement of secondary batteries in buildings Sealed cells
AS 2896	Medical Gas Systems – installation and testing of non-flammable medical gas pipeline systems
AS 3780.	Storage and handling of corrosive substances
AS 3959	Construction of buildings in bushfire prone areas
AS 4254.1 & 2	Ductwork for air-handling systems in buildings
AS 4289	Oxygen and Acetylene Reticulation Systems
AS 4326	The Storage and Handling of Oxidizing Agents
AS 4332	The storage & handling of gases in cylinders
AS/NZS 2107	Acoustics – Recommended design sound levels and reverberation times for building interiors
AS/NZS 3000	Electrical installations (Australian/New Zealand Wiring Rules)
AS/NZS 3102	Approval and test specification - Electric duct heaters
AS/NZS 3500	Water supply, sanitary plumbing and drainage
AS/NZS 3666.1	Air handling and water systems of buildings - Microbial Control
AS/NZS 3666.2	Air-handling and water systems of buildings-Microbial control Part 2: Operation and maintenance
AS/NZS 5149.1	Refrigerating systems and heat pumps - safety and environmental requirements

1 Introduction

1.3 Standards & Documents

Code Standards	Description
AS/NZS 5601.1	Gas Installations
AS/NZS IEC 61439.5	Low-voltage switchgear and control gear assemblies, Assemblies for power distribution in public networks
AS/NZS ISO 817	Refrigerant - Designation and Safety Classification

Industry Practice Guides

- Industrial Ventilation ACGIH

1 Introduction

1.4 Definitions

1.4.1 Abbreviations

Abbreviations	Description
A/C	Air Conditioning
AFFL	Above Finished Floor Level
AH	After Hours
AHU	Air Handling Unit
AS	Australian Standard
AS/NZS	Australian/New Zealand Standard
BMCS	Building Management and Control System
CO_2	Carbon Dioxide
CRAC Unit	Computer Room Air Conditioning Unit
DB temperature	Dry Bulb temperature
FCU	Fan Coil Unit
IP	Ingress Protection rating is a numerical two digit code to indicate the degree of dust and moisture provided by an enclosure of electrical switchboard, outlets or the similar equipment
MSSB	Mechanical Services Switchboard
PLC	Programmable Logic Controller
NTTA	National Association of Testing Authorities
NCC	National Construction Code of Australia
QA	Quality Assurance
UPS	Uninterruptible Power Supply
VCD	Volume Control Damper
WHS	Workplace Health and Safety

1 Introduction

1.4 Definitions

1.4.2 Terms

Terms	Description
Supply	"Supply", "furnish" and similar expressions mean "supply only".
Provide	"Provide" and similar expressions mean "supply, install and commission".
Approved	"Approved", "reviewed", "directed", "rejected", "endorsed" and similar expressions mean "approved (reviewed, directed, rejected, endorsed) in writing by the TAFE NSW appointed delegate".
Give notice	"Give notice", "submit", "advise", "inform" and similar expressions mean "give notice (submit, advise, inform) in writing to the TAFE NSW appointed delegate".
Obtain	"Obtain", "seek" and similar expressions mean "obtain (seek) in writing from the TAFE NSW appointed delegate".
Proprietary	"Proprietary" mean identifiable by naming manufacturer, supplier, installer, trade name, brand name, catalogue, or reference number.
Samples	Includes samples, prototypes and sample panels.
This Design Standard	TAFE NSW Mechanical Services Design Standard

Applications

2 Applications

2.1 Scope

2.1.1 How This Design Standard Applies

General

This Design Standard is intended to support the selection, design and procurement, and understanding of mechanical services in TAFE NSW sites.

Details of systems, as defined by government codes and standards, and relevant guides and standards will not be reproduced in this Design Standard.

This Design Standard does not constitute a detailed design specification. It will remain the responsibility of designers, installers, suppliers, and TAFE NSW to further develop the information provided to generate complete designs and installations meeting TAFE NSW's needs.

Compliance

This Design Standard must also be read in conjunction with:

- Statutory and legislative requirements
- Contractual agreement with TAFE NSW
- The project brief and relevant project requirements
- Any other TAFE NSW Design Standards

Where there is a conflict between this Design Standard and any statutory or legislative requirement, the most restrictive/higher/better requirement shall apply.

Mandatory/must

Where the word "must" is used, this indicates that a statement is mandatory.

Preferred/should

Where the word "should" is used, this indicates that a statement is a recommendation.

Contractual responsibility

The contents of this Design Standard does not relieve any consultant, contractor or supplier from their contractual responsibility relevant to the project.

It remains the responsibility of the consultant, contractor or supplier to fully complete, coordinate and identify any errors or omissions in the documentation produced for the mechanical design.

Queries

Any project specific queries are to be raised through the TAFE NSW project lead, or project manager as applicable.

2 Applications

2.1 Scope

If this document appears to contradict or deviate from good industry practice or any statutory requirements, this is to be brought to the attention of the TAFE NSW project lead responsible for the delivery of the mechanical design project.

2.1.2 Mechanical Systems Covered By This Design Standard

This Design Standard outlines the general mechanical services scope as follows:

- Space cooling systems
- Process cooling systems
- Heating systems
- Ventilation systems
- Compressed air and workshop gas systems
- Fume and chemical extraction systems
- Dust control
- Cool rooms
- Humidity Control
- Mechanical controls and BMCS
- Smoke Hazard Management

2 Applications

2.2 Project Application

2.2.1 Project Types

This Design Standard is intended to support the mechanical services design and delivery of a variety of physical environments including but not limited to the project types below:

Project designers are to assess the specific project design restrictions and scope against this Design Standard and apply the requirements as appropriate to the project scope. It is recognised that there may be project specific constraints that prevent full compliance. Deviations from this Standard are to be identified to the project team as departures. They are to be formally approved prior to proceeding.

Major Capital Works & Special Projects

All new building and major refurbishment projects must comply with this Design Standard.

Minor Works

All building alterations and additions must comply with this Design Standard.

Mini-Minor Works

All minor fitouts should make every effort to comply with this Design Standard.

2.2.2 Project Designer

The mechanical designer or consultant must be an experienced and suitably qualified mechanical services designer covered by professional indemnity and public liability insurance in accordance with the TAFE NSW contract and relevant industry requirements.

The mechanical designer must have the necessary certification/ accreditation required by the project certifier.

For TAFE NSW projects this may include chartered registration with Engineers Australia or equivalent, Competent Fire Safety Practitioner accreditation with the NSW Fair Trading.

At the completion of the briefing stage and at every design stage, the mechanical designer must obtain endorsement of the proposed design from the TAFE NSW project team to proceed to the next stage.

In addition to the project deliverables, the mechanical designer has the following obligations:

- Confirm with TAFE NSW if there are any specific TAFE NSW procurement agreements for major plant at the time of pricing. Where relevant, include reference to these agreements for specific plant in mechanical documentation packages, directing biding contractors to make use of the agreement.
- Review of all documents and specifications provided by the installer to maintain quality of the installation in accordance with the design.

2.2 Project Application

- Review of samples provided by the installer to maintain quality of the installation in accordance with the design.
- Inspect the new installation for compliance with the project design documentation, NCC and relevant standards.
- Review the project operations and maintenance manual, As-builts, and commissioning figures at the completion of the project.

2.2.3 Project Installer

The mechanical installer or contractor must be an experienced and suitably qualified mechanical services installer covered by professional indemnity and public liability insurance in accordance with the TAFE NSW contract and relevant industry requirements.

In addition to the project deliverables, the mechanical installer has the following obligations:

- Confirm with TAFE NSW if there are any specific TAFE NSW procurement agreements for major plant at the time of pricing. If an alternative to the procurement plan is proposed, provide justification for the selection, and receive TAFE NSW approval prior to proceeding.
- To establish the final locations of mechanical plant and mechanical services reticulation details, provide detailed on-site measurements, and coordinate with building elements and other services. The final mechanical installation plans are to be reflected in the mechanical shop drawings.
- The mechanical installation plans/shop drawings are to incorporate safe, and practical provisions for plant maintenance access.
- To provide detailed programs including milestones indicating shutdowns, temporary requirements to maintain occupancy, staging of works and commissioning prior to handover.
- To provide manufacturer’s workshop, equipment specifications and construction drawings, schedules and details.
- Provide handover training to TAFE NSW user groups and facilities management staff at the completion of the project detailing the full operation, and relevant maintenance requirements for the installed systems.

2 Applications

2.2 Project Application

2.3.1 Designer Deliverables

The mechanical designer or consultant must prepare and submit all reports, design documents and certification as required to fully describe the design and to suit the scale and complexity of the project. The minimum documentation is as indicated below, and any specific items noted in the specific technical sections:

Site Investigation and Audit Report

Site investigation and audit report must include:

A detailed site investigation and audit must be undertaken for the entire existing mechanical services including but not limited to all existing mechanical plant and infrastructure, control systems, BMCS systems, air conditioning and heating systems, ventilation systems. This must include:

- An assessment of the condition, available spare capacity and compatibility for the existing equipment and/or system and whether it is suitable for re-use
- Where no documentation of existing systems and plant is available, the designer must through their site investigations identify existing installation details which are relevant to the project. Where site constraints/access limit the possible findings, the consultant must identify the potential risks to the design due to unknown information, and make recommendations to mitigate the risks
- A due diligence review of any non-conformances to any applicable standards and authority requirements
- All non-compliance items with TAFE NSW standards and/or any other reference documents provided
- Any site constraints, potential hazards or risks
- An outline of the findings, outcomes and recommendations

Return Services Brief

Return Services Brief must be prepared and submitted to:

- Identify and qualify the strategic deliverables to be achieved
- Incorporate all site investigation findings and outcomes
- Indicate demolition, disconnection, making safe, dismantling and de-commissioning of existing redundant systems
- Outline staging of works in accordance with the construction deliverables satisfying stakeholder and user group requirements
- Where existing sections of the building are to remain operational during construction, advise if any temporary services are necessary to maintain accessible services to the building
- List relevant standards and codes which will be applied to the project
- Outline mechanical design criteria, including but not limited to indoor and outdoor design conditions, ventilation rates, building envelope characteristics, internal occupancies, internal heat gains, acoustics
- Provide outline of proposed mechanical design concepts
- Where existing mechanical plant is to be re-used for the proposed design, the designer must identify the associated risks to the project and prepare a life cycle analysis of the existing plant to confirm the justification for its use. Depending on the project scope, this may not involve analyses of large base building infrastructure. Where the consultant analysis has excluded base building infrastructure, the excluded plant/systems must be clearly noted in the return services brief

2.2 Project Application

- Provide mechanical plant locations and spatial considerations, and access provisions
- If relevant to the project, identify mechanical related sustainability initiatives and their design requirements. Refer TAFE NSW Sustainability Design Standard
- Outline any spare capacity allowances
- List any proposed departures from this TAFE NSW standard, or other TAFE NSW standards, including, justification, and implications

Budget Cost Summary

Budget Cost Summary must be prepared and submitted identifying costs for all mechanical services systems at each specific project milestone, in accordance with the project specific program. It is to outline any assumptions and exclusions.

Proposed Alternatives

Any proposed alternate innovative mechanical design solutions must undertake a cost/benefit analysis study. This must identify capital costs, ongoing energy and maintenance costs, along with a qualitative analysis illustrating the reliability, longevity, and maintenance regime for the alternative proposal against the option put forward by this Design Standard.

Design Calculations

Refer to relevant technical sections for details.

Risk Management Report

Risk Management Report must be prepared and submitted for all new projects at the design stage, and at the commencement of construction, identifying:

- Safety and design requirements for construction, operation and maintenance
- The origin of all identified risks
- Work to be carried out in hazardous and confined spaces

Risk-Management – additional reporting for non-mechanical items is to be provided by others.

- Asbestos retention and/or removal
- Hazardous goods handling and storage areas
- Any specific stakeholder insurance risk requirements
- Potential latent conditions including the process for early resolution to agree costs involved prior to proceeding with works and to avoid/mitigate construction delays.

Mechanical Specifications

Mechanical Specifications must incorporate and further develop the detail of the mechanical services design including requirements of all relevant report findings and outcomes, along with the inclusion of the following as a minimum:

- Address the design principles and strategies of this Design Standard

2 Applications

2.2 Project Application

- Address the project specific design strategies
- Clear description of mechanical services scope of works
- List of codes and standards that the project design is in compliance with
- A comprehensive project specific scope of mechanical services systems, plant items and equipment, installation details, power and control wirings, controls and BMCS, pipe and duct work, MSSB, fittings, access and interface requirements, schedules of equipment and all associated technical requirements
- Detailed demarcation requirements for the specified works with existing installations, and works by others
- Be co-ordinated with the latest reference documents and each trade services design input
- Commissioning, testing and quality monitoring framework during the construction works
- Requirements for handover and training to/for TAFE NSW staff
- Identify working and final documents and record requirements
- Identify comprehensive Operating and Maintenance Manual requirements
- Installer deliverables as detailed in section 2.3.2 Installer Deliverables of this Design Standard.

Mechanical Drawings

Mechanical Drawings shall include (as necessary) the following:

- Title block, drawing lists and legend of symbols.
- Site plan where relevant
- Mechanical services layouts proposed and demolition works, demolition works applies to mechanical plant items only, excludes builder's works or other services.
- Schematics - where relevant: airflow, water flow, ducting layouts, piping layouts, wiring layouts
- Typical installation details and part plans.
- Mechanical drawing scales are to be confirmed for each project, typically these would involve 1:200 – site plans, 1:100 - floor plans, 1:50 - plant areas.
- The mechanical drawings are to conform to the digital standards as setout by the TAFE NSW Smart Campus Design Standard, and the project specific BIM management plan (if available).

Certification

Certification must be submitted to the Principal Certifying Authority/person qualified to conduct a Certification of Crown Building Works in accordance with the NCC, statutory and regulatory authority requirements, this Design Standard and any other relevant TAFE NSW Standard.

2.3.2 Installer Deliverables

The mechanical installer or contractor must prepare and submit all reports, design documents and certification as required to suit the scale and complexity of the project. The minimum requirements for deliverables are as indicated below, and as noted in the specific technical sections.

Samples

Submit samples as per the project specific specification, and any items identified in the technical sections of this Design Standard.

Alternative Design Verification

Where alternatives are proposed, provide an alternative design assessment report indicating compliance with the mechanical design intent and design criteria. Provide all supporting technical data, and associated installation methodology which must be compliant with statutory requirements.

Any proposed alternate mechanical design solutions must undertake a cost/benefit analysis study. This must identify capital costs, ongoing energy and maintenance costs, along with a qualitative analysis illustrating the reliability, longevity and maintenance regime for the alternative proposal against the option put forward by the mechanical design documentation.

Risk Management Report

Risk Management Report is to be prepared and submitted identifying:

- Safety in Design requirements for construction and installation
- The origin of all identified risks
- Any potential mechanical hazards
- Any work to be carried out in hazardous and confined spaces
- Asbestos retention and/or removal
- Hazardous goods handling and storage

Interruption of Supply Notices

Notice of interruption of supply is to be submitted for acceptance when under-taking any planned interruption of supply to existing areas of an occupied building.

Commissioning and Testing

The mechanical contractor must develop and submit a project specific commissioning and testing plan in accordance with their quality assurance plan. This must be consistent with the builder’s construction program including:

- All defined handovers including staged areas
- All milestones
- Notice for witness upon completion of all acceptance testing and commissioning activities
- Completion of all mandatory site tests in compliance with standards and authority requirements
- Detail of testing for each system and associated sub-component

2.3 Project Design Documents

- Commissioning testing and witness testing to include the mechanical services interface with the Smart Campus systems. For further details refer to the Controls and BMCs section of this Design Standard, and the Smart Campus Design Standard.
- All acceptance testing and commissioning records and certificates
- All commissioning and test reports and certificates indicating observations and results of tests, commissioning and compliance or non-compliance with statutory authority requirements
- All final and acceptance test records in suitable format for the inclusion in Operating and Maintenance Manuals
- For Major projects, and where called for in the project specification, a twelve month building tuning process must be provided with commencement at handover to TAFE NSW with systems monitoring monthly reporting from BMCS for each three month period, including feedback from the TAFE NSW staff.

Workshop Drawings

Submit further developed detailed design drawings, addressing method of installation, mounting and fixing, temporary works and staging, minor alterations in construction, approved value engineering initiatives and alternative designs. Workshop drawings documentation is to conform to the digital standards as setout by the TAFE NSW Smart Campus Design Standard, and the project specific BIM management plan (if available).

As-built Drawings

Submit final As-installed drawings, and final equipment schedules, illustrating final as installed details for record and maintenance purposes. As-builts to be provided in the following formats: full size PDFs, CAD/DWG, Revit Model (if available for the project). As-built documentation is to conform to the digital standards as setout by the TAFE NSW Smart Campus Design Standard, and the project specific BIM management plan (if available). Potential items could include, but are not limited to: BIM modelling level, geo-location of plant, and specific plant metadata.

Warranties

Submit warranties for all installed works covering the mechanical contractor's works and installed plant. Specific warranties are to be provided for major mechanical plant. Refer to technical sections of this specification for any extended warranty requirements.

Installation Certification

Installation Certification is to be submitted to the Principal Certifying Authority/person qualified to conduct a Certification of Crown Building Works in accordance with the design documents, NCC, statutory and regulatory authority requirements, this Design Standard or and any other relevant TAFE NSW standard.

2.3 Project Design Documents

Operating and Maintenance Manuals

Prepare and submit an operating and maintenance manual electronically in PDF format, within 2 weeks of practical completion, with the inclusion of the following project specific detailed requirements:

- Table of contents: As per contractual requirements
- Directory: As per contractual requirements
- Format: As per contractual requirements
- Installation description: General description of installation.
- Systems descriptions: Technical description of the systems installed, written to ensure that the Proprietor's staff fully understands the scope and facilities provided. Identify function, normal operating characteristics, and limiting conditions.
- Systems performance: Technical description of the mode of operation of the systems installed.
- Mechanical controls/BMCS functional description
- Certificates:
  - Installation certificates certifying installation in compliance with the project design documentation, all statutory & authority requirements, the NCC, and TAFE NSW Standards
  - And where relevant:
  - Certificates from Authorities
  - Product certification
  - Contractor waterproof sealing of penetrations certificate
  - Contractor fire and smoke sealing penetrations certificate
  - Contractor acoustic sealing of penetration certificate
  - Seismic restraint mounting certification
  - Calibration certificates at acceptance testing and final testing
  - Supply authority completion forms and inspection records
  - Inspection and contractor rectification records
- Drawings and technical data: As necessary for the efficient operation and maintenance of the installation
- Equipment descriptions:
  - Name, address, telephone and facsimile numbers of the manufacturer and supplier of items of equipment installed, together with catalogue list numbers
  - Schedules of fittings, plant and equipment. Include identification locations, metering and control settings, performance figures and dates of manufacture. Provide a unique code (Asset) number.
  - Schedules of fittings, plant and equipment to include cross-reference to the record and diagrammatic drawings and schedules, including easy to find spare parts schedule, for each item of equipment installed.

