CURTIN UNIVERSITY

PROJECT DELIVERY GUIDELINES

MECHANICAL SERVICES GUIDELINES

000311

Curtin University

Definitions of terms and abbreviations found in this guideline can be found in Appendix 4.4 – Definitions.

Details of revisions			
Level	***Details***	***Date***	***Initial***
1	*Initial version prepared for Project Delivery Guidelines*	*Aug-16*	*RPS*
1	*Minor corrections to final version for publication*	*Oct-16*	*RPS*
1	*Minor corrections to final version for publication*	*Jul-17*	*RPS*
2	*Range of updates to section 3 and integration with 000346 Services Metering Guidelines*	*Oct-18*	*FC*
3	*Update following third-party review for currency*	*Aug-19*	*FC*
3	*Inclusion of wording to allow departures from the existing guideline*	*Nov-19*	*RPS*
4	*Update to Section 3.2.32 to include detail on COP management*	*Jan-20*	*FC*
4	*Addition of new section 2.4 – Consultant and Contractor Requirements, upgrade of Appendix 1*	*Feb-20*	*RPS*
4	*Insertion of Documentation Deliverables Guidelines as a reference*	*Aug-20*	*RPS*
5	*Significant Updates*	*Mar-22*	*PI*

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1 INTRODUCTION

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

Sustainability is fundamental to the ongoing success of Curtin University's business. All users of the Project Delivery Guidelines – Mechanical Services must do so in consultation with the University's Sustainable Design Guidelines.

The University has a vital interest in the quality of its built environment. A quantitative measure is life-cycle costing and these should be minimised as far as possible. The qualitative terms 'buildability' and 'maintainability' are equally relevant.

The as-installed project must conform to established University building standards and represent the best possible value for money consistent with planning and financial restraints. It must also be easy to maintain, energy efficient, easy to clean and environmentally and aesthetically acceptable, both internally and externally. It must be buildable and in the final form must be flexible enough to allow ready and inexpensive alterations.

The guideline contains mandatory requirements and general guidance. For the avoidance of doubt, if this guideline is silent on a method, standard, equipment, arrangement or other relevant information, it shall be construed as not being suitable and the designer shall seek advice, feedback and approval from the Infrastructure Manager, Mechanical Services for it, and document the same in a deviation register.

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

2 CURTIN REQUIREMENTS

2.1 DISABILITY ACCESS AND INCLUSION PLAN

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

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

For Mechanical services specific projects or where mechanical works could impact access, it is important to seek stakeholder input and if needed determine alternatives for access. Examples can include:

- Laydown area impacting disabled parking.
- Construction site prevents access to a lift.
- An occupant has a normal route of access which is disrupted in some form.

2.2 HEALTH AND SAFETY

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

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

A copy of our Health and Safety Management Standards can be found at:
https://healthandsafety.curtin.edu.au/local/docs/HSManagementStandards.pdf

2.3 SUSTAINABILITY AT CURTIN

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

2.4 PROJECT REQUIREMENTS

2.4.1 DESIGN APPROACH

Curtin University expects consultants and designers to provide designs that meet the project brief, Australian standards, and Curtin's guidelines. A copy of the latest guidelines are available to download from the Curtin PF&D website. The following are priorities that consultants and designers must be aware of and consider in their design:

a. Before starting with the design, the consultants are expected to provide a return brief that confirms all aspects of the project brief, design allowances, building fabric, usage, and operating conditions, environmental criteria, design approach and options to be considered as part of the concept design process; any deviation from Curtin's guidelines shall be highlighted and directly approved by the university Infrastructure manager. Any performance solutions shall be discussed during the initial stage of the project.

b. Provide environmental conditions that meet the project brief.

c. Take a long-term balanced view of capital costs, energy costs, maintenance costs, and longevity of equipment; for all major plants, a life cycle cost analysis shall be provided as part of the design return brief for review and approval.

d. All buildings shall be designed to allow future alteration and changes without any major changes.

e. Accessibility, ease of operation, and ease of maintenance shall be considered in the design. Consultants shall provide safety in design report during the different phases of the project. The safety in design report shall be updated and included as part of the operation and maintenance manual.

f. Ensure compliance for mechanical services fire and life safety systems including coordinating with others to achieve it. The Consultant shall also incorporate any specific requirements made under a fire engineering brief.

g. During the early stage of the project. The designer shall consider the impact of thermal zoning on the operation of the units and the energy consumption. As a first measure, combining various orientations into a single air handling unit/fan coil unit operating as a multizone reheat type system or similar is not permitted and systems incorporating variable air volume any reheat option shall be the last option to be considered. The preference is for dissimilar perimeter zones to have separate dedicated unit(s). To standardize the zoning across all buildings the perimeter zones depth shall be taken as 4 meters from the external facades. The perimeter zone depth may be reduced where perimeter skin systems are proposed for zones that have no direct solar load. Central zones above 500m^2 shall be served by a minimum of 2 units to ensure flexibility and better controls during after-hour operation.

h. Use the campus main chilled and heating hot water to serve the existing and new buildings for comfort air conditioning. DX units shall only be considered for comfort air conditioning under strict conditions. For any DX proposal, approval shall be requested from Curtin's infrastructure manager to use DX units.

i. Control systems shall be designed with simplicity and reliability in mind. Avoid multiple points of failure. The designer shall consult the incumbent BMS contractors from the early stage of the project and a detailed function description shall be developed, complete with a proposed hardware/network topology and any requirements incorporated into the design drawings and schematics. Schematics with minimum details shall not be accepted. The mechanical specification shall include an accurate point list taking into consideration other services that need to be controlled/monitored by the BMS

j. Allowance for adequate space for installation and maintenance of machinery is a requirement of Curtin university. All equipment whether located in a ceiling space or plantroom shall be provided with adequate access complying with the Australian standards. Equipment such as AHUs shall be located to allow enough space for future maintenance and replacement of coils. The plantroom shall be designed with accessibility and future replacement of equipment in mind. As an example, the main plant rooms with chillers shall have enough space for tube cleaning and future replacement of the chillers or any major equipment within the plant room.