2.3 Project Design Documents

- Schedules of fittings, plant and equipment to include manufacturers' technical literature for all plant items, equipment, switchgear, metering and controls, actuators, air fittings, filters, and all other mechanical plants and equipment installed, assembled specifically for the project, excluding irrelevant matter. Mark each MSSB, BMCS panel control device and plant item and the like mechanical equipment product data sheet to clearly identify specific products and component parts used in the installation, and data applicable to the installation.
- Generic Brochures are not acceptable. Provide project specific technical data of items installed
- Mounting and fixing to product data to illustrate relations of component parts. Include typed text as necessary.

- Manufacturer’s product data for proprietary equipment, including:
  - Technical specifications and drawings
  - Verification reports
  - Performance and rating tables
  - Recommendations for installation and maintenance
  - Schedule of proposed major products that are not specified as proprietary items
  - Product certification

- Operation procedures:
  - Manufacturer's technical literature as appropriate
  - Safe starting up, running-in, operating and shutting down procedures for systems installed. Include logical step-by-step sequence of instructions for each procedure including automatic and manual control override procedures
  - Plant, equipment and control schedule of settings established at acceptance and final commissioning and testing.
  - Control sequences and flow diagrams for systems installed.
  - Compile a mechanical services user interface guide to include all operating instructions to enable user to configure equipment to achieve a reliable, energy efficient, safe and fully functional operation

- Maintenance procedures:
  - Manufacturer's technical literature as appropriate. Register with manufacturer as necessary. Retain copies delivered with equipment
  - Detailed statutory switchboard maintenance testing and recording
  - Safe troubleshooting, disassembly, repair and reassembly, cleaning, alignment and adjustment, and checking procedures. Provide logical step-by-step sequence of instructions for each procedure
  - Schedule of spares recommended to be held on site, being those items subject to wear or deterioration and which may involve the Proprietor in extended delivery times when replacements are required. Include complete nomenclature and model numbers, and local sources of supply
  - Schedules of equipment, local sources of supply, and expected replacement intervals
  - Instructions for use of tools and testing equipment
  - Emergency procedures, including telephone numbers for emergency services, and procedures for fault finding

2.3 Project Design Documents

- Records and Documents:
  - All construction drawings should be revised to ensure inclusion of all additions, modifications and alterations during the construction stage to be submitted as As-built drawings, to same scale and format
  - All fabrication and workshop drawings should be revised to ensure inclusion of all additions, modifications and alterations during the construction stage to be submitted as As-built drawings, to same scale and format
  - All mechanical services system and control schematics, mechanical water, ventilation and wiring diagrams
  - Control and equipment schedules including mechanical service characteristics, controls and communications
  - All licensed versions of computerised software required to program and monitor systems
  - All security code access, usernames and passwords, configuring, data base and recovery protocols stored in digital format on an external hard drive, required to reset and access all energy management software
  - Equipment asset numbered schedules, identifying condition and use with unique label.
- Commissioning and Testing Records
  - Contractors completed self-regulated inspection & test plans for each mechanical services system installed
  - Completed logbooks and the like
  - Warranties

Handover Training Records

Provide written report outlining the details for the handover training provided to user groups and facilities management staff. This will include but not be limited to:

- Record of parties who conducted and received the training
- Dates provided
- Summary of mechanical services/plant covered
- Details of specific training provided

Design Strategies

3 Design Strategies

3.1 General

The following sections outline key design strategies that must be implemented when developing mechanical designs for TAFE NSW projects.

Where strategies are not practical or relevant for a particular project, they must be raised to the project manager complete with supporting material to justify the exclusion(s) in the design.

3 Design Strategies

3.2 User Wellbeing

Create a safe environment for occupants with user friendly interfaces that are readily accessible.

Strategy	Requirement
Safety	Identify potential hazards and undertake a risk assessment to implement: safe installation, operational procedures, ongoing maintenance, cleaning, and replacement of plant.
Accessibility	Create an environment that promotes equitable access for all users regardless of ability. Potential accessible features for user interfaces (controllers) could include: installation at accessible height and clear from obstructions, audible feedback, raised buttons, braille dimples, and simple design. For further details refer to the Controls and BMCS section of this Design Standard.
User Interface	Enable easy user-friendly interface with non-technical operating procedures.

3 Design Strategies

3.3 Adaptability

Mechanical installations to be consistent across TAFE NSW sites, and allow for future upgrade provisions.

Strategy	Requirement
Consistency	Provide consistency of plant manufacturer and type within buildings for a given site where practical.
Compatibility	New installation works where practical are to be compatible with existing installations to provide a seamless installation across the site.
Future growth	Allow spare capacity in major plant, 15% spare capacity. Allow additional spare capacity and spatial allowances for any future upgrades as identified by master planning, or by the TAFE NSW project team.
Climate change	Adjust design conditions to consider increased temperature extremes, select plant with increased safety margin, locate plant above potential flood levels, permanently fix external plant in place so it cannot easily be displaced by weather extremes.
COVID Considerations	The design is to incorporate any current health advice or standards for the mitigation for spread of COVID virus or the like within indoor spaces. This could include increased ventilation rates, improved filtration, positive and negative pressure zones purge modes, UVC sterilisation light tubes in the air distribution system, etc.
Environment	Address the longevity of the installation subject to the environmental conditions of the area such as high ambient levels of salt, pollution, dust, moisture and/ or temperatures. Selected outdoor plant is to have suitable protection for its environment, air filtration is to be selected based on ambient conditions.
Innovation	TAFE NSW supports innovation across all scales of project delivery. Where a consultant/contractor identifies an opportunity to implement innovative solutions these may be submitted to the TAFE NSW project lead for review and consideration.

3 Design Strategies

3.4 Understanding Context

Address the project scope, construction, cost, maintenance, sustainability and quality requirements.

Strategy	Requirement
Project Type	Facilitate the specific project scale, site conditions, campus location and project budget.
Construction	Resilient and robust construction to allow reliable use within the installed environment.
Whole of Life Cycle Cost	Undertake a holistic cost-effective design to mitigate procurement, installation, and ongoing maintenance costs and support the longevity of the proposed mechanical services installation. Where multiple options are considered, whole of life cycle costing shall be provided to assist with evaluation.
Selection	Select components that are readily available from local suppliers.
Maintenance	Facilitate ongoing monitoring procedures, and enable installation and maintenance without any access constraints or the need for dismantling or demolition.
Sustainability	Incorporate energy, carbon, and materials saving initiatives. Provide opportunity for the user to monitor energy usage and provide reporting to mitigate operational energy consumption. The mechanical design and installation is to incorporate the requirements identified in the TAFE NSW Sustainable Design Standard, potentially including Green Star or equivalent certification.
Quality	Assess, evaluate and verify performance, method of installation, commissioning and testing to meet functional and operational requirements and achieve longevity of the installation in accordance with warranties provided.
Existing Plant Upgrades	In general, replacement of any plant as required under maintenance will not trigger the need to upgrade an entire system to comply with the current NCC and standards. For example, replacement of a ducted fancoil unit due to the previous unit failure will not force the up-grade of the connected ducting insulation to current mandated levels. Alternatively, if refurbishment work calls for a new unit with new ducting, then the entire new installation is to be compliant with the current NCC and standards. Where existing plant connected to a fire trip relay is replaced, the new plant shall also be connected to the fire trip
Training Value	At schematic design phase, review potential for installed mechanical plant to serve as a training tool and confirm with TAFE NSW project team if this provision is to be provided. Typical areas of interest would include major central plant, key service reticulation areas, controls, and metering. This could require special allowances such as increased service/access space, open/transparent ceiling sections, and secure access to controls and meters.

Technical Sections

4 Technical Sections

4.1 General

General guidelines are provided to outline expectations for mechanical services in TAFE NSW projects.

ESD initiatives where practical, and feasible physically and financially with tolerance (contemplating whole of life-cycle cost and footprint) must be explored and prioritised.

4 Technical Sections

4.2 Space Cooling Systems

4.2.1 Summary

Space air conditioning design shall be based on the type of space served, size/capacity of the application, energy consumption/efficiency considerations, building aesthetics, available plant space, and space specific requirements.

Design

- Design calculations
- System selection

Systems

- Ceiling fans
- Evaporative coolers (indirect, direct)
- Individual split air conditioning systems – air cooled
- Multi Head air conditioning systems and Variable refrigerant volume/flow (VRV/VRF) – air cooled
- Air Cooled Package Units
- Water Cooled Package Units
- Chillers
- Cooling towers
- Pumps
- Water piping systems
- Variable Speed Drives

4.2.2 Design

Design Calculations

For estimation of system capacities utilise industry standard modelling software such as Camel, Carrier, or IES Heating and Cooling load software to estimate peak space cooling loads, taking in the following factors:

- Summer outside design conditions are to be based on the Bureau of Meteorology (BOM) weather from the most relevant weather station as recorded over the last 5 years. The presented temperature will take into account the average peak temperature, excluding the 10 highest temperatures as detailed AIRAH DA09 methodology for establishing design temperatures. This approach additionally takes into account increasing weather extremes, which are not accounted for in the standard AIRAH DA09 tables.
- Winter external design conditions are to be based on AIRAH DA09 data.
- Building fabric performance: For new buildings, building fabric specifications for the purpose of heat load calculations are to be confirmed by the project team; these are to be in line with the project NCC section J assessment report. For existing buildings, the mechanical designer is to estimate the expected building element thermal performances based on the observed existing building construction.
- Occupancy rates are to be based on the architectural plans, project brief, Room Specific Requirements section of this Design Standard, or in the absence of these AS1668.2 standard occupancy densities.

4.2 Space Cooling Systems

- Ventilation and internal heat gain rates are to be as per the Room Specific Requirements section of this Design Standard, as modified to accommodate project specific conditions/expectations, or in the absence of these AS1668.2 standard occupancy densities.
- Typical temperature control range for air conditioned spaces is to be 22.5°C +/-1.5 °C.
- Air conditioning sizing is to be based on the upper limit of the range i.e. 22.5°C +/-1.5 °C. On design days the internal temperature is expected to be up to 24°C at the sensor location.
- Temperature control range relates to temperature at the point of control (sensor location). For naturally ventilated spaces, the achieved temperature control range shall be subject to use of windows and doors which will influence room temperature.
- Air conditioning unit sizing is to assume that internal blinds are not deployed. It is noted however that operable internal blinds should be provided. This is crucial to allow building occupants to maximise their comfort levels. Occupants exposed to direct sun will feel warmer due to the radiative effects of the sun. These effects are not offset by air conditioning.
- Incorporate 10% safety factor into the calculations.

System Selection

General

Selection of the type of cooling system shall take into consideration the following considerations:

- Capacities estimated in section 4.2.2 Design Calculations
- Energy efficiencies, and ESD requirements
- Volume and type of space to be conditioned, for high volume spaces full air conditioning is not recommended
- Provide satisfactory thermal comfort conditions
- Life cycle costing
- Spatial limitations
- Acoustic performance
- Availability of makeup water for cooling water cooled systems
- Ongoing maintenance and servicing
- Availability of suitable maintenance staff
- Availability of spare parts
- Confirm with TAFE NSW if there are any specific TAFE NSW procurement agreements for major plant at the time of pricing. Where relevant, include reference to these agreements for specific plant, directing bidding contractors to make use of the agreement.

TAFE NSW Key Design Features

The following design features are to be implemented into the mechanical design where practical and relevant.

4 Technical Sections

4.2 Space Cooling Systems

- New build air conditioned spaces must be provided with a mixed mode air conditioning solution. For internal thermal comfort control, building occupants can open windows for natural ventilation when outdoor ambient conditions permit, and when ambient conditions are not suitable operate air conditioning. This should also be considered for refurbishment projects where practical.
- Potential risks to natural ventilation such as excessive ambient noise or air contaminants must be reviewed.
- Air conditioned spaces must be provided with dedicated independent temperature control for each space. Specific project budgets, or conditions may cause this to be impractical. In this instance the designer is to justify and outline the proposed design, its deviation from the above, and the proposed level of control to TAFE NSW for approval.
- For air conditioned spaces, ducted mechanical outside air must be provided; do not rely on operable windows for ventilation.
- Where mechanical ventilation is not practical the designer is to advise the project manager, provide reasoning for its omission, and confirmation that the space will achieve NCC natural ventilation requirements. The space user groups are to be made aware of the impacts from opening windows while the air conditioning is running in terms of system performance, and energy usage.
- Mechanical ventilation systems to air conditioned spaces must be provided with CO_2 demand control. Refer to Ventilation Systems in Section 4.5 for further details.
- Each learning space must be provided with a dedicated concealed ducted air conditioning system (fancoil unit, or variable air volume box), providing independent local temperature control. This solution will offer improved acoustic performance, air distribution, and provision to treat incoming outside air.
- Where space dedicated concealed ducted units are not practical due to spatial or budget constraints, consider in order of preference: 4-way blow ceiling cassette units, or wall mounted units.
- All front facing spaces, such as restaurants, salons, reception areas, must be provided with concealed ducted air conditioning systems to maximise aesthetic presentation.

4 Technical Sections

4.2 Space Cooling Systems

4.2.3 Systems

The following subsections detail specific considerations for individual systems and system components, for the presented systems.

Ceiling Fans

Ceiling fans can be employed as an ESD initiative to augment space thermal comfort conditions and reduce the reliance on air conditioning. In summer they provide additional air movement, and in winter they mix the room air to prevent stratification of hot air at high level.

Ceiling fans are recommended for learning spaces, administration areas, shop areas, and naturally ventilated spaces.

Typically ceiling fans are specified and provided as part of the electrical package. The inclusion of ceiling fans is to be coordinated with the design team.

Generally, the following shall be considered.

- One fan per 25m^2 of floor area
- Local control on/off and speed control
- For controls, please refer to Section 4.11 Mechanical Controls and BMCS
- Minimum clear height of at least 2.4m, under the fan
- Design to be coordinated with ceiling lights to avoid strobing
- Larger diameter fans are to be considered for higher ceiling spaces

Mechanical Ventilation, Duct and Fans

Refer Section 4.5 Ventilation Systems.

Evaporative Cooling

Evaporative cooling units are most effective in dry climate zones, for applications that require a level of comfort cooling, but not full air conditioning control, such as large volume double height spaces, workshops, or sports courts.

Direct evaporative cooling units can be considered in most instances, except where the associated increased supply air humidity levels are considered an issue. In this instance provide indirect evaporative cooling units.

Design considerations

- Where summer outside design conditions approach the range where evaporative cooling units are less effective (22 ^{o}C wet bulb temperature), alternative cooling options such as air cooled packaged units with relaxed temperature set points should be considered. Please refer to the Air Cooled Package Unit section of this Standard for further details. If evaporative cooling units are proposed for areas near 22 ^{o}C wet bulb design temperature, manufacturer selections must be obtained to confirm expected unit performance supply air temperatures during the design phase.
- Select units for 20-30 air changes per hour for comfort cooling, confirm with unit manufacturer.
- For higher wet bulb temperatures, higher air change rates will be needed. This must be confirmed with the manufacturer.
- Where evaporative cooling is proposed for regions near 22^{o}C wet bulb design temperature, indirect evaporative cooling units can be considered. Manufacturer selections and expected performance must be confirmed during the design phase.

- Provide adequate provision for relief air when the evaporative coolers are running, suggest motorized actuators to open high level reliefs vents.
- Controls typically include on/off/ mode selection
- For controls, please refer to Section 4.11 Mechanical Controls and BMCS
- Provide adequate drainage from unit to accommodate full drain down. Refer to manufacturer for drain down rate. Provide a dedicated drain pipe to an exterior drain point. Drainage to a tundish is not acceptable.
- Provide NCC compliant self closing damper to close off the supply air ducting when the units are not running.
- Combined evaporative cooler, gas heating units, are not recommended.

Single Split Air Conditioning Units

Direct expansion air cooled split air conditioning systems are recommended for air conditioning to small dedicated spaces, and for installations in existing spaces with spatial limitations.

This section applies to all 1-1 split air conditioning systems, regardless of the type of indoor unit. Typical indoor units, wall mounted, 4-way blow ceiling cassette, and concealed ducted.

Design Considerations

- For controls, please refer to Section 4.11 Mechanical Controls and BMCS
- Suppliers must provide only high quality systems from a reputable established manufacturer, with strong local ongoing maintenance after market support, and warranty provisions (minimum 5 years parts and labour) are to be specified and supplied.
- Confirm with TAFE NSW if there are any specific TAFE NSW procurement agreements for major plant at the time of pricing. Where relevant, include reference to these agreements for specific plant, directing biding contractors to make use of the agreement.
- Outside condenser air on temperatures should be selected based on the summer design DB temperature (refer to Section 4.2.2) plus an additional 5°C.
- Selected air conditioning systems shall continue to operate up to 50°C DB.
- Each fancoil must be dedicated to one space. A single unit should not serve multiple spaces.
- Where the subject site is located within 5km of the coast all condenser coils shall be treated to protect them from aggressive corrosion due to the salty environment. Factory applied Blygold or Dulux coil guard coating shall be provided as a minimum.
- System refrigerant concentrations should be designed to avoid the need for refrigerant monitoring wherever possible. The system design and installation must comply with AS/NZS 5149.1.
- Refrigerant pipe runs/rises should be minimised wherever possible. Unit selections shall consider derated unit performance associated with the pipe run.
- Condensers should be located in well ventilated spaces according to manufacturer installation instructions. Where multiple condensers are located in a single plant area, they are to be arranged to avoid potential short circuit of airflow. Where screens are provided, they shall have a minimum of 80% free area.
- For condenser installation configurations not covered in the manufacturer literature, request for the manufacturer to provide CFD modelling to confirm adequate heat rejection.

- Locating condensers on pitched roofs is not recommended due to the increased fall hazard for accessing the units. It is preferred to install units at ground level on plinths, or platforms for safe access. If they must be installed on roofs, purpose built platforms with safe access provisions are recommended. Permanently fix units to plinths/platforms complete with vibration isolation.
- Condenser unit location must consider aesthetic impact, security provisions, and safe access.
- Condenser unit acoustic impact on surrounding areas must be considered, and reviewed by an acoustic engineer early in the design stage.
- Indoor ducted units must be provided with drip trays, drained to a tundish.
- Condensate drain piping must be piped at a minimum 1:200 fall to drain points, complete with minimum 10mm air gap. Condensate drain pumps are to be employed only when condensate cannot drain by gravity.
- Acceptable refrigerants, R410A, R32. New refrigerants with low global warming potential (GWP) should be considered where practical.
- Refrigerant systems must be pressure tested, and vacuum tested according to manufacturer instructions prior to charging systems. For large projects pressure testing is to be witnessed. Submit records of pressure testing with the commissioning reports.

Multi head and VRF/VRV Air Conditioning Systems

Variable refrigerant flow/volume systems should be considered for projects where multiple indoor fancoil units are proposed, up to a total building load of approximately 1 MW. For projects above this threshold, chilled water systems should be considered.

Design Considerations

- Design requirements shall be the same as for single split air conditioning units, as previously noted, with the following additional requirements.
- VRF/VRV system minimum warranty 2 years parts and labour, including compressors. Alternative price for extended warranty option should be specified for extending the above to 3 years.
- Heat recovery systems must be used with sufficient refrigerant control boxes to ensure effective thermal zoning and control.
- Heat pump systems may be considered where suitable. Zoning of heat pump systems must be considered. To prevent heating/cooling mode space mismatches, all zones served by a single heat pump condenser must share similar façade exposures, and internal air conditioning load profiles. Where this is not the case separate condenser systems or VRF/VRV heat recovery systems must be considered.

Air Cooled Package Units

Air cooled package units are suitable to provide air conditioning to large spaces. These units should be considered where evaporative cooler units are not suitable due to high ambient humidity levels. Please refer to the Evaporative Cooling section of this standard for further details.

Design Considerations

- Consider relaxed temperature set-points to reduce energy consumption, typically 25-26 °C in cooling, to be confirmed with TAFE NSW during the design stage
- Consideration must be given to losses in energy efficiency due to large open doors. REED switches or mandated operational procedures must be considered to avoid air conditioning operation when doors are open.
- Units must be provided with air filtration
- Unit installation must allow safe access for filter, motor, and coil access in-line with manufacturer instructions.
- Where units operate with high ratios of outside air, air on temperature limitations must be confirmed with the manufacturer during the design stage.
- Economy cycles must be considered (in many instances these will be required for NCC compliance)
- Heat recovery style units could also be considered for high outside air ratio systems.
- Mechanical relief provisions must be provided
- Units must be provided with high efficiency digital variable capacity scroll compressors, and EC fan motors with speed control.
- Where air is delivered at high level, air diffusion patterns in both heating and cooling mode must be considered. Grilles that adjust their airflow pattern/direction specifically for heating and cooling modes are recommended
- For controls, please refer to Section 4.11 Mechanical Controls and BMCS

Water Cooled Package Units

Water cooled package units should only be considered for projects where a condenser water system is available for connection. Water cooled packaged units will typically be employed to provide air conditioning to small local areas, such as meeting rooms, or small learning spaces.

Design Considerations

- The base building design criteria must be confirmed during the design stage, these include: condenser water capacity available for the proposed new air conditioning works, design condenser water flow and return temperatures, condenser water heating provisions, condenser water availability schedule, and controls interface requirements between the package units and the base building.
- Space heating requirements must be considered early in the design stage. Base building condenser water systems may not have heating provisions, and the NCC Section J may not permit the use of electric heating coils. If neither of these options are permitted the designer must consider an alternative air conditioning system type, or justification for using electric eating coils, such as a continuation of an existing scheme. If the project proceeds with electric heating coils, acceptance of this scheme must be confirmed with the certifier.
- When calculating the water cooled package unit heat rejection to the condenser water system, the total unit heat rejection must be used, not the cooling capacity delivered to the space.
- Acoustic performance must be considered. Units should not be installed in ceiling voids above normally occupied areas. It is recommended to install units above storage rooms, or corridors. The unit acoustic performance must be reviewed by an acoustic engineer. Any acoustic wrapping/treatment recommended by the acoustic engineer must be installed.

- Units must be installed with the following: flow and return binder type test fittings, balancing valve, flow and return isolation valves, strainer, flow switch, motorized shut off valves, and drip tray extending under the entire unit, and valves.
- Motorized isolation valves must only open when the unit is called to operate; they should otherwise be closed.
- All necessary controls should be provided for interface with the base building controls system.
- For controls, please refer to Section 4.11 Mechanical Controls and BMCS

Chillers

Design Considerations

- The selection of the type of chiller must be analysed during the design phase to confirm the most suitable option for the specific application. Air cooled, air cooled with wetted pads, water cooled, and simultaneous cooling/heating chillers should be considered. The analysis shall include but not be limited to peak and part load performances, energy efficiencies, life cycle costing, spatial limitations, acoustic performance, ongoing maintenance, and potential synergies with other systems, such as simultaneous heating.
- Chillers must be selected to provide chilled water efficiently across the entire expected load range for the project. Systems shall be designed to maintain the required minimum water flow through the chillers during low load conditions, and have sufficient system volume to prevent chiller short cycling.
- Air cooling units shall be selected with an air on temperature based on the summer design DB temperature (refer to Section 4.2.2) plus an additional 5°C.
- The selected units must be from a reputable manufacturer, have a proven design, be readily available in Australia, and have strong local service support.
- Units shall be factory assembled complete with all components, accessories, internal power circuits, controls, starters, and safety controls.
- Units shall be mounted on a hot dipped, galvanised steel base or frame, complete with vibration isolation.
- Units shall be installed on dedicated concrete plinths, permanently fixed in place in line with project seismic requirements, using spring ant-vibration mounts.
- It is recommended for chillers to be provided with a minimum of 2-off independent refrigeration circuits for improved redundancy.
- Compressors shall be complete with variable speed control for efficient part load performance.
- Chiller installation location shall be considered, and appropriate corrosion protection provided to all external chiller components. Also refer to the Corrosion Protection comments in Split System section of this Design Standard.
- Chiller operation can have a significant impact on the surrounding building and area. Unit vibration control, and acoustic provisions must be fully reviewed by an acoustic engineer during the design phase. Mitigation measures raised by the acoustic engineer must be implemented into the design.
- Where chillers are installed in an enclosed plant room, the installation must comply with the safety requirements set out by AS/NZS 5149.1

4.2 Space Cooling Systems

- Recommended chilled water design temperatures, flow and return: 6 °C to 12 °C.
- Each chiller shall be provided complete with a dedicated chiller proprietary control system, including a local touch screen controller. The controls are to be interfaced with the building BMCS system using a high-level interface.
- For controls, please refer to Section 4.11 Mechanical Controls and BMCS
- It is recommended for each main chiller and its associated ancillary equipment to have its own dedicated mechanical services switchboard (MSSB).

Cooling Towers

- Cooling towers should only be considered where warranted by the size of the project, or where driven by project constraints.
- To be designed in accordance with AIRAH's Cooling Towers and Water Treatment design manuals DA 17 and DA 18.
- Cooling Towers shall be selected with an air on temperature based on the summer design DB temperature (refer to Section 4.2.2) plus an additional 5°C.
- Strict compliance with the requirements of AS/NZS 3666 is required. Design drawings and as installed drawings are to clearly indicate separation requirements have been achieved form any building ventilation openings and exhaust discharges.
- Side stream filtration shall be provided to effectively sweep all sediment from the cooling tower basin. Where more than one cooling tower is installed balancing lines and return pipework shall be sufficiently large to allow isolation of one cooling tower supply pipework without overflowing of the tower basins.
- Potable water only must be provided for cooling tower makeup water.
- Fault alarms and chemical dosing system notifications shall be transmitted via the BMCS or via a dedicated mobile system to the cooling tower water treatment specialist in real time.
- Variable speed drives shall be provided for capacity and noise control.
- Cooling tower shop drawings to show compliance with safe access requirements.
- Recommended condenser water design temperatures flow and return: 29.5 °C to 35 °C.

4 Technical Sections

4.2 Space Cooling Systems

Pumps

- Generally to be designed in accordance with AIRAH's Centrifugal Pumps Design Manual DA01.
- Pumps to be selected in compliance with current NCC Section J requirements.
- End suction pull out type supplied on inertia base, with permanent markings of rotation, make, model and serial number and rating.
- Casings to be cast iron or gun metal, impellers bronze with stainless steel shafts.
- Motors to be 1440rpm, IP 56, totally enclosed and non-overloading.
- When sizing pumps, provide an additional 20% pressure drop allowance to accommodate additional pressure drops associated with selected valve authorities, and overall system losses.

Water Piping System

- To be designed in accordance with AIRAH's Air Conditioning Water Piping Design Manual DA16.
- Maximum pressure drops to be as per NCC Section J requirements and in no case more than 400Pa/m and 2.4m/s.
- To mitigate against air build up in piping, for small pipes below 50mm internal diameter, the design velocity should be > 0.6m/s, and for pipes greater than 50mm dia, the design pressure drop should be > 75 Pa/m.
- Unless approved otherwise pipe connections shall be joined by Brazing, Welding, Flanged or Screwed connections with flanges or unions used for demountable connections. Clipped fittings shall not be used.
- For hot and chilled water systems allow for pressurised feed and expansion systems.
- For condensing water systems assume a minimum make up water of 2% of peak water flows. (Noting the final rates are to be based on the water treatment specialist's advice – refer to Cooling Towers above.)
- Pipe work material shall be as follows:
  - Chilled, Heating water up to 200 dia – Copper to AS 1432 Type A or B, or medium grade steel to AS 1074
  - Chilled, Heating water up above 200 dia – heavy black steel to AS1074
  - Condensing water up to 200 dia-Copper to AS1432 Type B, or 316 stainless steel
- Pipes shall be insulated to NCC section J requirements. Chilled and Hot water Insulation shall be continuous through walls, at valves, and up the final connections to equipment.
- Pipes shall have continuous vapour barriers.
- Chilled and hot water pipes shall be metal clad within 2m of the finished floor level. Where located externally. Cladding to be 0.55mm Zinc coated steel or 0.6mm 316 stainless steel with riveted joints and painted in a colour approved by the architect.
- Pressure testing shall be in accordance with AS 4041 Pressure Piping, Section 6. Examination and testing.
- Binder test points locations shall be provided across all pumps, strainers, filtration units, coils, heat exchangers, chillers, boilers, heat pumps, package air conditioning units, balancing, bypass and control valves.
- Pressure and flow indication (digital readouts or dials) shall be provided for all chillers, boilers, pumps, heat exchangers.

- A water treatment regime must be developed by a specialist contractor in compliance with relevant codes and standards. For new water systems the specialist contractor is to be engaged by the installing contractor during the maintenance and defects period. For existing systems, TAFE NSW must confirm that an incumbent specialist contractor is engaged.

Variable Speed Drives

- VSD drive kW rating same as motor served, 415V, 50 Hz and 3 phase. With operating temperatures between -10ºC and + 50ºC
- VSDs installed in protected areas that are not exposed to moisture must have a minimum IP55 rating; those installed outside must have a minimum IP67 rating.
- Where installed outside, weather protection, such as an awning cover should be provided for increased durability
- Permanent markings of make, model and serial number and rating.
- BACnet compatible
- Provided with control pad with manual/off/auto, start, stop functions, password protection, program lock with non-volatile memory
- Remote metering provision
- Incorporate internal filters and shielding etc to achieve/comply with AS/NZs CISPR11 GROUP CLASS A,
  - VDEO875 (EN550011),
  - IEC 801 PARTS 2 to 5,
  - AS/NZS 61000.3.12.2013 and AS 61800.3 -2005
- Provide the following motor protection
  - Over, under voltage and phase loss
  - Earth, short circuit, over current, overload and over temperature fault protection
- VSD must allow for isolation at motors while running without damage
- Must be installed to manufactures requirements, with shielded VSD cables and appropriate terminations

Air Handling Units and Fan Coil Units

- All fans should have EC motors or 3 phase motors provided with VSDs.
- Fans and motors must be vibration isolated from the AHU and FCU structure with additional vibration isolation between AHU and FCU boxes and building structure.
- Construction shall be double skinned sandwich panel construction, modular type with easy and safe access, complete with flanges for connection of external ductwork. With fixed locally switch lights where personal access is required for maintenance.
- Internal component velocity limits shall be:
  - Heating coils – 3.8m/s
  - Cooling coils – 2.4m/s
  - Filters – 1.8m/s
- Drip trays shall be stainless steel or aluminium
- External safety trays shall be galvanized steel and separately drained and trapped.
- Where humidification equipment is installed in AHUs , equipment shall be installed strictly in compliance with manufacturer's requirements and between cooling and heating coils, with drip trays continuous between coils.
- For controls, please refer to Section 4.11 Mechanical Controls and BMCS

4.2.4 Alternative Design Options

Geothermal

Geothermal solutions should be considered only for major new build or refurbishment projects. Geothermal involves drilling wells for pipework insertion into the ground for building cooling and heating. It is most suitable for geographic locations with significant low and/or high temperature extremes that negatively impact the efficient operation of air source air conditioning and heating systems. Major project risks include shallow installation of pipes leading to reduction in heating and cooling efficiency, and localised ground heating and/or freezing due to pipe installation being over too small an area to dissipate the heat effectively.

Chilled Beams

Chilled beams rely on induced airflow over coils cooled by chilled water to provide space air conditioning. Chilled beams offer advantages of reduced air conditioning ductwork and fan power consumption. The major project risk is condensation from the beams dropping into the occupied space. This is mitigated by tight control of the space humidity. Chilled beams are suitable for applications where there is no natural ventilation, and outside air can be de-humidified before entering the space.

4.2.5 Potential ESD Initiatives

The following ESD initiatives can be considered when preparing the mechanical design. The list is not exhaustive.

- Use of direct and indirect evaporative cooling in lieu of refrigerant based air conditioning – evaporative cooling provides a level of space cooling with a much smaller energy requirement than standard refrigeration based air conditioning. Evaporative cooling, however does not provide the same level of space temperature control to air conditioning. It is suitable for applications where interior temperature setpoints do not necessarily need to be maintained such as workshops or halls. Note evaporative cooling does require a significant quantity of domestic water for operation.
- High efficiency air conditioning system components in lieu of standard efficiency selections (VRV/VRF, or air cooled chillers). High efficiency systems typically have similar technology to standard systems. The higher efficiency is achieved by oversizing plant so it can operate at part load, and take advantage of higher part load efficiencies. This option will incur a larger plant foot print, and higher capital cost.
- Evaporative cooling pads for air cooled chillers – This option augments the efficiency of air cooled heat rejection. Like the evaporative cooler option, this also requires the use of potable water.
- Economy Cycles – When outside air conditions are cooler than indoor conditions, and air conditioning is required, the quantity of outside air is increased to provide a level of free cooling. This functionality is required by the NCC systems larger than specific thresholds. Consideration could be given to providing this for medium systems with supply air flow rates exceeding 700 L/s. For systems smaller than this economy cycles are typically not cost effective. Economy cycles require additional controls, typically as a minimum a small local BMCS system.
- Energy recovery from outgoing air streams - provide systems with heat exchangers to precondition incoming outside air streams, using recovered energy/heat from outgoing air streams. Typically this is provided by energy recovery ventilators (ERVs), units which incorporate an energy recovery heat exchanger, outside air fan, and relief air fan. These are suitable for applications where there is a continuous exhaust which draws air from an adjacent conditioned space. Examples would be administration areas, with adjacent toilets. Where the exhaust is taken from potentially moisture laden air, sensible only heat exchangers should be provided.
- Relaxed temperature setpoints – consideration could be given to relaxing the temperature setpoints to reduce air conditioning load. For this option to be considered the stakeholders will need to be consulted to discuss the associated implications.
- Interlocks with air conditioning and operable windows – providing automatic shut down of air conditioning when space windows are open. This would typically involve the use of reed switches, which can have questionable reliability, and incur larger maintenance requirements; this option is typically not considered.
- Optimise pump energy, by providing pump speed control based on system pressure drop.

4.2.6 Deliverables

General

Please refer to Section 2.3 Project Design Documents for project deliverables, and specific system deliverables as noted in this section.

- Justification/outline of process for selected cooling system
- Chillers - analysis report outlining factors considered when selecting the pro-posed chiller plant, life cycle analysis, part load provisions

4 Technical Sections

4.3 Process Cooling Systems

4.3.1 Summary

Generally, spaces requiring process cooling system shall be provided with dedicated air-cooled split systems for continuous operation. Typical examples of spaces requiring process cooling are, comms rooms, and server rooms.

Design shall be based on the type of space served, size/capacity of the application, energy consumption/efficiency considerations, building aesthetics, available plant space, specific requirements for a specific space.

Design

- Design calculations
- System selection

Systems

- CRAC units
- Air cooled split units

4.3.2 Design

Design Calculations

- Refer to Section 4.2 Space Cooling Systems" for internal and external load calculations
- TAFE NSW and other services are to confirm the specific equipment heat loads, and ventilation requirements to the mechanical designer, for example UPS rooms will require dedicated exhaust systems in compliance with AS 2676.2.
- Please refer to Section 5 Room Specific Requirements

System Selection

General

Selection of the type of Process cooling system shall take into consideration the following considerations:

- Capacities estimated in Section 4.3.2 Design Calculations
- Energy efficiencies, and ESD requirements
- Life cycle costing,
- Spatial limitations,
- Acoustic performance
- Ongoing maintenance and servicing.
- Availability of suitable maintenance staff.
- Availability of spare parts.
- Redundancy, N+1 requirement
- Level of indoor condition control, will standard commercial air conditioning be sufficient, or are CRAC units required
- Humidity control requirements

4.3.3 Systems

General

Consider the following general design considerations:

- The electrical designer/TAFE NSW are to confirm the expected heat rejection of the plant to be cooled
- Confirm locations of plant to be cooled, typically do not direct air conditioning air directly at plant, ex comms racks.
- Risk of water damage from air conditioning system is to be minimised. Potential mitigation measures include: locating condensate drains away from sensitive plant (ideally outside of room to be cooled), locate fancoil away from plant, provide drip tray under fancoil and piping, provide leak detection in drip tray.

Wall Mounted Split Air Conditioning Units

Refer to Space Cooling Systems - Single Split Air Conditioning Units.

Generally, wall mounted split air conditioning systems with either duty, or duty/standby configuration are suitable for all process cooling installations where specialised temperature control, and humidity control is not required. Avoid locating air conditioning units directly over sensitive electrical equipment and provided separately drained safety drip trays under all units complete with alarmed leak detectors interlocked with air conditioning units. High temperature alarms should be provided to all rooms with interfaces with the BMCs if available, or the security systems to notify suitable staff in the event of a unit failure, over temperature or water leak.

Ducted Split Air Conditioning Units

Refer to Space Cooling Systems - Single Split Air Conditioning Units.

Refer to Space Cooling Systems - Air Handling Units and Fan Coil Units

Generally, these units provide the option of external location to the room served, reducing the potential risk of water leakage within the space, and the need to enter the space to service the unit.

Computer Room Air Conditioning (CRAC) Units

Refer to Space Cooling Systems - Single Split Air Conditioning Units.

Refer to Space Cooling Systems - Air Handling Units and Fan Coil Units.

Typically, only provided where humidity control and tight temperature control are required.

The capital cost for CRAC units is significantly higher than commercial air conditioning systems.

CRAC units can provide humidity control via humidification, de-humidification, and a tighter level of temperature control.

Units can be standalone, or integrated into the room design with a raised floor plenum.

Requires coordination with the design team, and the manufacturer: including potable water connections, high temperature drainage pipework and bunded under floor trays or stand in drip trays at floor level, leak detection and alarm system should be installed with these units with controls interfaces to the BMCS.

Humidification

Refer to Section 4.10 Humidity Control.

Generator Backup

The need for generator backup of critical process cooling applications must be confirmed with TAFE NSW.