Provision of fixed access platforms, walkways, stairs, and ladders in accordance with AS.1657 to allow service/maintenance access to all items of equipment in ceiling spaces, roof spaces, and on roofs;

a. Roof access ways exposed to the elements shall be high tensile structural marine-grade aluminium engineered to support the heaviest piece of installed equipment including service loads and attached to the roof decking with approved weatherproof fixings isolating the access way from the roof material.

b. Walkways are to be provided in roof spaces, protected from the weather and shall be integrated with ductwork, pipework, and conduit layouts at the design stage so that all serviceable items of equipment can be accessed from the fixed walkway.

2.4.2 DESIGN INPUTS AND PROCESS

Curtin University expects consultants and designers to proactively inform, advise and contribute to the design process and in particular the following aspects:

a. **Building Physics** – provide advice to the project team, including other design team members that would improve the inherent building thermal performance, which may lead to a reduction in both capital and energy costs. This may initially take the form of simple advice and subsequently backed up by thermal modelling or similar methods. The process may take several iterative steps. The consultant or designer is expected to advise, contribute, and if necessary, lead such processes. Passive solutions and natural ventilation/ mixed mode ventilation must be considered where appropriate. If passive solutions are proposed, they need to be backed by codes/standards or computational fluid dynamics "CFD" analysis.

b. Planning **and architecture** – Provide advice on the appropriate location of plant rooms and reticulation strategy to assist in both the planning of the building and the facilitation of better maintenance in the future. Such advice must be provided in the early stage of the design and planning process so that this can be taken into consideration by the architect.

c. **Value** Engineering by definition is the process of reducing the cost of producing a product without reducing its quality or how effective it is[1]. Consultants shall advise the university on the value engineering options that may enhance the project outcome by reducing the capital cost (CAPEX) or ongoing maintenance cost (OPEX). Any value engineering shall not compromise the target energy consumption of the building or compliance with the relevant standards. Value engineering options that are purely driven by cost reduction shall not be approved. Any value engineering options shall be recorded in a tracking sheet for review and approval by Curtin's infrastructure manager.

2.5 COVID 19 MEASURES AND IMPACT ON DESIGN

2.5.1 GENERAL

There is evidence and acknowledgment from WHO (World Health Organisation) that in addition to the identified method of SARS-CoV-2 transmission via contact and droplet, the spread can occur via aerosols under favourable conditions, particularly in relatively confined spaces with poor ventilation. This has shed light on the importance of ventilation level as the most important engineering control in infection control. Each building is unique and requires specific assessment to be conducted to determine the suitable measures

There are many measures available to mitigate the risk of COVID-19 transmission in buildings. As shown in the traditional infection control hierarchy, mechanical and plumbing-related measures are at a higher level than the other elements. It's therefore important to consider ventilation in buildings to protect against airborne transmission.

[1] Cambridge Dictionary - https://dictionary.cambridge.org/us/

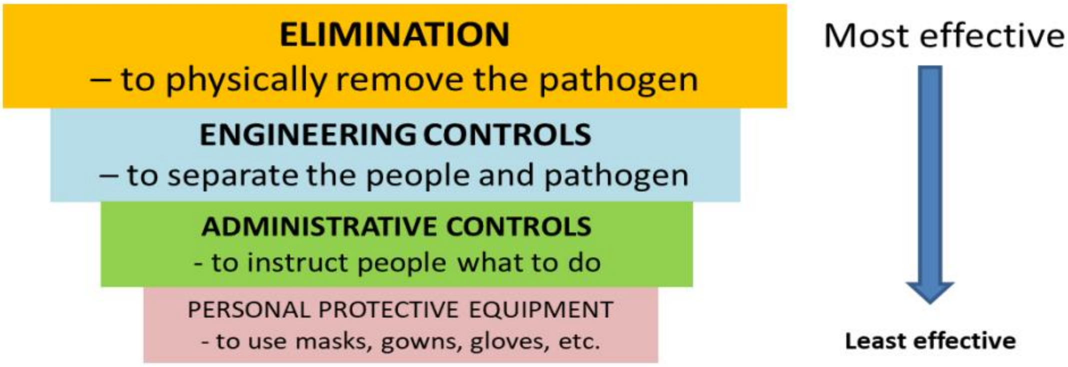


Figure 4. Traditional infection control pyramid adapted from the US Centers for Disease Controlxxxiii.

Curtin maintains a document titled Airborne Transmissible Disease Business Continuity Plan. This document may be provided on request to the Infrastructure Manager, Mechanical Services.

2.5.2 RECOMMENDED STRATEGIES

Based on the system arrangement and the type of ventilation, the following recommendations can be adopted. There are major differences between the operation of different types of buildings during epidemic mode and the recommended changes to be incorporated into the systems to reduce the risk of transmission. Consultants shall assess each project for

The recommendations are based on the available information from different sources such as ASHRAE, CIBSE and REHVA.

a. Systems with DCV controls (Demand control ventilation) to have a set point of 500PPM to ensure adequate ventilation to the spaces being served.

b. Filtration systems to have minimum efficiency filtration of MERV 13/F7. These types of filters have an efficiency of 80<Em<90% according to average efficiency test dust no.1 as per AS 1324.1-2001.

c. Incorporate a purging cycle through the BMS for 2 hours before and after the occupancy of the building. This is limited to systems with relief/return air fans or systems with mechanical supply and natural relief systems. Systems that are fully recirculating will be required to shut down.

d. Operate the dual fan / motor toilet exhaust systems in all buildings 24/7 via the BMS system.

e. UVGI disinfection equipment or virucidal filters are available products that can be used to reduce the risk of transmission. UVGI equipment will need to be correctly sized, installed, and maintained. Consultants shall assess the need for this on a case by case basis.

f. Installation of additional space mounted CO_2 sensors in areas with high occupancy levels with visual alarm devices to warn occupants against underventilation situations especially in busy areas where people spend one or more hours such as classrooms and meeting rooms.

g. Amend the BMS to include a single emergency isolate interface for each building that is activated by an operator.

2.6 CONSULTANT AND CONTRACTOR REQUIREMENTS

All contractors and consultants must demonstrate the following:

- evidence of participation in training programs, including safety training, to ensure knowledge and skills are kept up to date with industry changes and related standards
- experience working on projects with complex infrastructure in campus-style environments, including client-controlled systems and services.

2.6.1 CONTRACTORS

Mechanical contractors must demonstrate the following:

- evidence that the company holds a Refrigerant Trading Authorisation as issued by the Australian Refrigeration Council
- evidence that air conditioning and refrigeration technicians hold relevant Refrigerant Handling Licences as issued by the Australian Refrigeration Council
- mechanical technicians, where required to work on electrical plant associated with mechanical services, hold the relevant electrical licence/qualifications
- experience installing and maintaining large-scale district heating and cooling system infrastructure
- experience with installing and maintaining laboratory mechanical infrastructure, up to prescribed containment level 3
- experience with building automation management systems and integration with associated systems/infrastructure
- very sound capability in commissioning and balancing of systems and infrastructure associated with mechanical services
- strong documentation capability using industry-recognised platforms such as AutoCAD/Revit etc.

While it is recognised that organisations may not have competencies in every facet listed above, they should have a broad understanding and capability of all areas, with specialist expertise in at least two of the areas mentioned above as a maintainer or installer, with more being desirable.

2.6.2 CONSULTANTS

It is Curtin's expectation that all designers shall be qualified engineers with experience in campus-style projects. Prior to consultant engagement, the consultant shall provide a list of the engineers involved in the project including details of their qualifications and experience. Engineers working on Curtin's projects shall be capable of perform all design markups, calculations, equipment selections, quality checks, and analysis of commissioning data, know and understand technical specifications, BMS controls & hard wired controls, be knowledgeable on their subject and related standards and codes, and must consult with the Mechanical Infrastructure Manager.

Mechanical consultants must broadly demonstrate the following:

- experience in detailed engineering design practice as it relates to a campus-based environment, with a strong understanding and demonstrated experience with large-scale district heating and cooling systems and associated mechanical infrastructure
- experience with engineering design and compliance requirements of complex laboratory mechanical systems and infrastructure, up to prescribed containment level 3
- experience with building automation management systems, their design and integration with associated systems/infrastructure
- demonstrated capability to work with multidisciplinary engineering design teams in a collaborative way to produce desired building mechanical services outcomes
- very strong capability in understanding and oversighting the management processes in the commissioning and balancing of mechanical systems and infrastructure associated with mechanical services
- strong documentation capability using industry-recognised platforms such as AutoCAD/Revit, BIM etc.
- relevant professional engineering qualifications and affiliations
- A minimum of 5 years' experience delivering services in a similar context.

2.6.3 CALCULATIONS

Consultants shall use computer-based software to carry out the various calculations. Heat load software shall be based on heat balance or transfer function methods. Recommended software's are CAMEL, HAP or IESVE.

All nominated Static pressure for airside equipment shall be based on initial calculations based on the design documentation. Static pressure that is based on assumption shall not be accepted as this will impact the equipment sizes and power supply requirements if values are not accurate.

Like the airside, waterside calculations shall be conducted by the consultant to determine the size of the pumps. Any assumed values shall not be accepted.

Designers shall review the impact of the new systems/ Building on the overall chilled and heating hot water systems. This includes impact on the current pipe sizes and differential pressure control. Designers shall advise Curtin on the expected pressure required for both chilled and heating hot water systems. Any un-planned work that will impact the operation of the campus-wide chilled and heating hot water system shall not be approved and it remains the design responsibility of the consultant to avoid this situation.

2.7 DELIVERABLES

2.7.1 GENERAL

Curtin University capital projects that use these Guidelines will generally involve the appointment of a Lead Consultant to manage the project on the University's behalf.

Curtin will appoint a suitably experienced Lead Consultant/Architectural Services to assist Curtin University and other key stakeholders with defining the space planning, functional and operational requirements, and schedules of accommodation.

The Lead Consultant will be responsible for providing project design and management services throughout all phases of the project, including concept design, schematic design, detailed design and documentation, tender, construction contract administration, defects liability and handover phases.

The Lead Consultant will not be responsible for engagement of the cost consultant nor engineering consultants, who will be directly engaged by Curtin University. The Lead Consultant will however be responsible for coordinating the work of those other consultants and thereby ensuring that the deliverables for which they are directly responsible are delivered.

In smaller projects the Mechanical Consultant may be the Lead Consultant with a Project manager residing as the interface with the University.