4.3.4 Alternative Design Options

The following alternatives should be considered:

- Chilled water versus air cooled units for large systems
- Dedicated air or water-cooled chillers to minimise pipe runs, and provide independent operation from the remainder of the building

4.3.5 Potential ESD Initiatives

The following ESD initiatives can be considered:

- Avoidance of the need for process cooling where possible via the use of distributed electrical plant or alternative equipment selection to minimise internal heat gains for each space.
- Where close control of humidity, temperature and rates of temperature and humidity change are not critical consideration of ventilation only in lieu of process cooling systems.
- Select high efficiency plant, refer to Space Cooling ESD Initiatives.

4.3.6 Deliverables

General

Please refer to Section 2.3 Project Design Documents for project deliverables. The following sub-sections detail deliverables specific to these systems.

- Justification/outline of process for selecting cooling system.

4 Technical Sections

4.4 Heating Systems

4.4.1 Summary

Space Heating design shall be based on the type of space served, size/capacity of the application, energy consumption/efficiency considerations, building aesthetics, available plant space, specific requirements for a specific space.

Non-fossil fuel-based heating technology must be provided. The mechanical design is to avoid the use of fossil fuelled plant, except where alternative means are not practical. Should fossil fuel-based heating be proposed, TAFE NSW approval is required to proceed.

Design

- Design calculations
- System selection

Systems

- Individual split air conditioning systems
- Multi head air conditioning systems and variable refrigerant volume/flow (VRV/VRF) – air source
- Simultaneous heating/cooling chiller
- High level electric radiant heaters (shop areas)
- High level gas fired radiant heaters (shop areas), only to be employed where electricity is not practical
- Air source heat pumps
- Condensing Gas Fired Heaters, only to be employed where electricity is not practical

4.4.2 Design

Design Calculations

- Refer to Section 4.2 Space Cooling Systems for internal and external load calculations
- Please refer to Section 5 Room Specific Requirements

System Selection

General

Selection of the type of heating system shall take into consideration the following considerations:

- Non-fossil fuel-based systems must be provided, except where not practical
- Capacities estimated in 4.4.2 Design Design Calculations
- Energy efficiencies, and ESD requirements
- Volume and type of space to be conditioned, for high volume spaces radiant heating solutions are recommended
- Life cycle costing
- Spatial limitations

- Acoustic performance
- Ongoing maintenance and servicing
- Availability of suitable maintenance staff
- Availability of spare parts
- Underfloor radiant heating is not to be provided for shop areas – there is significant risk to damage to system when drilling into shop floor.
- Combined evaporative cooler/gas heating systems are not to be provided-these have been problematic to operate and maintain.
- All front facing spaces, such as restaurants, salons, reception areas, are to be provided with concealed ducted type heating and air conditioning systems to maximise aesthetic presentation.

4.4.3 Systems

The following subsections detail specific considerations for specific systems.

Individual Split Air Conditioning Systems

Refer to Space Cooling Systems Single Split Air Conditioning Units.

Multi-Head Air Conditioning Systems and Variable Refrigerant Volume

Refer to Space Cooling Systems Multi head and VRF/VRV Air Conditioning Systems.

Simultaneous Heating/Cooling Chillers

- Refer 4.2 Space Cooling Systems – Chillers, Pumps, Water piping systems and Air Handling units and Fan Coil Unit.
- Refer Air Source Heat Pumps below.
- More expensive and complicated than dedicated cooling and heating plant, however can achieve energy savings where heating water and chilled water are required simultaneously.
- Reduced plant footprint, compared to separate chilled water and heating water plant.
- For areas with design temperatures below 0°C consult manufacturer regarding suitability of system for installation in cold climates. The system may require electric or gas fired backup.
- Recommended temperature range for heating water flow and return 55°C to 45°C.

4 Technical Sections
4.4 Heating Systems

High Level Electric Radiant Heaters (Shop Areas, Sports Halls)

- High level shortwave radiant heaters
- Heaters to be fitted with low glare reflectors, to minimise light output
- Units can be either wall or ceiling mounted with manufacturer supplied brackets
- Heater exterior body to be extruded aluminium to reduce impacts of corrosion
- Provide heaters complete with heater manufacturer supplied guards. Removal of guards can only be considered if the heaters are installed in areas where the risk of accidental contact is negligible.
- Heaters to be provided with manufacturer proprietary controls to allow variable control of heater output, scheduling, and time switches
- For controls, please refer to Section 4.11 Mechanical Controls and BMCS

Additional items to consider:

- Minimum mounting height, spacing, and service clearances are to be confirmed with manufacturer during the design process.
- Coordinate installation with other services, and observe minimum service clearances.
- Locate heaters in clearly visible areas to mitigate risk against potential accidental contact.
- The use of electric heaters does not meet the NCC Section J deemed to satisfy (DTS) requirements. Compliance with the NCC will need to be via an alternative solution prepared by the project ESD consultant, and confirmed acceptable by the certifier. A potential option for an alternative solution is to provide additional photovoltaic (PV) capacity to offset the additional electrical load associated with the use of the electric heaters when compared to the hypothetical electric load that would be needed if a DTS compliant heat pump system was provided.

High Level Gas Fired Radiant Heaters (Shop Areas, Sports Halls)

Only to be considered where electric options are not practical. TAFE NSW approval must be received prior to proceeding with this option.

Units to consists of:

- Low intensity gas radiant tube heaters in either straight, U shaped, or double ended patterns.
- Powered gas burner assembly, with flue piped to the outside complete with roof cowl.
- Provide heaters complete with heater manufacturer supplied guards. Removal of guards can only be considered if the heaters are installed in areas where the risk of accidental contact is negligible.
- Heaters to be provided with manufacturer proprietary controls to allow variable control of heater output, scheduling, and time switches
- For controls, please refer to Section 4.11 Mechanical Controls and BMCS

Additional items to consider:

- Minimum mounting height, spacing, and service clearances are to be confirmed with manufacturer during the design process.
- Coordinate installation with other services, and observe minimum service clearances.

- Locate heaters in clearly visible areas to assist to mitigate against potential accidental contact.
- Installation to be compliant with the gas standard AS/NZS 5601.
- Consider acoustic performance of system. The gas heater acoustic performance should be reviewed by an acoustic consultant at the design stage.
- Natural gas, or LP gas piping and supply to be by the hydraulics contractor.

Air Source Heat Pumps

- Typically used in conjunction with chilled water systems and as heat injection systems for condensing water systems.
- Refer to 4.2 Space Cooling Systems – Chillers, Pumps, Water piping systems and Air Handling units and Fan Coil Unit.
- Refer to Simultaneous heating/cooling chiller section.
- Larger footprint and capital cost than gas fired equipment.

Condensing Gas Fired Water Heaters

Only to be considered where an electric option is not practical. TAFE NSW approval must be received prior to proceeding with this option.

Refer to 4.2 Space Cooling Systems – Pumps, Water piping systems and Air Handling units and Fan Coil Unit.

Condensing gas fired heater considerations:

- Not carbon neutral and sites require gas supply or bottled gas.
- Running cost higher than air source heat pumps however lower capital cost.
- Stainless steel flues and acid neutralizer required as condensate contains sulphuric acid which is corrosive
- Bypass line and dedicate pumps required to ensure minimum flows achieved.
- Shall be factory assembled completed with all fans, burners, insulations, gas valve trains, safety valves and dedicated control systems.
- To realize the water heater condensing efficiency, return water temperatures should be set below 54oC. Note if a non-condensing water heater is selected return water temperatures should be above 55oC to prevent condensation which can corrode the unit.

4.4.4 Potential ESD Initiatives

General

Generally, all mechanical plant and systems will be variable speed and variable capacity systems to allow future flexibly and minimum energy use. Where possible variation in capacity shall be achieved via speed modulation of mechanical plant and via system temperature resets, rather than bypassing or artificially loading of systems

The following ESD initiatives should be considered for inclusion in the mechanical services:

- Refer to 4.2 Space Cooling Systems
- Condensing gas fire water heaters – If it is necessary to provide fossil fuel fired plant, (no electrical option is available), provide high efficiency condensing water heaters.

4.4.5 Deliverables

General

Please refer to Section 2.3 Project Design Documents for project deliverables, and specific system deliverables as noted in this section.

- Justification/outline of process for selected heating system

4 Technical Sections

4.5 Ventilation Systems

4.5.1 Summary

Ventilation design shall be based on the type of space served, size/capacity of the application, energy consumption/efficiency considerations, building aesthetics, available plant space, specific requirements for a specific space.

To be designed in conjunction with the space heating and cooling systems, refer to Sections 4.2 and 4.4 of this Design Standard.

Design

- Design calculations
- System selection

Systems

- Natural
- Mechanical
- Kitchen exhaust
- Fans
- Ducts
- Inlets
- Exhaust
- Roof ventilators

4.5.2 Design

Design Calculations

For estimation of system capacities take into consideration the following factors:

- Please refer to Section 5 Room Specific Requirements
- Space occupancy and usage details are to be provided by TAFE NSW during design phase
- Exhaust rate necessary for contaminate control.
- Outside air rates sufficient to serve as make up for the exhaust systems
- Incorporate 15% safety factor for occupancy allowance into the calculations where practical

The requirements listed in Section 5 Room Specific Requirements are to be considered in conjunction with:

- AIRAH Air Conditioning Load Estimation Manual DA 9 for internal and external load calculations of non-airconditioned spaces requiring ventilation to limit excessive temperatures.
- ASHRAE Standard 55 for Human Comfort For Occupied Spaces Without Air Conditioning.
- ACGIH Industrial Ventilation : A Manual of Recommended Practice, as applicable to the space served/pollutant generated.

4 Technical Sections

4.5 Ventilation Systems

Final ventilation rates must comply with the relevant statutory requirements in the appropriate order of precedence:

- NCC, and Specific NSW legislation requirements, including any active NSW Government public health orders mandating ventilation requirements.
- AS1668.2 revision referenced in the current NCC.
- Safe Work Australia – Workplace exposure standards for airborne contaminants for standard of performance,
- Any project sustainability or green building initiatives – typically these call for increased ventilation rates, or CO_2 demand control. Refer to the TAFE NSW Sustainability Design Standard.

System Selection

General

Selection of the type of ventilation system shall take into consideration the following considerations:

- CO_2 demand control mechanical outside air ventilation must be provided where practical
- Capacities estimated in 4.5.2 Design Design calculations
- Ventilation effectiveness
- Energy efficiencies, and ESD requirements
- Life cycle costing
- Spatial limitations
- Acoustic performance
- Ongoing maintenance and servicing
- Availability of suitable maintenance staff
- Availability of spare parts

System complexity, cost and maintenance requirements are expected to increase in ascending order for the following systems:

- Natural ventilation
- Local and general ventilation
- Filtered recirculatory systems for example alternative solutions for kitchen exhaust using high efficiency filtration to allow low level exhaust.

Generally, it is preferred to use the simplest system with the lowest maintenance requirement that can achieve the mandatory minimum system ventilation rates, design capacities and any project specific ESD requirements. For the selected systems the designers need to justify that the level of complexity of the selected systems are warranted by the projects requirements and can achieved with in the limited project budgets.

4.5.3 Systems

The following subsections detail specific considerations for individual systems.

Natural Ventilation

Natural ventilation is suitable:

- Where mechanical ventilation is not practical – i.e. existing learning spaces with minimal ceiling void space, or large well ventilated spaces
- Where mechanical ventilation would add excessive complexity – for example: the requirements set out by AS5601 (Natural Gas), AS4333 (Cylinder storage) etc. natural ventilation via louvres directly to outside is preferred over a mechanical system

Natural ventilation considerations:

- Must comply with the NCC, and should comply with AS1668.4
- Where practical provide designs that facilitate cross flow ventilation, with natural ventilation openings on two opposite façade exposures.
- Consider low level intakes, and high level reliefs, for improved heat rejection
- Natural ventilation must only be considered where outside air quality is considered suitable for natural ventilation, and adjacent acoustic transmitters are not too loud to force the windows to remain closed to achieve an acceptable interior acoustic performance.

Mechanical Ventilation

- Comply with AS1668.2
- CO_2 demand control ventilation must be provided to modulate outside air rates based on occupancy levels. Typical set points are 600 to 800 PPM for CO_2 concentration thresholds. Refer to AS1668.2 for details.
- When providing a demand control outside air system, building make up air requirements for exhaust systems must be considered. The overall air balance should be maintained as slightly positive to minimise infiltration.
- Select outdoor air intakes to minimise risk of outside air stream contamination.
- Provide filtration on outside air systems as required for AS1668.2 compliance or as necessary to limit ingress of outside air pollutants. As a minimum provide G4 filtration on all outside air systems before the air is delivered to the space. Can be via integral air conditioning unit filter.
- For improved contaminant and heat rejection consider providing a cross ventilated design with low level make up air intakes and high level exhaust/relief.

Kitchen Exhaust

- Must comply with AS1668. 1 and 2.
- High efficiency/low exhaust rate hoods are preferred over NCC deemed to satisfy hoods, washable grease filters are required.

- Make up must be filtered and introduced into kitchens in a manner that does not reduce the effectiveness of the exhaust systems, or cause discomfort to occupants.
- Discharges must be in compliance with AS1668.2, typically vertical for airflows of 1000 L/s or greater, and located such that they do not provide a disturbance, or contaminate air intake openings.
- To minimise potential grease build up horizontal duct runs should be minimised.
- Maintenance access for cleaning of ductwork must be provided inline with AS1668.1, drainage at all system low points with ducts graded back to the hoods at a minimum grade of 0.5%. Access panels shall be mounted of the side of the ducts with neoprene gasketed to prevent any leakage of liquid or air from the duct.
- Ducts shall be constructed as per AS4254.2.

Fans

- Generally to be designed in accordance with AIRAH's Fans Design Manuals DA 13
- Selected with 10% spare flow capacity at the design pressure
- Noise
- Energy use
- Construction shall be rigid, airtight, corrosion resistant
- Impellers shall be statically and dynamically balanced and have flexible mounts and connections for vibration isolation
- Motors to be total enclosed induction motors or EC type with local electrical isolation
- Motors shall be speed controllable via VSD or electronic speed controllers with sine wave filters as required for any external rotor motors
- Direct drive is preferred to belt driven, where belt driven, provisions shall be made for belt tensioning
- All potentially accessible rotating elements shall be protected with demountable finger and belt guards and the like
- Kitchen exhaust fans must be corrosion protected and have provisions for cleaning, drainage and leak tight gasketed access panels. Specialised fans design for grease laden are preferred, for example bifurcated fans

Ducts

- To be designed in accordance with AIRAH's Ductwork Design Manuals DA 03
- Complying with AS4254.1, 2 and SMACNA Standard.

4.5 Ventilation Systems

- Materials – generally galvanized mild steel with a minimum zine coating of Z275, except for – swimming pools, humidifiers, directly behind outside air inlets or otherwise exposed to highly humid or corrosive environments, where aluminium or stainless steel is recommended.
- Plastic ducting can be considered for excessively corrosive applications such as fume cupboard, or pool balance tank exhaust. Note If plastic piping is considered a fire engineering solution will be required for the project. Refer to Section 4.12 Smoke Hazard Management for further details.
- Insulation – generally metal perforated faced, internally lined except where moisture might be present in the ducting. In this instance naked ducting with external insulation is preferred. Should internal insulation be required for acoustic reasons, it must be treated with factory applied mylar or moisture impervious liner. If this is to be provided ongoing servicing provisions are to be considered.
- Unless required for dust transport or similar (See Section 4.8 Dust control) duct velocities shall not be greater than:

Duct work	Velocity limit (m/s)
Main Riser, Main Duct Run	7.5
Branches	6.0
Terminal runs to diffusers/from grilles	3.5
Flexible ducts	3.5

  - Note - the NCC may require lower duct velocities.
  - Duct static pressure drop shall not exceed 0.8 Pa/m

- Recommend to provide of 3m of minimum 50mm internally lined acoustic ductwork either side of all Fans, FCU, AHUs.
- Lockable balancing provisions to be provided to enable system design flow to be balance to within +10%, -0%. And at least in the following locations:

Location	Type
Floor take off	Opposed blade damper
Major branch	Opposed blade damper
Spigot connection for Flexible duct	Butterfly

- External ductwork
- All longitudinal and transverse joints shall be sealed with a flexible UV stable mastic, be free draining, have top hat sections over all flanges, joints and flexible connections.
- Be installed with 200mm clear beneath them for cleaning and where penetrating the roof have 200mm high under flashing.
- Where exposed to high winds shall be suitably fixed to the roof structure via a method approved by the structural engineer.
- External galvanized mild steel ducts shall have their zinc coating thickness adjusted to suit location with Z275 as a minimum and Z600 for more coastal environments

Diffusers, Grilles and Relief/Return Air Paths

- Velocity limit of 2.5m/s face velocity for all return and exhaust air grille
- Locations of supply and return/exhaust fittings to avoid short circuiting and stagnation.
- Aluminium, painted in colours approved by the architect
- Door undercuts and grilles only to be considered for spaces which are not acoustically sensitive.
- Door grilles shall be limited to 1m/s face velocity and only to be used.
- For all acoustically sensitive spaces 50mm internally lagged transfer air ducts shall be used with a minimum of 2-off, 90^{o} bends, greater than 1.5m of duct length and no line of sight through ductwork.
- Ducted return air systems shall be used in all attic spaces, return air ceiling plenum systems in these areas are not permitted.
- All supply and return diffusers and grilles shall be provided with internally lagged plenum boxes and all supply air fittings shall be provided with air pattern adjustment.
- Final space air velocities shall be suitable to the space served. For example, offices and general learning spaces air velocities shall comply with the requirements of ASHRAE Standard 55, while supply air and makeup air introduced to a space shall not negatively impact on the operation of any local exhaust hoods, fume cupboards and the like.
- Diffuser selection shall take into consideration both winter heating and summer cooling requirements and avoid stagnation of hot air at high level in heating and drafts in cooling. Where diffusers require reconfiguration between heating and cooling adjustment shall be automatic.

Filtration

Generally with the exception of car parks and most workshops, outside air and makeup air shall be filtered prior to introduction to the buildings occupied spaces.

- Filters shall be installed at a sufficient distance from outside air inlets to avoid being effected by moisture ingress, and plenums behind inlet louvre shall fall to outside at a minimum of 1:200 without any ponding.
- All filter shall be sealed to avoid any bypass of unfiltered air.
- Safe and easy access shall be allowed for the testing of any HEPA filters
- Types of filtration shall be:

Air Handling Units	Deep bed filters and G4 panel filters
Fan Coil Units	Panel filters
Kitchen exhaust hoods	Aluminium honeycomb

- Filtration maximum velocities shall be 1.8m/s generally and 0.45m/s for HEPA filtration.
- Magnehelic gauges shall be provided with clean and dirty pressures indicated. Gauge deflection shall be no more than 2 times total dirty pressures.

Inlet, Relief and Exhaust Louvres

- Aluminium, weatherproof, corrosion resistant, complete with vermin proof mesh, and painted in a colour approved by the architect.
- Inlet louvres shall be sized to avoid, as far as possible, any ingress of water and to drain to the façade with no ponding.
- Inlet Face velocities to be limited to a maximum of 2.5m/s
- Exhaust face velocities to be limited to 2.5m/s face velocity.
- Louvre sizing calculations to be confirmed against specific manufacturer data.