A summary of the services and deliverables to be delivered during a project is as follows, and is not intended to limit or restrict the extent of the consultants' works that may be outlined herein, later in this document or in the project brief/scope of works:

- design works associated with the total delivery package
- all specifications and drawings included as a tender package
- provision of submissions and consents
- preparation of tender documentation, management of the tender process and preparation of a tender evaluation report
- management of project resources sufficient to ensure commissioning and other later-stage deliverables are not left under-resourced
- project surveillance during construction from kick-off meeting to final commissioning and handover
- management of defective work and oversight of its rectification during the works
- responsibility for the as-constructed component of the project, ensuring that:
  - all as-constructed drawings are provided in accordance with the Curtin University *Documentation Deliverables Guidelines*

- Curtin University has received all operations and maintenance manuals specified
- all in-ground infrastructure is surveyed at the time of installation, including the coordination of information into the Curtin GIS system.

The Consultant shall provide a full service unless advised by Curtin University that a nominated partial service is required.

Continuous communication with the Responsible Officer for any Mechanical Services consultancy is required throughout service delivery, in order to achieve the following deliverables:

2.7.2 SCHEMATIC DESIGN STAGE

SERVICES

The Consultant shall

- establish site constraints
- undertake a site survey and obtain in-ground services data from Curtin University
- prepare schematic drawings including site plan, building services, infrastructure and preliminary line diagrams as applicable
- prepare design options if required
- provide indicative equipment dimensions and loadings
- provide preliminary distribution scheme
- liaise with other consultants in the preparation of drawings, reports and cost estimates, as required
- prepare an indicative cost estimate for the project.

DELIVERABLES

The Consultant shall:

- deliver a Design Report including anticipated maximum demand and energy consumption calculations, energy management sketch drawings and an indicative cost estimate.

2.7.3 DESIGN DEVELOPMENT STAGE

SERVICES

The Consultant shall:

- attend design meetings with Curtin University and provide briefing and design reviews
- develop an agreed design option/options
- assist in revising cost estimates
- develop drawings and documents for University review and submission to government agencies as required
- develop a preliminary program for the works, in consultation with Curtin University.

DELIVERABLES

The Consultant shall deliver:

- drawings and documents
- submissions to government agencies
- a revised cost estimate
- a preliminary program.

2.7.4 DOCUMENTATION STAGE

SERVICES

The Consultant shall:

- prepare detailed tender documentation
- incorporate all consent conditions into the documentation
- provide an updated cost estimate
- review compliance of the documents with the project brief
- examine specifications prepared by other consultants (if applicable) and make comment
- be prepared to modify specific elements to comply with budgetary constraints
- participate in value engineering and management studies if nominated in the project brief
- provide an updated program of works.

DELIVERABLES

The Consultant shall deliver:

- specification and drawings
- an updated cost estimate
- an updated program of works.

2.7.5 TENDER STAGE

SERVICES

The Consultant shall:

- examine other consultants' documentation (if any) to avoid ambiguity or contradiction between documents
- prepare tender documentation, in association with Curtin University
- prepare a tender form and tender breakdown
- assist with the selection of tenderers
- assist with the calling of tenders if requested
- answer tender queries during the course of tendering
- issue tender addenda if required
- prepare a tender evaluation report and make a recommendation, including meeting with tenderers if necessary.

DELIVERABLES

The Consultant shall deliver:

- specification and drawings
- a tender form and tender breakdown
- addenda
- a tender evaluation report.

2.7.6 CONSTRUCTION STAGE

SERVICES

The Consultant shall:

- incorporate tender negotiation outcomes into documentation where necessary
- provide 'For Construction' documentation

- provide assistance in validating the contractors' claims for progress payments
- undertake regular site inspections during the course of the works and report results
- undertake factory inspections for switchboards and the like and provide a short report
- examine shop drawings and make comment
- review test results and comment
- provide an 'Outstanding Items/Defects List' at the end of the construction period and prior to Practical Completion
- ensure as-built drawings and manuals are submitted in accordance with Curtin University requirements
- provide visual observation certification that the works have been completed generally in accordance with the contract documentation.

DELIVERABLES

The Consultant shall deliver:

- 'For Construction' documentation
- site inspection reports
- factory inspection reports
- commented shop drawings
- test result comments
- 'works complete' certification.

2.7.7 COMMISSIONING AND HANDOVER STAGE

SERVICES

The Consultant shall:

- evaluate all commissioning results
- validate integrated functional fire testing
- review and validate BMS controls' operational functionality
- review and validate graphics, points, etc.
- review operations and maintenance manuals and As Constructed data.

DELIVERABLES

The Consultant shall deliver:

- safety in design report
- commissioning defects lists
- BMS defects lists
- Certification of functional fire mode testing.

POST-CONSTRUCTION/DEFECTS LIABILITY PERIOD STAGE

SERVICES

The Consultant shall:

- provide a close-out of the Outstanding Items/Defects List
- undertake a site inspection within one month of the end of the Defects Liability period and report on any/all defects
- close out defects
- provide assistance to Curtin University in resolving faults during the course of the Defects Liability period.

DELIVERABLES

The Consultant shall deliver:

- a signed-off defects list
- a defects report at the end of the liability period and close out.

2.7.8 TUNING STAGE (IF REQUIRED)

SERVICES

The Consultant shall:

- evaluate operational performance of the system and BMS
- review and provide input into the contractors' tuning/performance report
- attend tuning/performance meetings and provide input
- close out tuning/performance defects.

DELIVERABLES

The Consultant shall deliver:

- tuning/performance reports

- tuning/performance meeting minutes.