Exhausts

- Exhaust discharge locations to comply with AS1668.2.
- Consider additional guidance for to prevent contamination of incoming airstreams and ventilation openings, ACGIH's Industrial Ventilation a Manual of Recommend Practice, Section 5.15 and Figures 5-31,5-32 and 5-33 for guidance for fume cupboards, Kitchen exhaust, generator flues, smoke exhausts and the like these exhausts can require greater than 6m separation to avoid contaminating building inlet air.
- Provide drainage for all vertically discharging exhausts not provided with rain proof discharge dampers. Where drainage discharge is likely to contain grease consider piping it to a trade waste.
- Locate high velocity discharges as far as practical from boundaries and sensitive receives.

Roof Ventilators

Generally – can be used to supplement or as part of natural ventilation provisions.

Where minimum space internal comfort conditions are to be maintained, units are to be provided with motorized dampers to allow openings to be closed when not required, and in winter.

Typical roof ventilator configurations to consider:

- Wind driven
- Hybrid, wind driven with electric motor assist
- Electric powered motor

Consider potential water ingress risk when specifying. Water can enter via poorly sealed roof penetrations, or in the case of extreme driving rain the roof ventilators themselves.

4.5.4 Alternative Design Options

High efficiency filtration to allow reduction of outside air rates, potential reduction air conditioning/heating energy usage, but increase in fan power, and servicing requirements. Some split, and VRF/VRV fancoil units do not have sufficient static pressure to support higher efficiency filters.

Commercial kitchen exhaust treatment – if it is not practical to locate the kitchen exhaust discharge sufficiently far away from building openings, or property boundaries, treating of the kitchen exhaust could be considered. This would typically involve the combination of electrostatic filtration, combined with ozone generation. The filtration provided is to be by a reputable filtration provider and come complete with AS1668.2 equivalency test certificate. Note filtration does not fully remove the odour and grease from the discharge, as such the location of discharges in highly sensitive areas even with filtration is not recommended.

4.5.5 Potential ESD Initiatives

Generally all mechanical plant and systems will be variable speed and variable capacity systems to allow future flexibly and minimum energy use. Where possible variation in capacity shall be achieved via speed modulation of mechanical plant and via system temperature resets, rather than bypassing or artificially loading of systems.

The following ESD initiatives can be considered for inclusion where suitable.

- Hybrid roof ventilators, where motors only activate when there is insufficient wind power

4.5.6 Deliverables

General

Please refer to Section 2.3 Project Design Documents for project deliverables. The following sub-sections detail deliverables specific to these systems.

- Justification/outside of process for selecting ventilation system.

4 Technical Sections

4.6 Compressed Air and Workshop Gas Systems

4.6.1 Summary

Compressed air and workshop gas system design requirements must be confirmed by TAFE NSW at the design stage for each project.

Gas installation and associated controls must be carried out by a specialised industrial gas subcontractor.

Design

- Design calculations
- System selection

Systems

- Compressed air systems
- Acetylene and Oxygen systems
- Shielding Gasses for electric welding, refer to TAFE NSW Welding Bay Design Standard
- Gas alarms
- CO_2 gases for Retail training spaces
- Medical Gas
- Cylinder storage systems
- Cryogenic storage systems and Bulk storage systems
- Compressed air plant
- Piping systems
- Manifolds
- Terminals and fittings

4.6.2 Design

Design Calculations

For estimation of system capacities utilise industry standards to estimate peak system loads, taking into consideration the following factors:

Standards

- AS 4289 Oxygen and Acetylene Gas Reticulation Systems: (systems size limits and pressure limits)
- AS 2896 Medical Gas Systems – Installation and testing of non–flammable medical gas pipe line systems: (general system configuration and component sizes , CO_2 gas bottle limits)
- AIRAH Handbook: (diversity factors, pipe sizes)

Initial Design allowances and considerations

- Heating, cutting, brazing, soldering gases: 40L/minute/terminal
- Shielding gases for electric welding: refer to TAFE NSW Welding Bay Design Standard
- Compressed air for workshop equipment: 120L/minute /terminal
- System diversity factors to AIRAH Handbook “Diversity – Medical Gases”
- Incorporate 10% safety factor into the calculations

- For bottles gas minimum storage the greater of 1 week (connected) + 1 week (spare) – or 2 x minimum delivery time.
- For Liquified Gases the greater of 1.5 weeks or 1.5 x minimum delivery time.
- External conditions refer Space Cooling Systems Section 4.2.2 Design

System Selection

General

Selection of the type of gas system shall take into consideration the following considerations:

- Capacities estimated in Section 4.6.2 Design - Design Calculations
- Life cycle costing
- Spatial limitations
- Acoustic considerations – compressors and concentrators and delivery noise
- Delivery limitations – truck access, overhead clearances
- Ongoing maintenance and servicing
- Availability of suitable maintenance staff
- Availability of spare parts

4.6.3 Systems

The following subsections detail specific considerations for individual systems.

Compressed Air Systems

General design to AS2896 Section 2.9 and L.8 with the following amendments which are to be confirmed with TAFE NSW at the time of design.

- Duty only compressors, dryers, filtration
- No carbon filtration or secondary filtration required
- Oil free compressor
- Supply pressures – 8 bar at terminals (adjustable)
- Inline oilers
- Pressure dew points external ambient minimums

Acetylene and Oxygen Systems

- To AS 4289
- Proof that installers are “Competent Personnel” is required in writing from installing staff confirming relevant experience with AS4289 systems.
- Note Gas and Electricity (Consumer Safety) Regulation and associated statuary requirements.
- Provide flashback arrestors at all regulator outlets and torch inlets.
- The designer must confirm the project specific requirements with TAFE NSW. Portable systems with bottles should be considered.

4.6 Compressed Air and Workshop Gas Systems

Shielding Gases for Electric Welding

Refer to the TAFE NSW Welding Bay Design Standard for further details.

Gas Alarms

Gas alarms must be considered for all areas where gases are stored and piped. These must comply with the following:

- AS 4332
- Work Health and Safety Regulations
- Where the potential gas concentration in a space exceeds 5% greater of the Lower Explosive Limit/Lower Flammability Limit (LEL/LFL), a specialist review of mitigation and monitoring and alarm measures must be conducted as per AS 4332.
- Typical gas alarms will include: oxygen depletion, oxygen enrichment, high flammability.

CO_2 gases for Retail Training Spaces

General design to AS2896 Section 2.4 and L.2 with the following amendments which are to be confirmed with TAFE NSW at the time of design.

- Supply pressures – 8 bar at terminals (adjustable)
- Note AS 2896 section 2.4.10 Liquefied gases in cylinders for CO_2 installations.

Medical Gases

- To AS2896
- Note Gas and Electricity (consumer Safety) Regulation and associated statuary requirements.

Cylinder Storage Systems

To comply with AS 4332 – The Storage and Handling of Gases in Cylinders.

Generally:

- External to comply with Major storage requirements of AS4332
- Not underground or in basements
- Easy, level access required
- No overhead power lines or building structures preventing offloading with articulated arms.
- Concrete off-loading area
- Naturally ventilated
- AS 4289 Oxygen and Acetylene gas reticulated systems
- Drains or sump pits to not be provided in bottle storage areas as per standards

4 Technical Sections

4.6 Compressed Air and Workshop Gas Systems

Cryogenic Storage Systems and Bulk Storage Systems

- Cryogenic storage to AS 1894 – The storage and handling of non-flammable cryogenic and refrigerated liquids.
- LP gas to AS 1596 – The storage and handling of LP Gas

General

- External, not underground or in basements
- Easy, level access required
- Concrete off-loading area
- Naturally ventilated

Note additional in:

- AS 4289 Oxygen and Acetylene gas reticulated systems

Compressed Air Plant

General

- Preferably Installed in acoustically rated, naturally ventilated plant rooms
- Ventilation to limit internal temperatures to 10°C above ambient, taking into consideration the maximum heat rejection of the compressors and drying plant.
- Local drainage required for condensate.
- Easy access for maintenance required.

Piping Systems

To comply with:

- AS 2896 – Medical Gas Systems, Section 4 installation requirement for pipelines (non-flammable gases and compressed air)
- AS 4289 – Oxygen and Acetylene gas reticulation systems
- AS 5601 for LG gas and NG systems – refer to the TAFE NSW Design Standard Hydraulics

General requirements:

- Designed to AIRAH Handbook: (diversity factors, pipe sizes) to suit capacities calculated in Section 4.6.2 Design
- Copper with brazed joints only except for Acetylene gas which shall be stainless steel joined in accordance with AS 4289.
- For workshop compressed air systems without dryers, Pipe falls 1:200 to 2 x 15mm drains c/w ball valves at end of lines and where pipe step up in ceilings and adjacent to each group of terminal BSP fittings a drier/oiler/filter unit is to be provided

Manifolds

Cylinder Manifolds

- Automatic change over manifolds required
- Alarms to AS 2896 section 3.2

Terminals and Fittings

General

- For workshops quick connect ¼ BSP type
- To suit equipment served

Confirm final details with TAFE NSW.

4.6.4 Alternative Design Options

Avoidance of reticulated systems via the use of Portable or mobile oxy-fuel gas systems to AS4839.

Gas concentrators for N_2 and O_2 systems.

4.6.5 Deliverables

General

Please refer to Section 2.3 Project Design Documents for project deliverables. The following sub-sections detail deliverables specific to these systems.

- Justification/outline of process for selection of systems including design flow calculations.

4 Technical Sections

4.7 Fume and Chemical Extraction Systems

4.7.1 Summary

Extraction and filtration systems design shall be based on the type of effluent produced and statuary requirements for control, key design factors/ details:

Design

- Design calculations
- System selection

Systems

- Welding exhaust
- Grinding exhaust
- Fume cupboards
- Chemical Stores
- Other specialised exhausts

4.7.2 Design

Design Calculations

For estimation of system capacities utilise industry standards to estimate peak system loads, taking into consideration the following factors:

Industry standards

- ACGIH Industrial Ventilation – a manual of recommended practice. (for welding and specialised exhausts)
- AS 4326 The storage and handling of oxidizing agents
- AS 1940 The Storage and handling of flammable and combustible liquids
- AS/NZS 2982 Laboratory design and construction, (for chemical stores and hazardous substances)
- AS/NZS 2243. 8 Fume cupboards
- Safe Work Australia – Workplace exposure standards for airborne contaminants
- AS 1668.2 The use of ventilation and air conditioning in buildings.

Design factors

- Refer to Ductwork and Exhausts in Section 4.5.3 Ventilation - Systems
- Please refer to Section 5 Room Specific Requirements
- Incorporate 10% safety factor into the calculations
- For Fume Cupboards flowrates to be as specified by manufacturer of hood.

4 Technical Sections

4.7 Fume and Chemical Extraction Systems

System Selection

General

Selection of the type of extraction and filtration system shall take into consideration the following considerations:

- Recirculating systems using filtration which discharge back into the occupied spaces are generally not acceptable.
- Capacities estimated in Section 4.7.2 Design - Design Calculations
- Life cycle costing
- Spatial limitations
- Acoustic performance
- Ongoing maintenance and servicing
- Availability of suitable maintenance staff
- Availability of spare parts.

4.7.3 Systems

For the selected systems the designers need to justify that the level of complexity of the selected systems are warranted by the projects requirements and can achieved with in the limited project budgets.

The following subsections detail specific considerations for individual systems and system components of the above systems.

Welding Exhaust

Refer to the TAFE NSW Welding Bay Design Standard for further details.

Grinding Exhaust

Local exhausts must be provided either via purpose built downdraft tables, or retractable/adjustable hoods (similar to welding hoods), refer to the TAFE NSW Welding Bay Design Standard for hood details. Confirm project specific preferences with TAFE NSW stakeholders at design stage.

Extraction systems for the local exhaust must be via a purpose built dust control system, refer to Section4.8 of this standard.

Fume Cupboards

Confirm with TAFE NSW for each installation general requirements are:

- 0.5m/s face velocity with sash fully open, 7m/s duct exhaust velocity,
- Constant velocity hoods with bypass valves, where room pressures differences are specified otherwise variable speed fans and VSDs.
- Fume hoods to be selected based on consultation with manufacturer and project specific needs as confirmed by TAFE NSW.
- Exhaust fan to be UV stable plastic complete with drains, vertical discharges >3 m above the finish roof level or at a hight or 1.25 x the hight of the building – greatest of.
- Fan motors to be 3 phase direct drive IP56 complete with local isolation and VSD driven.
- Hoods to be NATA certified.

- Plastic corrosion resistant ducting to be provided. This will require a fire engineering solution. Refer to Section 4.12 Smoke Hazard Management of this Design Standard.
- Consider room air balance, and provide provision to maintain balance for all sash positions.

Items to be clarified with TAFE NSW:

- Activities conducted
- Chemicals employed
- Single of double side opening
- Minimum internal clear size
- Piped gas
- Electrical, and data
- Lighting
- Drainage and scrubbing
- Water supply (hot, cold, RO, potable)
- Alarm
- Fire mode isolation of services.

Chemical Stores

Generally non ventilated chemical cabinets or external naturally ventilated stores are preferred.

- Coordinate TAFE NSW requirements with end users.
- Conform with Dangerous goods report requirements.

Discharges

Systems discharges must be designed in accordance with AS1668.2, and shall exhaust vertically and shall be designed to prevent any recirculation of effluent back into the building. - Refer ACGIH's Industrial Ventilation a Manual of Recommend Practice, Section 5.15 and Figures 5-31,5-32 and 5-33 for guidance.

4.7.4 Deliverables

General

Please refer to Section 2.3 Project Design Documents for project deliverables. The following sub-sections detail deliverables specific to these systems.

- Justification/outline of process for selection of exhaust system type and capacity, exhaust location and makeup air systems.

4 Technical Sections

4.8 Dust Control

4.8.1 Summary

The dust control system design shall be based on the type of dust transported, filtration requirements and numbers and types of inlets, key design factors/details:

Design

- Design calculations
- System selection

Systems

- Dust extraction systems
- Filtration
- Ducts
- Inlets
- Wood dust recirculating filtration units

4.8.2 Design

Design Calculations

For estimation of system capacities utilise industry standard

- ACGIH Industrial ventilation – A Manual of Recommended Practice to estimate peak system loads
- Safe Work Australia – Workplace exposure standards for airborne contaminants for standard of performance,

The following should be considered:

- Please refer to Section 5 Room Specific Requirements
- Exposure standards of dust to be controlled.
- Explosion venting, To the NAPA 68 Guide for explosion venting.

System Selection

General

Selection of the type of duct filtration system shall take into consideration the following considerations:

- Consideration and Capacities estimated in Section 4.8.2 Design Calculations
- Life cycle costing
- Spatial limitations
- Acoustic performance
- Ongoing maintenance and servicing
- Availability of suitable maintenance staff
- Availability of spare parts

4.8.3 Systems

The following subsections detail specific considerations for individual systems and system components.

Dust Extraction Systems

Generally, the system consists of local exhaust points connected to dust extraction plant.

- Wood dust extraction system is not to be combined with any other extraction system.
- For wood dust, provide a minimum of 1-off sweepout per work zone
- Dust extraction units shall be located in acoustic enclosures
- Explosion venting and isolation shall be provided.
- Dust hoppers shall be handled by forklifts and with sufficient capacity to only need emptying once a day.
- Spare hoppers shall be provided for transport of dust.
- Rotary valves will be used to isolate the hoppers from the vacuum in the filtration unit.
- Compressed air or filter shakers shall be provided to automatically clean the fabric filers for continuous operation.
- A potable water tap and hose shall be provided adjacent to the filtration units hoppers for dust control while changing hoppers.
- VSDs shall be provided for unit variable speed operation, and balancing
- Silencers shall be specified.
- Access panels shall be provided as required remove any blockages.
- Consider unit spatial requirements at design stage, including allowance for servicing and waste collection.
- Units to be constructed from corrosion protected, welded and bolted steel plates on a free-standing frame. Units to be automatically self-cleaning, have all necessary demountable access panels, be provided with suitable explosion venting to NAPA 68 to ensure the safety staff and personnel in the event of a dust explosion. Units to be provided with VSD driven 3 phase fans will thermal overload, fault and mechanical over load protection.
- TAFE NSW to confirm expected level of work shop usage. Estimate the usage diversity factor; this is typically 85% -100%. Once established it is recommended for it to be reviewed with the perspective unit manufacturer/supplier during the unit selection process.
- TAFE NSW to confirm if an allowance for potential future expansion should be incorporated into the design.

Filtration

See Dust Extraction Systems above.

Generally fabric collectors are used to achieve the reduction in airborne contaminant required by Safe Work Australia see:

- Safe Work Australia – Workplace exposure standards for airborne contaminants for standard of performance,
- Filtration ACGIH Section 4.4 and 4.7 – Unit collectors, fabric collectors

4.8 Dust Control

Dust Extraction Ducting

Generally design in accordance with AGCIH Industrial Ventilation, Section 5.19, Figures 5-15 to 5-33. with:

- Duct velocities to ACGIH Section 3.6, specific for materials to be exhausted, typically in the order of 18-20 m/s
- Round Galvanised steel ducts rated for + 2.5kPa.
- Minimum radius bends of 2 or greater,
- Branch connections not to exceed 45º,
- Transitions to less than 30º,
- Clean out door provided at all elbows, junctions and risers and every 3 to 4m

Inlets

Generally, in compliance with ACGIH Industrial Ventilation Sections 10.95 for wood, Section 10.80 for cleaning, grinding, buffing and polishing.

All inlets to be complete with sliding isolation gate.

Nominal exhaust values are as follows, final flowrates to suit equipment selected and material processed)

Wood

- Typical exhaust allowances shall be 350L/s/machine service by extraction system, to be modified as needed for specific plant.
- Rip Saw 377L/s
- Horizonal sanders 208L/s
- Planers 370L/s
- Molders 165L/s
- Wood lathe 350L/s
- Router 350L/s
- Band saw 180L/s
- Table Saw 210L/s
- Radial Arm saw 235L/s
- Swing Saw 210L/s
- Joiners 260 L/s

Metal/other materials

- Grinding Wheels 350L/s
- Surface grinder 210L/s
- Buffing and polishing 290L/s

Discharges

Systems discharges shall exhaust vertically and shall be designed to prevent any recirculation of effluent back into the building. Refer ACGIH's Industrial Ventilation a Manual of Recommend Practice, Section 5.15 and Figures 5-31,5-32 and 5-33 for guidance.

Wood Dust Recirculating Filtration Units

These units are not to be provided in lieu the wood dust extraction system, or general room ventilation. These units are recommended as a means to further improve air quality within a space.

Recirculating filtration units shall achieve an air change rate of at least 10 air changes an hour and filter air to 2 microns or better.

Controls shall be wired and wall mounted.

4.8.4 Deliverables

General

Please refer to Section 2.3 Project Design Documents for project deliverables. The following sub-sections detail deliverables specific to these systems.