2.8 COMPLIANCE WITH REGULATIONS

The following standards shall be complied with as a minimum. The list of standards is not intended to limit compliance requirements where they may be relevant but not listed below. A reference to Australian Standards (AS) also includes joint Australian and New Zealand Standards; a reference to a standard includes all parts. The standard to be complied with is always the most recent and current version, unless specified otherwise.

- National Construction Code (NCC)
- AS1132 – Methods of test for air filters for use in air conditioning and general ventilation
- AS1170.4 - Earthquake Action in Australia (Seismic Restraints)
- AS1200 - Pressure equipment
- AS1318 – Use of colour for the marking of physical hazards and the identification of certain equipment in industry (known as the SAA Industrial Safety Colour Code)
- AS1324 – Air filters for use in general ventilation and air-conditioning
- AS1345 – Identification of the contents of pipes, conduits and ducts
- AS1432 - Copper tubes for plumbing gas fitting and drainage applications
- AS NZS 1477 - PVC pipes and fittings for pressure
- AS1530.3 – Methods for fire tests on building materials, components and structures, simultaneous determination of ignitability, flame propagation, heat release and smoke release
- AS1571 - Copper seamless tubes for refrigeration and air conditioning
- AS1668.1 – The use of ventilation and air conditioning in buildings Fire and smoke control in buildings
- AS1668.2 – The use of ventilation and air conditioning in buildings Mechanical ventilation in buildings
- AS1668.3 – The use of ventilation and air conditioning in buildings Smoke control systems for large single compartments or smoke reservoirs
- AS1668.4 – The use of ventilation and air conditioning in buildings Natural ventilation of buildings
- AS1670 – Fire detection, warning, control and intercom systems

- AS1677 - Refrigerating systems - Refrigerant classification & Safety requirements
- AS1682 - Fire Dampers Installation (All Parts)
- AS1940 – The storage and handling of flammable and combustible liquids
- AS2107 – Acoustics – Recommended design sound levels and reverberation times for building interiors
- AS2243 - Safety in Laboratories (All Parts)
- AS2430 – Classification of hazardous areas
- AS2700 – Colour standards for general purposes
- AS2982 – Laboratory design and construction (All Parts)
- AS2896 - Medical Gas Systems (Reference)
- AS3000 – Electrical installations
- AS3008 – Electrical installations – Selections of cables
- AS3102 – Electric Duct Heaters
- AS3439.1 – Low voltage switchgear and control gear assemblies – Type tested and partially type-tested assemblies
- AS3666 – Air handling and water systems of buildings
- AS3780 - Storage & Handling Corrosives
- AS3959 - Construction of buildings in bushfire-prone areas
- AS4041 – Pressure piping
- AS4114 – Spray painting booths, designated spray painting areas and paint mixing rooms.
- AS4254 – Ductwork for air handling systems in buildings
- AS4289 - Oxygen and acetylene gas reticulation systems
- AS4332 - The storage and handling of gases in cylinders
- AS4426 – Thermal Insulation of Pipework, Ductwork and Equipment – Selection, Installation and Finish
- AS4508 – Thermal resistance of insulation for ductwork used in building air-conditioning
- AS4859.1 – Materials for the thermal insulation of buildings - General criteria and technical provisions.

- AS2566.1&2 - Buried Flexible Pipelines
- AS5601 - Gas Installation
- AS/ISO5149 - Refrigerating systems
- AS NZS 60079 - Explosive atmospheres - Classification of areas - Explosive gas atmospheres
- Office of the Gene Technology Regulator – Guide to physical containment levels and facility types

The following list of standards is not intended to limit compliance requirements for physical containment facilities where they may be relevant but not listed below. All standards listed are managed by the Office of the Gene Technology Regulator (OGTR).

- Guidelines for certification of a Physical Containment Level 1 facility
- Guidelines for certification of a Physical Containment Level 2 facility
  - Animal facility
  - Aquatic facility
  - Constant temperature room
  - Invertebrate facility
  - Laboratory
  - Large grazing animal facility
  - Large scale facility
  - Plant facility
- Guidelines for certification of a Physical Containment Level 3 facility
  - Invertebrate facility
  - Laboratory
- Guidelines for certification of a Physical Containment Level 4 facility
- Further information and guidelines can be found from https://www.ogtr.gov.au/

3 TECHNICAL REQUIREMENTS

3.1 MECHANICAL, HVAC (INCLUDING BMS CONTROL)

3.1.1 GENERAL

Sustainability is fundamental to the ongoing success of Curtin University's business. All users of the Project Delivery Guidelines – Mechanical Services must do so in consultation with the University's Sustainable Design Guidelines.

Designers interpreting these guidelines are to understand that changes to technology and policy may outpace the content of these guidelines. Prior to the calling of tenders for building services, the Curtin University Project Manager and the appropriate Infrastructure Manager and Services Manager must approve the following:

- scope document (preferably in diagrammatic format), which clearly indicates intent
- equipment schedules where appropriate
- list of suggested tenderers.

3.1.2 SPECIFICATIONS

The content of these guidelines must be fully integrated into consultant specifications. The practice of appending these guidelines to generic specifications will not be accepted. Generic specifications, if used, must be edited to eliminate any conflict with the content of these guidelines.

Approved **equivalent** – The University will determine whether an alternative product submitted is an Approved Equivalent. Consultants and Contractors shall submit detailed information demonstrating equivalence with an easy to read side by side comparison. Any omission of particulars that the University deems is critical to decision making shall be immediately addressed. The University's decision will be final.