- Justification/outline of process for selecting system
- Maintenance and access provisions showing forklift access, cleaning of filtration units and ducts.
- Details of explosion prevention provisions
- Details of acoustic provisions
- Design diversity factors

4 Technical Sections

4.9 Cool Rooms

4.9.1 Summary

Cool rooms design shall be based on the cool room functional requirement (product type, temperature requirements, cool down times, hours of use etc.), capacity of the applications, energy consumption, efficiency considerations, buildings aesthetics, available plant space, Key design factors/details:

Design

- Design calculations
- System selection

Systems

- Cool room and freezer refrigeration systems
- Cool room and freezer room construction

4.9.2 Design

Design Calculations

For estimation of system capacities utilise industry standards (AIRAH) to estimate peak system loads, taking into consideration the following factors:

- Refer to Section 4.2 Space Cooling Systems for external design conditions
- AIRAH Design Manual - DA12 Energy Efficiency in Cold Rooms
- AIRAH Handbook – Refrigeration
- Compliance with AS NZS 5149.
- For plant capacity calculations recommended to use specialised plant sizing program provided by specialized refrigeration suppliers
- Incorporate 10% safety factor into the calculations
- Design load to allow for
    - Transmission loads,
    - Product loads,
    - Internal loads,
    - Cool down times,
    - Infiltration and ventilation loads (if occupied),
    - Evaporator fan loads and defrost cycles,
    - Floor drains and door heating elements.
- System capacity shall be such that design loads shall be met with the system running a maximum of 16 hours a day on a design day.
- Liquid receivers shall be sized to accommodate 120% of liquid refrigerant volume.

4 Technical Sections

4.9 Cool Rooms

System Selection

General

Selection of the type of cool room system shall take into consideration the following considerations:

- Capacities estimated in Section 4.9.2 Design - Design Calculations
- Energy efficiencies, and ESD requirements
- Life cycle costing
- Spatial limitations
- Acoustic performance
- Ongoing maintenance and servicing
- Availability of suitable maintenance staff
- Availability of spare parts

4.9.3 Systems

The following subsections detail specific considerations for individual systems.

Cool Room and Freezer Refrigeration Systems

Generally system minimum requirements to include:

- Microprocessor controls and electronic sensors
- High level interfaces (BCAnet) where BMCS is installed.
- Cool room refrigeration systems shall be designed to achieve space humidity control suitable for the product store via the limitation of evaporator temperature differences (see AIRAH Handbook – Refrigeration).
- Systems are to be complete with auto defrost cycle
- High efficiency evaporators and condensers
- EC motors for evaporators and condensers.
- Electronic Expansion Valves.
- Insulated refrigeration piping with all external piping metal clad.
- Condensers shall be located externally with good air flow and not exposed to direct sun.
- Minimise pipe runs.
- Each cool room shall have a separate dedicated refrigeration system.
- Systems shall have low temperature difference condensers with a maximum temperature difference of 5°C
- Do not use Toxic or Flammable refrigerants
- Provision of refrigerant monitoring as required by AS 5149
- All evaporator condensate drains shall be externally insulated and heat traced.

4 Technical Sections

4.9 Cool Rooms

Cool and Freezer Room Construction

Generally preferred to use preassembled cool rooms manufactured by a suppler specialising in cool room and freezer construction.

- LED lights shall be used with occupancy sensors or timers
- Quick acting roller doors
- Optimise defrost heating of floors, doors, drainage lines and drains to minimise heat input while not comprising their function.
- Provide heated floors for all cool rooms and freezers with design temperatures below 5°C, and where installed on a suspended slab.
- Provide heated door frames for all cool rooms and freezers
- Provide heat tracing for all condensate drain piping within cool rooms and freezers.
- Generally constructed from cool room panels should consist of white pre-painted, galvanized mild steel sheets > 0.6mm cladding, Polyisocyanurate (PIR), Factory Mutual (FM) rated fire resistant insulation core and extruded aluminium sections and fittings, design to avoid thermal bridging and providing a continuous vapor barrier.
- Insulation thickness to be not less than:

PIR Minimum thickness (mm)	Minimum temperature
65	-5°C
65	-10°C
80	-15°C
95	-20°C

- Cool room panel, framing and fitting joints shall be sealed with a flexible non-hardening mastic suitable the maximum and minimum operation temperatures
- Cool room panel ceilings shall be trafficable without the need for external bracing or guywires.
- Floors shall be constructed from expanded polystyrene foam under a hardened, waterproof and sealed concrete screed complete with vapor barrier and floor heating element and shall be designed to withstand service loads without cracking or deformation. Floors and walls shall be sealed to prevent leakage during washdown
- The designer is to coordinate any slab setdown requirements during the design stage.

4.9.4 Potential ESD initiatives

The following ESD initiatives should be considered:

- Increase level of cool room insulation to allow reduction in size of refrigeration plant
- Locate condensers in shaded well ventilated areas for maximum heat rejection efficiency
- Provide invertor style variable speed refrigeration plant for improved part load efficiencies.

4.9.5 Deliverables

General

Please refer to Section 2.3 Project Design Documents for project deliverables. The following sub-sections detail deliverables specific to these systems.

- Justification for type, temperature and size of cool room systems
- Maintenance access

4 Technical Sections

4.10 Humidity Control

4.10.1 Summary

Applications include specialised spaces that require close humidity control, for example mainframe server rooms, and archive stores.

Design

- Design calculations
- System selection

Systems

- Steam-electric
- Ultrasonic
- Evaporative
- Room Sealing

4.10.2 Design

Design Calculations

For estimation of system capacities estimate peak system loads, taking into consideration the following factors:

- Refer to Section 4.2 Space Cooling Systems for internal and external load calculations
- Please refer to Section 5 Room Specific Requirements
- Incorporate 10% safety factor into the calculations

System Selection

General

Selection of the type of Humidification system shall take into consideration the following considerations:

- Capacities estimated in Section 4.10.2 Design Design calculations
- Energy efficiencies, and ESD requirements
- Life cycle costing
- Spatial limitations
- Ongoing maintenance and servicing
- Availability of suitable maintenance contractors
- Availability of spare parts
- Gas powered steam humidification is not preferred due to concerns over the use of fossil fuels

4.10.3 Systems

The following subsections detail specific considerations for individual systems.

Steam Electric Humidifiers

- Electric steam humidification systems are preferred due to their relatively small physical size, minimal water treatment requirements, and high level of controllability
- Steam humidifiers are typically used in laboratories, hospitals, computer rooms and the like due to the better control of relative humidity and with correct installation, any water quality issues tend to be contained within the units themselves
- Where air volumes are relatively small these systems are more often used, however large systems can require a major electrical upgrades of the buildings infrastructure
- The ongoing running costs of distributed electric steam humidifiers may exceed those of the evaporative humidifiers

Ultrasonic Humidifiers

- Ultrasonic humidifiers are to be considered only for applications where electrical power supply is insufficient for steam electric humidification
- Require good quality water supply
- A high level of water treatment, and cleaning is required to maintain a safe system
- Ultrasonic units are limited to relatively small installations

Evaporative Humidifiers

- Evaporative humidifiers are only to be employed where humidification is needed for large spaces, and electric steam humidification is not practical
- Require good water quality and can increase building heating requirements in winter however in summer can reduce the cooling input energy. Due to the much lower energy requirements evaporative humidifiers can serve much larger installations
- A high level of water treatment, and cleaning is required to maintain a safe system

Room Requirements – Sealing

- Good sealing of rooms required to maintain close control
- During construction walls, ceiling and floors to be inspected and all gaps and joints sealed with flexible mastic

4 Technical Sections

4.10 Humidity Control

Services Requirements

- Water quality shall be potable or reverse osmosis water. Ground water and recycled water are not acceptable due to high dissolved solids content and adverse water PH which can damage units
- Automatic dissolved solids monitoring required with dump valve modulation to limit total dissolved solids
- High temperature waste water discharge and tundishes required for steam electric humidifiers
- Raised bunds and leak detection alarms shall be provided for floor standing units
- In duct relative humidity sensors shall be used down stream of ducted Ultrasonic and Steam humidifiers these sensors shall temporarily suspend humidification when induct humidity levels exceed 90% (adjustable)
- Humidifiers shall modulate humidification rates to maintain an adjustable room relatively humidity set point
- Ductwork for the installation of humidifiers shall be externally lagged stainless steel or aluminium with internal drains and access to both side of the humidifier
- The internal drain pan length and duct velocities shall be to the manufacturer's requirements. minimum sizes shall be not less than 1 duct heigh before and 2 duct heights after for a maximum duct velocity of 2.4m/s

4.10.4 Potential ESD Initiatives

- Use of Evaporative humidification can be used in lieu of steam/electric humidification

4.10.5 Deliverables

General

Please refer to Section 2.3 Project Design Documents for project deliverables. The following sub-sections detail deliverables specific to these systems.

- Justification type of humidification system proposed
- Maintenance requirements
- Limit on relative humidity control – tolerance

4 Technical Sections

4.11 Mechanical Controls and BMCS

4.11.1 Summary

The mechanical control systems and BMCS (Building Management Control Systems) shall be designed based on the type of mechanical systems to be controlled, energy monitoring and ESD requirements, TAFE NSW central control/monitoring expectations, and the extent of other systems served.

The design team must facilitate a design workshop with key TAFE NSW stake holders to review and develop the proposed mechanical control schemes for each project. Some key items to be considered include:

- Accessibility of local controllers for staff with disabilities, refer to local controller performance requirements below; it may be necessary to develop a purpose built controller to meet TAFE NSW needs
- Air conditioning and ventilation functional control scheme, refer to later in this section for typical schemes to consider
- Central/Remote monitoring and access provisions
- Connectivity with TAFE NSW Smart Campus System

Design

- Design
- System selection

Systems

- Local controls
- Central controllers – VRV/VRF systems
- Building Management Control System (BMCS)
- Typical Learning Space Controls Functional Descriptions
- Smart Campus System Integration

4.11.2 Design

General

The control system type, size complexity must be project specific. It must be integrated with the TAFE NSW Smart Campus System, and where a BMCS is provided, with other services.

Project control systems can range from simple standalone controls, to full BMCS systems. The proposed level of control system is to be included in the initial project brief. It is to be further developed by the design team in conjunction with the TAFE NSW project team and stakeholders during the design phase.

Key design factors include:

- Provide simple user control interfaces which are fully accessible to users with disabilities.
- Please refer to Section 5 Room Specific Requirements
- Please refer to Section 4.2 Space Cooling Systems
- Provide sufficient and suitable control provision to achieve good/stable control for each system and space.

- Reliability
- Functionally
- Optimisation of running and capital costs
- Central remote access provisions
- Backup provisions
- Integration with the TAFE NSW Smart Campus System
- Interfaced with other services

System Selection

General

Selection of the mechanical control system shall take into consideration the following:

- Level of system complexity needed to achieve acceptable control
- Level of complexity of the mechanical systems.
- Energy efficiency and ESD requirements
- Life cycle costing and project budget
- Ongoing maintenance and servicing
- Availability of suitable maintenance staff
- Availability of spare parts
- Project budget and scope

4.11.3 Systems

The following subsections detail specific considerations for specific systems.

Local Controls

This section applies to local control provisions for all mechanical systems ranging from simple on/off controls for fans or natural ventilation dampers to dedicated room air conditioning controls (split system, VRF/VRV, chilled/heating water fancoils, evaporative coolers, etc).

- Local controllers must be designed and located to be fully accessible by users with a disability, in particular mobility, visual, and hearing.
- It is noted that stock controllers currently available on the market may not meet the noted criteria. If a stock item is not available, designers, contractors, suppliers, and manufacturers will be responsible to develop a custom-made product to meet these criteria.
- Wired wall mounted controllers must be provided; wireless remote controllers are not acceptable.
- Local controllers must provide: on/off, and limited temperature adjustment.
- Controllers must incorporate simple operation, user feedback and signage sufficient to be operated by users with a visual, hearing, or physical disability. This could include provisions for items such as audible feedback, raised buttons, braille dimples, etc.

- Where proprietary systems such as individual split or VRF/VRV systems are to be controlled, if the manufacturer cannot supply or develop a compliant controller, a third party controller may be required. In this instance, due to limitations associated with the air conditioning proprietary controllers, it may be necessary to simplify the third party controller to just on/off functionality. TAFE NSW is to approve of any reduction in controller functionality.
- Proprietary air conditioning manufacturers may wish to consider development of a compliant controller, to have improved opportunity for ongoing TAFE NSW projects.
- The proposed controller is to be workshopped with the project design team and TAFE NSW during the project design stage.
- A sample controller is to be provided for review by the team where relevant.
- Provide a dedicated local controller/control per space.
- Local controllers are preferred not to be located in public areas, in particular for front facing areas such as restaurants, salons, reception areas, etc.
- Where controllers must be located in public areas, or areas where there is risk of tampering, their functionality is to be password protected. If password protection is not available, then provide a clear lockable anti-tamper box around the controller. If the controller includes an integral temperature sensor the box is to have adequate ventilation openings for temperature sampling.
- Controllers must be installed at accessible height, (underside 1300 above finished floor), usable for all parties, and not in the corner of a room (minimum 1000mm from inside of a room corner or obstruction). Final dimensions must be confirmed by TAFE NSW.

Central Controllers – VRF/VRV Systems

Generally proprietary systems dedicated to the central control and management of VRV/VRF systems. In addition, the controllers should also provide:

- Full override control for all connected VRF/VRV units, including provision to lock out local control functionality
- Password protection for controlled access and anti-tampering
- To be located in a secure area, such as maintenance office, administration office or a comms room
- Potential control for compatible individual split systems, note these units need to be from the same manufacturer, and supplied with a network adaptor card.
- Potential on/off control for ventilation fans
- Online remote web access
- High level interface with the BMCS system if available, will require BACnet interface card
- High level interface with TAFE NSW Smart Campus System, will require BACnet interface card.

4 Technical Sections

4.11 Mechanical Controls and BMCS

Building Management Control System (BMCS)

General

A BMCS will typically be considered for the following applications:

- Large scale project, where a higher level of building integration is expected
- Complex mechanical systems, such as chilled and heating water systems, or humidity control
- Campus or regional applications where multiple buildings or sites are linked to the same BMCS

BMCS features to be considered

- BMCS must be designed by a specialist controls supplier with extensive experience in the design, construction, testing, documenting and maintenance of BACnet BMCS systems.
- Where an there is an existing BMCS, it is recommended that all maintenance and new projects additions be performed by the original controls supplier
- Fully BACnet compliant to ANSI/ASHRAE 135 and LAN to ISO/IEC 8802-3. (Application, Network, Data link and Physical layers). The controls supplier is to provide a BACnet Protocol Implementation Conformance Statement (PICS) for each component provided.
- All wiring shall be compliant with SAA wiring rules AS3000
- Web access and security
- Logical, and well presented graphical User Interface
- Systems Architecture
- Maintenance.
- Backup
- Individual control provisions for each item of plant.
- Alarm management
- Trend logging
- Fire mode interlocking (Hard wired, failsafe and to AS1668.1, BMCS monitors Fire mode systems only)
- Afterhours interfaces
- Sensor selection.
- Interfaces with other non-mechanical systems.
- Gateways for incorporating non–BACnet components and systems.

BMCS Communications minimum requirements

- System protocols shall be to ANSI/ASHRAE 135
- BACnet network using ISO/IEC 8802-3(Ethernet) Data link and BACnet/IP addressing
- Via telecommunications network fibre and copper circuits.
- Speed > 100 Mb/sec.
- Generally System response time to be < 2 seconds (data transfer, graphics display updates, system logs updating etc), for systems and equipment control applications (for example , pump speed modulation to maintain system pressure set points) system response times to be as required for stable operation, while maintaining setpoints within design tolerance bands.

BMCS Architecture

- Generally BMCS systems shall include web interface via Routers, web-servers, and switch panels communicating with networked system/ equipment controllers. With hardware points (sensors/actuators) either Networked BACnet objects or interfaced via low level signals (0 to 10 Volts, 0 to 24mA to a system or equipment controller).
- Systems shall be expandable to at least twice the original design size.
- BMCS shall be provided with central work station (CWS) for the graphical user interface to interface with the BMCS server consisting of;
  - BACnet operator workstation.
  - LCD visual display unit, keyboard, mouse, printer,
  - UPS and all necessary wiring.
  - All necessary software.
- Web servers and servers shall enable access via any standard web browser via the internet, with: user name password access, defined levels of read /write access, encrypted security data, automatic logout delays, access logs.

BMCS Alarms

- Alarm processing and reporting to direct alarms based on alarm type propriety and time schedules.
- Power failure consequential alarm limiting.
- Alarm messages to be in English without acronyms and to indicate nature, source and location.
- Alarms to have adjustable delays and fault/limit levels
- Alarm management to be consistent BACnet alarm services.

BMCS Backup Provisions

Automatic non-volatile backup of all data, setpoints, states, firmware and software, graphics and devise configuration. Servers provide system and controllers backup, controllers shall individually back themselves up. Service and Controllers shall be able to download backed up data after power and network failures.

BMCS Graphics

Graphical user interfaces (GUIs) are required and are to include the following attributes:

- Mouse and menu driven with the same look and feel as Windows User Experience Interaction Guidelines
- Individual Graphic screens for each site, floor, plant room, system, plant item, trending, alarms and interface, with Hierarchical arrangement with point and click navigation between screens.
- Screens to include sensor and system element locations and current readings and alarm status, with dynamic colours to indicate zone status.
- Screens shall allow the operators to monitor and edit status, alarms, set points and display the most important data associated with screen and allow set point editing and include animation to indicate status.
- Industry standard file formats compatible with world wide web consortium standard browsers without the need for plug-ins.

4.11 Mechanical Controls and BMCS

- GUIs to include provisions for operators to individually update, edit, add, integrate and remove systems graphics, and be provided with standard, editable graphics libraries of all building services elements.
- Operators to be able to expand graphics libraries via editing and saving existing library elements or creating new graphics via importing .PDF, .DWG, .DXF files.
- GUIs to be able to display in real time and edit all BACnet objects and all object properties, setpoints, alarms, scheduling, backup, object operational relationships, attributes and control provisions.
- Document alarms with BACnet alarm service and trends with BACnet trend objects complete with trend graphs.
- Report generation with fully editable standard reports. Reports to be exportable in Word, PDF and Excel formats. Standard reports to include systems and objects attributes, status, alarms, setpoints, sensor readings, logs and trends.
- Log and retain systems data for alarms, trends, operator activity, sensor readings, equipment status and scheduling.
- GUI to use standard IS units and English

BMCS interfaces with non-mechanical systems

Standard non-mechanical monitoring provisions shall be adjusted to suit individual project needs. A typical list is as follows:

Electrical:

- Metering
- Lighting
- MDB faults
- Generator status
- System alarms

Security system interface:

- Comms room high temperature, water leak and AC unit fault alarms

Fire:

- General fire trip
- Zone in fire mode
- Equipment in fire mode and status

Note: BMCS to only monitor Fire systems all fire systems controls and fire mode controls to be via dedicated non BMCS control systems.

Hydraulics:

- Hydrant status
- Major plant status
- System Alarms

Lifts:

- Lift failed to start

- Lift running on fire service
- Alarm button pressed
- Lift running on independent service
- Lift in normal service
- Lift on maintenance
- Lift on hazardous goods operation

BMCS Software Functionality

Operating systems to be Microsoft Windows, with the following system / interface functions.