3.1.3 SURVEYED AS-CONSTRUCTED IN-GROUND SERVICES

All in-ground services are to be surveyed by a licensed surveyor, picking up location, inverts at critical intervals and levels of tops of pits.

Information is to be aligned to GDA94 coordinates to allow insertion into the University Master Site Services Plan.

3.2 ACCESS, MAINTENANCE MANUALS AND DATA COLLECTION

3.2.1 GENERAL

Maintenance of the University's facilities is a significant commitment in the University's operating costs. It is therefore imperative to ensure that all facilities are constructed bearing in mind life-cycle costs and maintainability.

Planning, design documentation and construction will make adequate provision for:

- servicing and maintenance
- easy removal and replacement of plant and equipment
- access
- durability.

3.2.2 OPERATIONS AND MAINTENANCE MANUALS

Operations and Maintenance Manuals shall be provided prior to Practical Completion for every building project and they shall address all finishes and services. These manuals shall include but not be limited to:

- cover sheet (refer Appendix 1)
- contents
- contractor and consultant details
- detailed description of the installation
- design criteria (as noted in Section 3.4 and building materials & glazing thermal performance data)
- detailed equipment performance and technical schedules
- detailed plant and equipment controls system description and operational descriptions
- colour schedules
- maintenance instructions and schedules
- schedule of suppliers and sub contractors
- supplier information
- commissioning data, set points, flow rates, timer settings etc.
- copies of all as-installed drawings in electronic format (PDF and native file formats)
- control and electrical plans, complete with terminal numbers corresponding to wiring ferrules and cross-referenced as necessary (PDF and native file formats)
- one hard copy manual and one electronic copy provided on a DVD inserted in the inside cover of the hard copy (PDF and native file formats).

For specific requirements relating to Operations and Maintenance Manuals for Mechanical Services see section 3.4.29.

3.2.3 DATA COLLECTION

3.2.3.1 Information for the CMMS

The contractor is required to complete the data capture requirements outlined in the FM Asset Register template. The data capture includes but is not limited to information on:

- Existing assets
- Retired assets
- New assets

This ensures that the CMMS remains current particularly where existing assets are retired.

3.2.3.2 Information for Infrastructure Management

The mechanical services area of Curtin University maintains a comprehensive suite of data that assists the University with the master planning process that underpins the strategic development of the University. Ensuring the currency of this data is paramount and consultants and contractors are crucial to this process.

The following are the key sources of data that the mechanical services field aims to maintain:

1. chilled and heated water site-connected load data
2. cooling and heating equipment data
3. chilled and heated water pipework & fittings technical data
4. an inventory of all metering devices, which includes electricity, gas, water and thermal chilled and heating water meters associated with building space heating
5. plant and equipment reference data
6. schematic line diagrams of air conditioning duct layout within buildings and site chilled and heating water schematic diagrams.

It is important that project specifications refer to the capture of this data and that the mechanical contractors (and other engineering disciplines) play their part in providing this data to the University so that data sets can be updated. To assist in this process, templates have been developed for the first five categories listed above that the contractor shall use to record the required data and submit to the Properties, Facilities and Development Mechanical Engineering Department at the time of project Practical Completion.

Sample templates for each of the above data set areas are contained in Section 4 Appendix 1 of this document. Consultants and contractors should contact the Mechanical Engineering Department to obtain soft copies of the templates in which the data is to be submitted to the University. Item 6 requires that the relevant as-constructed AutoCAD drawings relating to ductwork layout and site chilled and heating water drawings be compliant with the requirements described in the *Documentation Deliverables Guidelines* & *Standard Mechanical Engineering Data Capture_ Bentley Campus* and are forwarded to the Mechanical Engineering Department at project Practical Completion.

3.2.4 ACCESS FOR MECHANICAL ENGINEERING SERVICES

Simple maintenance procedures throughout the buildings are vital, and shall be reviewed with the University before going to tender.

The design and construction materials shall reflect low maintenance considerations. All fabric, structural and service components shall be readily accessible and shall not be labour-intensive at the repair stage.

Consultants shall ensure that they indicate:

- how each item of plant is to be installed initially
- how the University's routine service personnel will access each plant item
- the method to be used in changing the largest item of plant in any plant room or plant area.

'Adequate access' for routine servicing means sufficient space for a plant mechanic, irrespective of working age, to reach all items requiring routine service safely and without undue stress.

Any equipment installed in a trafficable ceiling space, or on the roof, shall have a permanently fixed ladder and easily opened trap door. The design and location shall be approved by the University Project Manager.

Mechanical and electrical plant and equipment, particularly those requiring manual operation such as electrical control panels, or routine maintenance such as pumps and fans, shall have safe and comfortable access. A 'loose' fit is essential to enable work to be carried out around them.

The Project Architect shall ensure that there is coordination between the structural engineers and service engineers to allow incoming underground services, in the form of pipes and cables, to pass through the building footings with the ability to replace them with ease as may be required in the future.

Adequate spare conduits to allow for future growth of services shall be allowed. Such things as electrical and telephone cables may be too big and heavy to be pulled around conduit bends – straight access, without bends or obstructions, shall be provided.

3.2.5 PLANT ROOMS

The Project Architect shall request from consultants the range of sizes for all items of mechanical and electrical plant. The Architect shall ensure that the final selection of mechanical and electrical equipment will not require additional space.

The Project Architect and consultants shall ensure that the plant room layout at the design stage provides for future expansion.

Direct access from corridors to roof areas, plant rooms, tunnels, etc. shall be provided where possible to enable the independent control of these areas by Curtin Properties, Facilities and Development Department.