- Adjustable, editable and expandable system configurations
- Automatic storage of system database, controllers memory downloads, firmware and software with automatic updating of software
- Online help and system diagnostics
- View of controllers status, restarting and manual updating and editing/ configuring of system attributes
- Remote, securer access with Password management
- Real time clock with automatic synchronising of systems times
- As required to carry out required project specific functions
- PID control loops for dynamic plant control
- On – off control with adjustable setpoints and hysteresis, short cycling protection
- Sequencing of plant for equalising of plant run hours and coordination of equipment
- After hours control
- Test mode
- Manual Maintenance lockouts, with maintenance alarms base scheduling and hour of run
- Sensor polarity adjustment and scaling and celebration routines
- Provisions for gateways, high level and low-level interfaces

On completion of installation ownership of all software shall transfer to TAFE NSW with no limits on licences for operator interface and software.

Fully automatic restoration of control system after any interruption

Fail Safe operation.

See also Graphics above.

4 Technical Sections

4.11 Mechanical Controls and BMCS

BMCS Controllers

The controllers referred to in this section are programmable logic controllers (PLC) which are necessary for programming/controlling individual pieces of plant. They are not front facing controllers which are accessible to the general building users. For these controllers refer to the Local Controllers section.

Controller shall include the following:

- Conform to BACnet Building, Advanced Application or Application Specific Controllers devise requirements
- Be of a construction suitable for the application and location, in that they are corrosion resistant, of sufficient IP rating, not negatively impacted by dust, humidity, vermin, expected temperatures, or by variation in supply voltage
- Suitably sizes terminals
- Capable of achieving the accuracy, repeatability detailed in Sensor below, and communication requirements detailed above
- Capable of driving and controlling actuators directly without additional control boards
- Automatically uploading and downloading of data, Software and Firmware where connected to a BMCS
- Internally automatically backing up system data, software and systems parameters to allow recovery after power failure and standalone operation on communication systems failure or where no BMCS is used
- Have service ports for communication with BMCS and portable operator's devices
- Have non-volatile memory for all software, firmware and system parameter and battery backup >72 hours for system data, trends and logs
- Be capable of networked data sharing to allow distributed control, central monitoring and alarms
- To be modular and expandable, with dedicated equipment controllers and system controllers
- To have local isolation, and power supplies rated for 125% of installed requirements, and separate supplies from field devices
- To not be affected by power supply voltage variation of +30%, and be protected from over and under current and voltage, surges, revise polarity
- Hardware input and output control circuits to operate at 0-10 volts and 4 –24mA
- To have a real time clock, data processing, analogue integrating, plus summation and rate calculation, diagnostics

BMCS Mechanical Plant Control Provisions

Generally, to provide the following functions for plant control. Note this is to be modified for specific plant as required.

- Coordination of systems equipment for system starting and stopping and central plant equipment cycling
- Modulate central plant speed and duties to minimise energy use via control valve position
- Scheduled switching

- Holiday programme
- Failure to start alarms
- Run time totalisation
- Closing Dampers
- Time Switches
- Optimum start/stop
- Night time purge, setbacks and afterhours control
- Alarm management
- Off-limit alarms
- Trend logs for key plant inputs and outputs

BMCS Sensors

Generally, provide input devices with the following characteristics:

- With range, accuracy and response time appropriate to the required control function including the effects of transducer accuracy and signal transmission errors
- Maintain documented performance over time
- Requiring maintenance or re-calibration to maintain performance at not more often than 12-month intervals
- Designed for the type of location and application in which they are installed
- Located for easy access for inspection, calibration, cleaning and maintenance
- Tamperproof if located in occupied areas
- Protected by location or otherwise from extraneous influences including sunlight, heat sources and non-representative locations.
- Not affected by induced voltages or EMI

BMCS Actuators

Generally, provide actuators designed for the type of location and application in which they are installed and the required control functions.

- The actuators type shall be electronic, incorporating a disengagement mechanism that permits manual operation in the event of power failure without disconnecting the actuator. Provide a position indicator on the actuator.
- If a position feedback signal is required, provide a potentiometer on the actuator.
- Mounting: Provide actuators and mounting selected to provide sufficient torque to allow changes of position with the fans or pumps operating.
- Protection: Minimum IP56 enclosure. If the actuator is located outdoors provide additional weather protection.
- Overload and stall: Protect actuators against overload. Provide electronic or magnetic clutch type stall protection effective throughout the entire actuator stroke. Do not rely on end switches that require field adjustment.
- Fail safe operation: If fail-safe operation is required, provide integral spring return via clutch only.
- Noise: Provide actuators that are inaudible in occupied areas.
- Override provision

- Provide a manual positioner adjacent to the respective controller for each of the following:
  - Each modulating valve.
  - Each motorised damper except those in VAV boxes or required to operate in fire mode.
- Facilities: Provide the following:
  - An AUTO-OFF-MANUAL override switch to enable the position to be manually set.
  - Position adjustment potentiometer to drive the controlled device to any position in manual mode. Mark the potentiometer to indicate the position of the controlled device.
  - A reversing switch.
- Non-powered operation: To permit the actuator to be manually positioned when not powered:
  - Provide non-spring return actuators with an external manual gear release.
  - Provide spring return actuators having > 7 N.m torque capacity with a manual crank.

Typical Learning Space Controls Functional Descriptions

Typical TAFE NSW learning space air conditioning system functional descriptions are provided for consideration by the project design team, and TAFE NSW stake holders for each project. These are to be modified and combined as needed to meet project specific requirements.

Also refer to the Local Controls, Central Controllers – VRF/VRV, and BMCS sections of this Design Standard for controls details.

Local Control and Central Monitoring

- This would typically be applicable to situations where individual split systems are provided.
- Provide wired local controller, with full functionality, on/off, temperature setpoint, modes, and scheduling control.
- Consider controller location to prevent unwanted tampering. If this is a concern as a first priority provide a controller password lockout, if this cannot be provided, provide a lockable transparent, ventilated security box for the controller.
- Remote central monitoring to be provided via separate dedicated BMCS sensors installed in the space, potential monitoring points, temperature, CO2

Local and Central Control

- This option would typically be suitable for systems where VRF/VRV systems are installed with a central controller, or where chilled water/heating water systems are provided with a BMCS
- Provide wired local controller, with partial functionality, on/off, limited temperature setpoint range.
- Full temperature setpoint control, modes, and scheduling, along with full override is to be provided via the central controller.
- The central controller is to be located in a secure location, such as a comms room, plant room, maintenance office, or controlled access admin space, with password protection.

- Full online remote monitoring and control, including temperature monitoring is to be available via a web based interface with the central controller, or the BMCS if it is available. If CO_2 monitoring is required it shall be via the installation of a BMCS sensor.

Automatic Operation

All air conditioning installations must be provided with a level of automatic operation to prevent systems running when spaces are unoccupied. The designer shall confirm the preferred scheme with the TAFE NSW stake holders during the design phase. The provided options can apply to either local and central monitoring or local/central control as noted above.

- Scheduled - program scheduled operation for the air conditioning systems to run automatically during normal hours of operation, taking into account weekends, and holidays. Users do have the option to manually override the system to start/stop as needed via the local controller. This allows space conditions to be at setpoint during the entire duration of operation, and facilitates automatic pre-conditioning of the spaces before occupancy.
- Run on timer – users can manually start/stop the system via the local controller. Once started the system will run for a set duration then automatically shut down, typically 2 hours. This option can be provided in combination with the scheduled options above for unit operation outside of normal scheduled operating hours. This option avoids the potential unnecessary energy usage when air conditioning is accidentally left running. This does not provide the option to automatically pre-condition spaces before occupancy, and can be a nuisance to restart during longer periods of space usage.
- Occupancy sensor – interlock the air conditioning operation with the room occupancy to automatically shut down after a pre-determined period of time (typically 30 minutes) when the room is no longer occupied. Users will be responsible for manually starting the air conditioning, with the option to stop the system via the wall controller. The benefit is similar to the run on timer option, where the air conditioning will only run when the room is occupied, but the nuisance of having to restart the system is removed. This does not provide the option to automatically pre-condition the space before occupancy.

CO_2 Outside Air Control

CO_2 outside air control must be provided for TAFE NSW projects where practical.

- Provide a CO_2 sensor for each air conditioning zone. The sensor can be located within the occupied space, or in the return air ducting, depending on which is more practical.
- When the air conditioning system is started, the associated outside air is to start at the minimum outside air rate. If the space CO_2 level reaches the design threshold for a set period of time (recommend 5 minutes), the outside air rate is to increase to the maximum rate. It is to remain at this rate until the CO_2 level drops below the low point CO_2 threshold for a set period (recommend 5 minutes) and then drop back down to the minimum rate.
- Thresholds and minimum rates are to be set by the design team. As minimum they are to comply with AS1668.2. They may also be adjusted as needed to comply with specific project sustainability requirements. Refer to the TAFE NSW Sustainability Design Standard.

- The method for variation of the outside air rate is left to the mechanical designers. Typically this might involve the use of motorized volume control dampers on the outside air and return air ducts, and/or modulation of the outside air fan speed.

Smart Campus System Integration

The mechanical services are to be fully integrated with the TAFE NSW Smart Campus Systems. Refer to the TAFE NSW Smart Campus Design Standard. The level of integration must be confirmed for each project by TAFE NSW, and the project design team.

BMCS integration with Smart Campus Systems is intended to provide monitoring and reporting capability, as well as the ability to run automation programmes to optimise energy usage based on data trends, local conditions, or other algorithms.

Where a BMCS has not been provided, the mechanical scope for integration may include the provision of local BMCS sensors and PLC controllers for integration of space temperature conditions into the Smart Campus System. If a VRF/VRV central controller is provided it shall interface via high level interface with the Smart Campus System.

The mechanical designer/installer will be responsible for providing provision for low level or high level interface with the Smart Campus System for all necessary plant and input/output devices. This will typically involve connection to the TAFE NSW data platform. The Smart Campus System contractor will be responsible to provide all necessary gateways, connections, and terminations to the Smart Campus System.

All parties are responsible for coordinating, to provide a fully integrated installation.

During construction the mechanical contractor and the Smart Campus System contractor are to fully commission and test, complete with witness testing, the integration, connectivity, and functionality between the two services.

4.11.4 Deliverables

General

Please refer to Section 2.3 Project Design Documents for project deliverables. The following sub-sections detail deliverables specific to these systems.

- Justification of the type of system proposed.
- System configuration and areas controlled and monitored.
- System size, numbers of points
- System points list
- Controls functional descriptions
- BACnet compliance - BACnet Protocol Implementation Conformance Statement (PICS) for each component are required.
- Web interfaces and existing BMCS interfaces.

4 Technical Sections

4.12 Smoke Hazard Management

4.12.1 Summary

Key Design Factors/Details

- Statutory and project specific requirements
- System selection
- Key smoke control items to consider for typical TAFE NSW applications

4.12.2 Design

Statutory and project specific requirements

Systems are to be designed in compliance with:

- NCC
- NCC Volume 1 - Schedule 1 - State and Territory Appendices - New South Wales
- AS1668.1
- Project specific fire engineering requirements, identified in the project fire engineering report

System Selection

Generally passive systems are preferred over active. Designers should endeavour to provide solutions which minimise complexity and maintenance requirements where possible.

Ducting and pipe routing is to be arranged to minimise penetrations through fire and smoke separations, and thus reducing the need for fire/smoke sealing and fire/smoke dampers.

4 Technical Sections

4.12 Smoke Hazard Management

Key Smoke Control Items to Consider

The following list is provided to identify smoke control measures which are typically applicable to TAFE NSW projects. It is not an exhaustive list, and does not replace the need for the designer to consult current codes and Design Standards to provide a solution in compliance with statutory and project specific requirements.

Item	Typical Requirements	Notes
Mechanical installation to conform to site fire/ smoke control matrix/system	Designers/installers must familiarise themselves with the functionality, and design requirements of the fire/smoke control matrix/system for any site which they are performing work on. Any new works must be in-line with the system functionality and intent. The final installation is to include commissioning and witness testing for operation in fire alarm, and once the fire alarm is cleared.	This could include but not be limited to: the installation of fire and smoke dampers, fire trips, and plant operation in fire mode, etc.
Air Handling System Automatic shut down	For a Class 9B assembly building, an automatic shut down in fire mode must be provided for all air handling systems, other than non-ducted individual room units below 1000 L/s, and miscellaneous exhaust systems	Typically, all classrooms with ducted mechanical outside air, or ducted air conditioning will require a fire trip in fire mode. Buildings might not require AS1670 compliant smoke detection systems. If an AS1670 compliant system is not installed, a fire detection system in compliance with the NCC will need to be installed to provide the fire trips. This will need to be coordinated with the electrical/dry fire designer during the design stage. Where existing units connected to a fire trip are replaced with new, the fire trip provision is to be connected to the new unit.
Mechanical Services Switchboards	When designing new MSSBs the designer /installer must confirm if a fire trip is required. If required, the MSSB must be provided with all necessary relays, and a fire trip indicator lamp.	The dry fire contractor must wire the fire trip signal to the MSSB, for termination by the mechanical contractor.
Smoke Dampers	Smoke dampers are required for any duct penetration through a fire separation greater or equal to 0.1m^2.	To be considered wherever fire dampers are installed.
Fume cupboard operation in fire mode	Consideration could be given to allowing fume cupboard exhaust systems to continue to run in fire mode to continue to contain fumes	To be reviewed by fire engineer and certifier. Ducting is not to cross and fire separations, may require dedicated fire rated shafts.
Fume cupboard PVC plastic ducting	PVC plastic ducting may be required for corrosion resistance. This ducting does not meet the fire testing requirements as set out in AS4254.2, and AS150.3	It is common practice to provide a fire engineering solution, prepared by the fire engineer, as a means to achieve compliance. Where PVC ducting is proposed the designer should raise this with the certifier and fire engineer during the design phase. Alternatively stainless steel ductwork could be considered, its corrosion suitability will need to be assessed for the specific application.

4 Technical Sections

4.12 Smoke Hazard Management

Item	Typical Requirements	Notes
Shop general exhaust operation in fire mode	Typically, any large general exhaust systems would be expected to be shutdown in fire mode	Designer to review the need to for the system to run in fire mode, if deemed necessary the system design is to be reviewed by the fire engineer and certifier. It may be necessary to design as smoke exhaust system, and include override controls on the fire fan control panel. Consider access provisions for dampers.
Shop speciality exhaust operation in fire mode	Typically, these would be required to shut down in fire mode	Provide interlock with industrial gases to be shut off in the event of shut down of the specialty exhaust fan.

4.12.3 Deliverables

General

Please refer to Section 2.3 Project Design Documents for project deliverables. The following sub-sections detail deliverables specific to these systems.

- Identify any requests for alternative solutions the NCC deemed to satisfy requirements early on in the design phase, so it can be addressed by the project certifier, and if relevant the fire engineer.
- Provide a functional description/fire matrix for the mechanical design/installation.

4.13 Other Mechanical Considerations

Additional items that should be considered in the mechanical design include, but are not limited to as noted below.

4.13.1 Acoustic Design

Mechanical acoustic design considerations – It is recommended that an acoustic engineer be included on the design team for most projects to advise on acoustic mitigation measures necessary for the mechanical plant acoustic performance to comply with any relevant development requirements, project specific performance criteria, AS 2107, and AIRAH's Noise Control Design Manual DA02. Furthermore it is recommended that for design and construction contractor engagements, the requirement for an acoustic engineer engagement be included in the mechanical scope.

4.13.2 Seismic Design

Typically the mechanical design and installation is to be in compliance with AS 1170.4. This is to be confirmed with the certifier early in the design stage of each project. Should this require the installation of compliant seismic mounts and restraints for mechanical plant, the engagement of a specialist design and construct contractor is to be nominated in the design documentation. The specialist contractor is to provide the design, installation, and engineering certification for their installation.

4.13.3 Bushfire Compliance

Projects or portions of projects may be located in bushfire prone zones. In this instance the bushfire ratings for the buildings in the project must be confirmed by a suitable specialist consultant. The mechanical design and installation must then be compliant with AS 3959 and the corresponding project bushfire report.

Room Specific Requirements

5 Room Specific Requirements

5.1 Categories

Room specific requirements are grouped into the following categories and set in alphabetical order:

- General
- Kitchen and Food Services
- Learning Spaces
- Office/Administration
- Retail Spaces
- Specialist Areas
- Sports Areas
- Workshops/Labs

Notes:

- The number of people noted is for the continuous outside air provision. It is understood that more people may be attending the space; albeit, for short periods of time. Space usage and occupancy rates are to be confirmed for each project at design stage; the general design values are to be adjusted accordingly. Where practical consider allowance for potential future occupancy increases up to an additional 15%.
- Generally, no humidity control is proposed. The relative humidity range is achieved as a result of mechanical air conditioning cooling. The indoor conditions will typically be between 40-60% RH.
- Lighting allowances are only applicable to the mechanical system capacity calculations and are not reflective of actual lighting design.
- Specific service allowances to specialised spaces are to be confirmed by the designer with TAFE NSW during the design phase. The details provided in are generic in nature and are to be confirmed for each project during the design stage.
- Project sustainability initiatives may modify the indicated outside air rates. Refer to the TAFE NSW Sustainability Design Standard.