Plant rooms shall be located convenient to the most direct point of vehicular access that can be achieved without the introduction of extensive service road connections.

It is preferred that plant rooms be located at rooftop or basement level rather than in the body of the building. Provision shall be made in elevated plant rooms for hatches and lifting equipment to facilitate conveyance of equipment to the ground.

Plant room floors shall be graded to floor waste water outlets in order to permit hosing down of floors. Floor surfaces are to be sealed against spillages and flooding by bunding or other approved methods and painted with paving paint.

Plant rooms shall be designed so that the noise level measured with all the equipment operating under full load will not exceed the current exposure standard less 3 dbA. Where this cannot be achieved, the University Project Manager shall be consulted.

3.3 SEISMIC REQUIREMENTS

Failure of engineering services as a result of an earthquake have a significant effect on life safety and economic loss. AS 1170.4 provides information about certain non-structural building parts and components that would need to be designed to resist the horizontal and vertical earthquake forces.

For any new buildings, the earthquake design criteria shall be established by the structural engineer. All mechanical consultants shall ensure that their documentation reflect the requirements and standard construction details shall be provided as part of the design documentation for the project.

The following installations may be excluded from any seismic requirements in accordance with AS1170.4, however designers must satisfy themselves that this is the case.

- Gas piping less than 25mm inside diameter
- Piping and boiler in a mechanical plantroom less than 32mm inside diameter
- All other piping less than 64mm inside diameter
- All rectangular air handling ducts less than 0.4m^2 in cross sectional area
- All round ducts less than 700mm in diameter
- All ducts and piping suspended by induvial hangers 300mm or less in length from the top of the pipe to the bottom of the support for the hanger

3.4 MECHANICAL, VENTILATION AND AIR CONDITIONING

3.4.1 GENERAL

This section of the Project Delivery Guidelines outlines the University's minimum requirements for air conditioning and ventilation systems for both new buildings and buildings being refurbished.

The following functional requirements are to be given special design consideration:

- energy efficiency
- simplicity of design
- accessibility, ease of operation, simplicity of maintenance, combined with minimal maintenance frequency
- life-cycle cost analysis to govern the selection of systems and equipment (the University may call for calculations on competing systems)
- centralised chilled and heating water systems. It is recognised that chilled water systems may initially require a higher capital cost than alternatives such as DX systems, however, on a life-cycle cost analysis, chilled water may be preferable. The decision shall be undertaken in consultation with Curtin's Infrastructure Manager Mechanical Services
- comprehensive metering of chilled water and heating water system usage, in accordance with the requirements described in *000346 PDG Services Metering Guidelines*
- allowance for adequate space for installation and maintenance of machinery whether it be in a designated plant room, ceiling space or otherwise. Lack of space is not considered an acceptable constraint on mechanical design
- compliance with all statutory requirements
- compliance with AS3000. All required test results, including earth looping impedance testing, shall be issued with the as-constructed documentation.

All staff studies are to be provided with an air conditioning system conforming to the following:

- Staff occupy their offices approximately 15 hours per week.
- The system must have an economy cycle in accordance with the NCC requirements or, where systems are greater than 36 kW(r), whichever is the stricter.
- Sensors are to be located 1,200−1,500 mm from the outside wall and on the room dividing wall where the whiteboard/pin-up board is located.

3.4.2 DESIGN CRITERIA & PERFORMANCE STANDARDS

Careful consideration should be given to the design conditions for various areas with the following design criteria to be the basis of all construction and associated projects.

3.4.2.1 External Design Conditions – Summer

Description	**Condition**
Teaching Areas	37°C DB, 24°C WB
Office & Research Areas	37°C DB, 24°C WB
Critical Applications (8am to 6pm)	40.0°C DB, 23.0°C WB
Critical Applications (24 hour)	39.7°C DB, 23.6°C WB
Comms and AV Rooms (Critical applications)	39.7 ° C DB, 23.6 °C WB.

3.4.2.2 External Design Conditions – Winter

Description	**Condition**
Non Critical Applications	7.0°C DB
Critical Applications	3.5°C DB

3.4.2.3 Internal Design Conditions − Summer

Air conditioning plant shall be designed to maintain the following internal design conditions:

Description	**Condition**
Space Temperature	22.5 °C DB ± 1.5 °C
Space Relative Humidity	55% RH by virtue of cooling coil performance, or
	RH ± 5% for specific humidity control environments
	RH ±1% RH for specific humidity critical control environments

Humidity control will not be provided unless specifically called for or where special circumstances dictate. Where special conditions are required, these will be nominated by the user and agreed by the University Project Manager. Refer also to Section Communications and AV Room Air Conditioning Requirements.

3.4.2.4 Internal Design Conditions − Winter

Internal Winter Design Conditions shall be: 22.5 ±1.5 °C.

3.4.2.5 Internal Design Conditions –Comms and AV Rooms and Critical Areas

Internal design conditions shall be: 22.5 ± 1.0 °C.

3.4.2.6 Internal conditions- Carbon Dioxide Levels

Teaching Areas	500-800 ppm
Office & Research Areas	500-800 ppm

3.4.2.7 Internal conditions- Volatile Organic Compounds

Determine for each project how it intends to deal with VOC's pertaining to its Community Green Star certification. Seek information from the Lead design consultant, Project Manager or Curtin project manager.

3.4.2.8 Room Occupancy Number

Occupancy levels are based on the University's space allocation rates for various building/facility utilisations. Where project briefing documentation does not stipulate space occupancy rates for specific projects that are required for determining heat-loads, consultants shall forward a request to Curtin University for further relevant information. Where this information is not available, conform to AS1668 Part 2 as nominated by the Building Code of Australia.