5 Room Specific Requirements

5.2 General

Room	Occupancy Rate (m^2/ people)	Min. Outside Air (l/s/person)	Average Lighting (W/m^2)	Average Equipment (W/m^2) or as noted	Air Conditioning/ Heating	General exhaust ($L/s/m^2$)	Specialised exhaust (Equipment + L/s)	Gases (Type)	Comments
Car Park	N/A	To AS1668.2, or natural makeup	N/A	N/A	No	To AS1668.2	No	No	Consider natural ventilation where appropriate in compliance with AS1668.4
Changes rooms/Locker rooms	2	To AS1668.2, or as required for makeup air	10	10	Yes	5	No	No	Potential cost savings measure – delete air conditioning, consider geographical location
Comms/server rooms	N/a	4 $l/s/m^2$	N/A	3kW sensible / rack – to be confirmed at design stage	Yes	No, unless UPS installed, exhaust to be provide in compliance with AS2676.2 with a minimum of 5 air changes per hour for small rooms	No	No	Consider AC redundancy, and power supply requirements, locate indoor unit to avoid direct airflow onto comms racks
Corridors, Circulation	N/A	1 $l/s/m^2$	10	10	No	No	No	No	
Electrical/Switch rooms	N/A	4 $L/s/m^2$ or to limit room temperature rise to based 5°C Del T.	N/A	To installed equipment	No	No, unless UPS is in room, see battery storage	No	No	Main switch rooms are fire rated enclosures, mechanical penetrations typically require fire and smoke dampers
Grease Arrestor and Garbage Rooms	N/A	N/A	N/A	N/A	No	5 or 100L/s (min)	No	No	
Lifts	N/A	N/A	N/A	N/A	No – see notes	N/A	N/A	No	Provide lift shaft natural or mechanical ventilation to satisfy the NCC, external glazed shafts may require mechanical air conditioning
Plant rooms - Hydraulics Services	N/A	Refer to notes	N/A	N/A	No	5, refer to notes	No	No	If NG and LPG plant, regulators, meters are installed will need to comply with AS5601 could require additional natural ventilation openings, or mechanical outside and exhaust air systems

5 Room Specific Requirements

5.2 General

Room	Occupancy Rate (m^2/ people)	Min. Outside Air (l/s/person)	Average Lighting (W/m^2)	Average Equipment (W/m^2) or as noted	Air Conditioning/ Heating	General exhaust ($L/s/m^2$)	Specialised exhaust (Equipment + L/s)	Gases (Type)	Comments
Storage-Battery	N/A	As required for makeup	10	TBC based on installed equipment	Air conditioning may be required depending on unit heat rejection	5, refer to comments	No	No	Any battery charging to consider H2 gas control measures to comply with AS2676.2 with a minimum of 5 air changes per hour for small rooms
Storage Room - Chemical	N/A	N/A	N/A	N/A	No	5	No	No	Chemical storage to codes, e.g. AS1940.
Storage - Gas bottles	N/A	To AS4332	N/A	N/A	No	To AS4332	No	Refer to notes	Natural ventilation is preferred where practical Provide indication and monitoring as required by the relevant standards Consider limitations on drainage provisions, and to adjacent energized plant as required by the relevant standards
Storage Room - General	N/A	N/A	N/A	N/A	No	5	No	No	
Toilets, Showers, Amenities	N/A	N/A	N/A	N/A	No	$10L/s/m^2$ or 25L/s/fixture	No	No	Potential to increase exhaust rate in showers for improved steam extraction

5 Room Specific Requirements

5.3 Kitchen and Food Services

Room	Occupancy Rate (m^2/ people)	Min. Outside Air (l/s/person)	Average Lighting (W/m^2)	Average Equipment (W/m^2) or as noted	Air Conditioning/ Heating	General exhaust ($L/s/m^2$)	Specialised exhaust (Equipment + L/s)	Gases (Type)	Comments
Butchery Training Area	3.5	10 L/s/person or increased to suite exhaust	10	10	Yes	10, with manual local control. System provided to allow for exhaust when needed, and assistance to remove humidity from during washdown process	No	No	At design stage confirm space design temperature, Outside air delivered to the space is to be de-humidified before being delivered to the space, typically via the local air conditioning plant to prevent potential condensation within the space
Commercial Kitchen, Baking	3.5	10 L/s/person or increased to suite exhaust	10	50, to be confirmed based on actual kitchen equipment	Yes	No	AS1668.2/1 compliant commercial kitchen hood exhaust system	No	Cool room/freezer room refrigeration requirements to be confirmed by kitchen designer
Food Technology Workroom	3.5	10	10	30	Yes	5	Residential style kitchen hoods over cook tops, typically 100-150 L/s per hood	No	May require commercial hoods, to be confirmed based on cook top selection. Cool room/freezer room refrigeration requirements to be confirmed by kitchen designer
Light commercial	3.5	10 L/s/person or make as required for exhaust	10	15	Yes	5	No	No	Assumes minimal cooking takes place, otherwise refer to Commercial Kitchen. Cool room/freezer room refrigeration requirements to be confirmed by kitchen designer
Washup area	3.5	10 L/s/person or make as required for exhaust	10	50	Yes	5 $L/s/m^2$, where commercial dishwasher is provided without hood increase to dissipate steam	Condensate/dishwasher hood exhaust where required	No	

5 Room Specific Requirements

5.4 Learning Spaces

Room	Occupancy Rate (m^2/ people)	Min. Outside Air (l/s/person)	Average Lighting (W/m^2)	Average Equipment (W/m^2) or as noted	Air Conditioning/ Heating	General exhaust ($L/s/m^2$)	Specialised exhaust (Equipment + L/s)	Gases (Type)	Comments
Art Rooms	3.5	10	10	10	Yes	Yes – refer to notes	No	No	Consider general exhaust for drying area
Auditorium, multipurpose rooms, performance venue	0.6	10	10	5	Yes	No	No	No	Consider CO_2 demand control for OA, also option to reduce OA max rate to 7.5 L/s with demand control or high efficiency filtration
Classroom, Learning Space, Mobile Training Unit	2	10	10	10	Yes	No	No	No	
Digitally Enabled Space, Computer rooms, software applications, communications,	2	10	10	35	Yes	No	No	No	Equipment heat loads to be reviewed during design stage
Self-Directed Learning/Lounges, Collaboration Space, Resource Centre	3.5	10	10	10	Yes	No	No	No	

5 Room Specific Requirements

5.5 Office/Administration

Room	Occupancy Rate (m^2/ people)	Min. Outside Air (l/s/person)	Average Lighting (W/m^2)	Average Equipment (W/m^2) or as noted	Air Conditioning/ Heating	General exhaust ($L/s/m^2$)	Specialised exhaust (Equipment + L/s)	Gases (Type)	Comments
General office	10, or to suit seating layout or $10m^2$/person	10	10	15	Yes	No	No	No	Consider general exhaust for breakout/lunch rooms and photo copier/printer areas
Meeting rooms	To suit seating layout or $1m^2$/ person	10	10	15	Yes	No	No	No	

5 Room Specific Requirements

5.6 Retail Spaces

Room	Occupancy Rate (m^2/ people)	Min. Outside Air (l/s/person)	Average Lighting (W/m^2)	Average Equipment (W/m^2) or as noted	Air Conditioning/ Heating	General exhaust ($L/s/m^2$)	Specialised exhaust (Equipment + L/s)	Gases (Type)	Comments
Bar	1	10	10	5	Yes	No	No	No	Aesthetic presentation to be prioritised, concealed type air conditioning to be provided
Dining Room, Cafeteria Seating, Restaurant	1.5	10	10	10	Yes	No	No	No	Aesthetic presentation to be prioritised, concealed type air conditioning to be provided
Retail Outlet	5	10	10	10	Yes	10 $L/s/m^2$ toilet and change room exhaust	No	No	Aesthetic presentation to be prioritised, concealed type air conditioning to be provided

5 Room Specific Requirements

5.7 Specialist Areas

Room	Occupancy Rate (m^2/ people)	Min. Outside Air (l/s/person)	Average Lighting (W/m^2)	Average Equipment (W/m^2) or as noted	Air Conditioning/ Heating	General exhaust ($L/s/m^2$)	Specialised exhaust (Equipment + L/s)	Gases (Type)	Comments
Beauty Therapy, Massage, Tannery	5	10	10	10	Yes	5	No	No	To be maintained at a negative pressure relative to adjacent spaces EA rate > OA rate Aesthetic presentation to be prioritised, concealed type air conditioning to be provided
Child Care Centre	Design specific	12	10	5	Yes	10 $L/s/m^2$ toilet and change room exhaust. Domestic range hood exhaust (assume 150 L/s)	No	No	Cooking facility may require AS1668.1/2 commercial kitchen exhaust system
Darkroom Photo Film Processing	10	10	10	20	Yes	Minimum 15 air changes, including bench top capture locations	No	No	
Dental Technology	3.5	10	10	10	Yes	No	Dental suction	Medical air, nitrous oxide	Suction and gas requirements TBC at design stage
Hairdressing, Salon	4	15	10	20	Yes	5	No	No	To be maintained at a negative pressure relative to adjacent spaces EA rate > OA rate Aesthetic presentation to be prioritised, concealed type air conditioning to be provided
Kiln Room	N/A	N/A	N/A	N/A	No	No	Stainless steel hood over kiln with mechanical exhaust	No	Alternative, natural ventilation, fully louvred room with louvres on two faces, and not adjacent to regularly occupied areas, and for NG or LPG fired kilns, high and low level openings in-line with AS5601.

5 Room Specific Requirements

5.7 Specialist Areas

Room	Occupancy Rate (m^2/ people)	Min. Outside Air (l/s/person)	Average Lighting (W/m^2)	Average Equipment (W/m^2) or as noted	Air Conditioning/ Heating	General exhaust ($L/s/m^2$)	Specialised exhaust (Equipment + L/s)	Gases (Type)	Comments
Laundry, Textile Care	10	10, or to suit exhaust	10	50	Yes, for commercial laundry could consider relaxed temperature setpoint or spot cooling to reduce Air conditioning load	15,$L/s/m^2$ 20 $L/s/m^2$ if dry cleaning is taking place	Commercial dryer exhaust	No	Commercial dryer compartment preferred to be naturally ventilated, if this is not practical mechanical outside air and exhaust is required for compliance with AS/ NZS 5601
Music, Radio, Sound Studio	3.5	10	10	30	Yes	No	No	No	Mechanical design to allow for acoustic treatment, confirm extent during design with acoustic engineer, ducted air conditioning typically required

5 Room Specific Requirements

5.8 Sports Areas

Room	Occupancy Rate (m^2/ people)	Min. Outside Air (l/s/person)	Average Lighting (W/m^2)	Average Equipment (W/m^2) or as noted	Air Conditioning/ Heating	General exhaust ($L/s/m^2$)	Specialised exhaust (Equipment + L/s)	Gases (Type)	Comments
Staff/Student Gymnasium, Squash Courts	3.5	10	N/A	N/A	Refer to comments, heating - yes	No	No	No	Direct air conditioning not proposed, consider geographical location, indirect evaporative coolers may be appropriate to temper outside air
Weight/Resistance Training Room, Aerobics Training Room	5	10	10	10	Yes	No	No	No	

5 Room Specific Requirements

5.9 Workshops/Labs

Room	Occupancy Rate (m^2/ people)	Min. Outside Air (l/s/person)	Average Lighting (W/m^2)	Average Equipment (W/m^2) or as noted	Air Conditioning/ Heating	General exhaust ($L/s/m^2$)	Specialised exhaust (Equipment + L/s)	Gases (Type)	Comments
Autobody Workshop	3.5	15	N/A	N/A	Refer to comments, heating - yes	No	Grinding, and paint fume exhaust systems	Compressed air	Direct Air conditioning not proposed, consider geographical location, indirect evaporative coolers may be appropriate to temper outside air. High level grilles to be selected considering throw, and achieved air velocity at occupant level. Consider destratification fans where practical, coordinate with electrical designer.
Automotive – mechanical Works, Dynamometer Areas	3.5	As required for exhaust makeup air	N/A	N/A	Refer to comments, heating - yes	Consider for general ventilation, even if not required by AS1668.2 due to provision of direct tailpipe exhaust systems	Preferred direct tailpipe exhaust systems in line with AS1668.2	Compressed air	Direct Air conditioning not proposed, consider geographical location, indirect evaporative coolers may be appropriate to temper outside air. High level grilles to be selected considering throw, and achieved air velocity at occupant level. Consider destratification fans where practical, coordinate with electrical designer.
Ceramic Tile Cutting, Brick/ Masonry Cutting	3.5	10	N/A	N/A	Refer to comments, heating - yes	No	Localised dust exhaust at cutting stations/locations	No	Direct Air conditioning not proposed, consider geographical location, indirect evaporative coolers may be appropriate to temper outside air. High level grilles to be selected considering throw, and achieved air velocity at occupant level. Consider destratification fans where practical, coordinate with electrical designer.
Labs	3.5	10, or as required for makeup	10	10	Yes	Potential odour control general exhaust	Potential Fume Cupboards	No	

5 Room Specific Requirements

5.9 Workshops/Labs

Room	Occupancy Rate (m^2/ people)	Min. Outside Air (l/s/person)	Average Lighting (W/m^2)	Average Equipment (W/m^2) or as noted	Air Conditioning/ Heating	General exhaust ($L/s/m^2$)	Specialised exhaust (Equipment + L/s)	Gases (Type)	Comments
Workshop – double height	3.5	15	N/A	N/A	Refer to comments, heating - yes	TBC at design stage based on usage	TBC at design stage based on usage	TBC at design stage based on usage	Direct Air conditioning not proposed, consider geographical location, indirect evaporative coolers may be appropriate to temper outside air. LPG by Hydraulics Trade. High level grilles to be selected considering throw, and achieved air velocity at occupant level. Consider destratification fans where practical, coordinate with electrical designer.
Workshop – single storey room	3.5	10, or as required for makeup	10	10	Yes	TBC at design stage based on usage	TBC at design stage based on usage	TBC at design stage based on usage	Light technical work indoor classroom setting
Work Shop – Wood/Timber, double height	3.5	15	N/A	N/A	Refer to comments, heating - yes	No	Dust extraction to specific pant	Compressed air	Direct Air conditioning not proposed, consider geographical location, indirect evaporative coolers may be appropriate to temper outside air. Provide dust filtration machines. High level grilles to be selected considering throw, and achieved air velocity at occupant level. Consider destratification fans where practical, coordinate with electrical designer. Dust extraction unit spatial implications, discharge provisions, and waste collection/storage to be considered at design stage

Work Health & Safety

6 Work Health & Safety

6.1 General Requirements

The "Common Work Health & Safety Concerns" table identifies common Work Health & Safety concerns arising from mechanical services that have been identified from past TAFE NSW projects. Each project team must demonstrate that all safety concerns raised have been addressed as part of their involvement with any project to which this Design Standard applies. The safety concerns listed in the table must be included in project-specific Safety-in-Design Registers to ensure that project teams demonstrate how they have been addressed through all phases of any project.

Please note the information in the table is:

- For guidance only,
- Not exhaustive and does not take into account specific circumstances and should not be relied on in that way, and
- Does not alleviate the respective TAFE NSW team, designer, supplier or contractor from their own Work Health and Safety obligations and duties.

Legend	Level of Risk	Action Required
H	High	Implement cost effective risk control measures and formalise procedures or management responsibility for reducing risk. Amend design to reduce risk, or seek alternative option. Only accept option if justifiable on other grounds.
M	Moderate	Incorporate cost effective risk control measures within the scope of long-term planning. Management responsibility must be specified. Check that risks cannot be further reduced by simple design changes.
L	Low	Manage by routine procedures. Check that risks cannot be further reduced by simple design changes.

6 Work Health & Safety

6.2 Common Work Health & Safety Concerns

Safety Issue Raised	Potential Control or Treatment measure	Reference to Design Standards/ Statutory Requirements	Level of Risk	Phase: Design Delivery	Phase: Construction, Supply, Installation	Phase: Operation and End use
Water leaks into electrical and comms rooms	No water services to be provided in or above rooms serving switchboards, comms, or other electrical equipment.		H	Y	Y	
In food service areas -potential condensation on walls, and dirt build-up – risk to electrical outlets, and mould growth	The mechanical design is to provide adequate ventilation, dehumidification to food service areas to minimise any potential condensation on walls. Industry standard cleaning practices are to be undertaken. The mechanical design is to be in accordance with the NSW Food Act, Food Regulations, AS 4674, and nominated development application requirements. Wall mounted air conditioning units are not to be provided.		H	Y	N	Y
Fall hazard in Installation and servicing of high-level plant	Install plant at levels where they can be safely accessed with minimal fall hazard. Where plant must be installed at high level, all work to be performed using mechanical lifts, appropriate fall protection equipment, and appropriate PPE.		H	Y	Y	Y
Fall hazard for installation and servicing of roof top plant, and plant near drop offs	Install plant away from edge of roof, provide fall protection barriers. All work to be performed using appropriate fall protection equipment, and appropriate PPE.		H	Y	Y	Y
Risk of contact with plant moving parts – normal operation	All mechanical plant with moving parts is to be fitted with appropriate guards and covers to protect against moving parts, and installed in areas where access is restricted to trained maintenance personnel.		H	Y	Y	Y
Risk of contact with plant moving parts – servicing	Follow manufacturer's recommended service and installation procedures, ensure lockout of all equipment before starting work, do not work on live equipment, employ appropriate PPE, only properly qualified personnel are to undertake works on plant.		H	Y	Y	Y
Risk of electrocution while servicing active plant	Follow manufacturer's recommended service and installation procedures, ensure lockout of all equipment before starting work, do not work on live equipment, employ appropriate PPE, only properly qualified personnel are to undertake works on plant.		H	Y	Y	Y
Risk of oxygen depletion due to refrigerant leaks	All installation to be in-line with the safety requirements as set out in the refrigeration standard AS/NZS 5149.	AS/NZS 5149	H	Y	Y	Y
Risk of burns due from heating water	Install heating water plant in plant spaces where access is restricted to properly trained personnel. Provide drip trays under all heating water valves and fancoil units installed in the ceiling void		H	Y	Y	Y
Risk of accidental contact with plant	Plant not to be installed in normal occupancy zone, or circulation areas.		M	Y	Y	Y
Risk of contamination leading to silicosis	Provide adequate ventilation in areas where silica dust is likely to be present. Utilise appropriate PPE.		H	Y	Y	Y

6 Work Health & Safety

6.2 Common Work Health & Safety Concerns

Safety Issue Raised	Potential Control or Treatment measure	Reference to Design Standards/ Statutory Requirements	Level of Risk	Phase: Design Delivery	Phase: Construction, Supply, Installation	Phase: Operation and End use
Risk of heat stroke from extreme interior temperatures	Interior spaces are to be designed with adequate ventilation and provision for cooling to maintain safe indoor temperatures. Should space interior temperature be considered unsafe, the space should be vacated.		M	Y	Y	Y
Risk of heat stroke in lifts	The mechanical design is to include adequate ventilation, and for exposed glazed shafts air conditioning to comply with the NCC lift shaft design requirements.		M	Y	Y	
Risk of reduced air quality due to process fume hazards	Design appropriate ventilation outside air and exhaust to remove fumes. Exhaust discharge points to be located away from building air intakes, and occupants, and in such a way so fumes will not be entrained into the building. Use appropriate PPE, and working procedures.		H	Y	Y	Y
Contaminated air, or oxygen depletion in chemical store	Provide adequate ventilation and safety monitoring measures to the space designed in accordance with AS 4332, and other relevant standards. Limit access to space to qualified personnel only.					
Risk of oxygen depletion or breathing air contamination from leaky gas storage cylinders, or fire	All storage facilities are to be designed as per AS 4332, and other relevant standards. Where noted by standards, restrictions on drainage considerations, and distances to electrified plant are to be implemented.		H	Y	Y	Y
Excessive heat in kiln room	Design room with natural ventilation louvres on at least 2-off opposite walls. Louvres must open to the outside and not be located adjacent to transient or congregation areas. If natural ventilation cannot be achieved provide mechanical hood and exhaust to remove heat		M	Y		Y
Failure of MSSB	MSSB design to allow thermal scanning of switchboards to be carried out safely to be carried out periodically.	AS/NZS61439.1, AS/NZS 61439.2	M	Y		Y
MSSB missing pole covers and schedules	Inspections required after work on switchboards.	AS/NZS 3000	M			Y
MSSB access	MSSB access to be readily accessible by maintenance staff in accordance with the NCC and AS standards. MSSB to be provided in lockable cupboard. Do not locate MSSB cupboard on fire rated wall. MSSB's are not to be installed in areas accessible to general users, and not in the front of house areas	NCC/BCA	M	Y		
MSSB potential weather damage, leading to electrical risks	Where practical MSSBs are to be installed in weather protected areas. Where they cannot be installed inside the building, they shall be installed in a location complete with weather protection		M	Y		

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