3.4.2.9 Lighting Loads

Lighting loads shall be obtained from the Electrical Consultants based on their lighting layout. LED lighting is being rolled out throughout the University and a general rule lighting load can be calculated as follows. In the absence of any data refer to rates within the NCC. These rates do not include for any specialist lighting:

Description	**Rate**
Teaching, Research and Computer Labs	8.5 W/m^2
Laboratories	8.5 W/m^2
Offices	8.5 W/m^2
Lecture Theatres	11.0 W/ m^2
Corridors	8.0 W/ m^2

3.4.2.10 Equipment Loads

Equipment loads can be equal to those shown below and are subject to confirmation by the University Project Manager.

Description	**Rate**
General office	15 W/m^2
Computer terminal (lab) rooms	100 W/m^2 – to be individually determined.
Laboratory - Undergraduate (1st Year)	30 W/m^2 – to be individually determined, noting that high intensity labs can be as higher

Laboratory - Postgraduate	30 W/m² – to be individually determined, noting that high intensity labs can be as higher
Laboratory – with specialist equipment	Minimum 100 W/m² and to suit equipment
Seminar Rooms	15 W/m²
Lecture Theatres	15 W/m²
Lecture Class Rooms	15 W/m²

A request for the comms and/or AV equipment loads shall be submitted to Curtin University to provide the relevant heat load information prior to the sizing of air conditioning equipment. Depending on the nature of the consultant's engagement, the request may need to be via the project electrical/communications/audio-visual consultants for follow-up with Curtin University.

The returned heat load information shall consider:

- equipment load
- UPS load (if provided)
- spare future expansion capacity
- fabric loads, etc.

During construction and prior to the ordering of comms and AV air conditioning equipment, a final survey of the comms and AV equipment shall be conducted to ensure that no changes have been made to the equipment during the design phase.

Where equipment loads have not been identified for a particular area, forward a request to Curtin University for the relevant information.

3.4.2.11 Outside Air Rates

As a minimum, outside air rates shall be in accordance with AS1668.2 as nominated by the Building Code of Australia. Due to the risk with viral transmission such as COVID, its recommended that the outside air is increased above the requirement of AS1668.2. This should be assessed based on the project requirements and compliance with NCC section J requirements and the University obligations under its Community Green Star certification.

Consultants shall evaluate in early design phase increasing the outside air rates by 1½ times and by 2, as part of the design brief. The evaluation shall include LCCA.

Where outside air rates are increased designers must consider heat recovery systems combined with dehumidification control. Sizing of cooling / heating coils shall be suitable to provide normal cooling and heating without heat recovery at the minimum required outside air rate.

3.4.2.12 Infiltration

The following infiltration rates are to be used within heat load calculations, adjusted as necessary to meet the NCC section J building sealing levels.

Description	Rate
Perimeter zones	0.5 air changes per hour
Entry Lobbies with revolving doors	0.5 air changes per hour
Entry lobbies with manual doors	1 air change per hour
Entry Lobbies with sliding doors	2 air changes per hour

Reduction of the above rates should be considered to the extent that the building is pressurised.

3.4.2.13 Evaporative & Indirect Evaporative Cooling

Evaporative cooling for rooms such as commercial kitchens and the like shall be designed to a minimum acceptable air change rate of 25 to 30 air changes per hour, subject to heat load calculations limiting the space temperature to 28-29 °C.

Evaporative cooling & Indirect Evaporative cooling for rooms such as glass houses and the like shall be designed to a minimum acceptable air change rate to suit the application, subject to heat load calculations, limiting the space temperature to that determined by the user group.

Adequate consideration shall be given for sufficient relief air paths for all evaporatively cooled areas.

3.4.2.14 Chilled Water Conditions

For design purposes the following water temperatures are to be used:

Description	Temperature
Network supply water	7.0 °C
Network return water	14.0 °C
Chiller leaving water	7.0 °C
Chiller entering water	14.0 °C

Special attention must be paid when modifying or extending an existing chilled water system with respect to the impact on the existing plant capacity, distribution system and controls. The designer shall review the design parameters of all equipment on that system to ensure design chilled water temperatures and flow rates are normalised to meet the current design standard for the site and that the piping and valve configurations for the system are in accordance with the design intent of the system.

Curtin University’s Mechanical Services section within the Properties, Facilities and Development Department (PF & D) maintain an inventory of chilled water connected load flow rate data for chiller generation plant through to each building down to individual air handling unit coil level. To ensure accuracy of the inventory is maintained, the mechanical services engineer shall ensure that both design and as-installed flow rate data is provided to PF&D on completion of any project that results in addition or changes to chilled water flow rates. The inventory for chilled water systems is available to design engineers upon request.

Designers shall pay attention when selecting cooling coils across the campus to ensure close balance is achieved between the water flow rate and water return temperature so ΔT can be maintained across the chilled water flow and return temperatures and reduce any impact on the staging of the chillers.

3.4.2.15 Condenser Water Conditions

EXISTING PLANT

For design purposes the following water temperatures are to be used for the existing plant:

Description	Temperature
Tower entering water	35.0 °C
Tower leaving water	29.5 °C
Tower ambient design	24.0 °C WB
Tower leaving water over condensing	18.0 °C
Chiller leaving water	35.0 °C
Chiller entering water	29.5 °C

NEW PLANT

For design purposes the following water temperatures are to be used for any new plant:

Description	Temperature
Tower entering water	35.0 °C
Tower leaving water	28.0 °C
Tower ambient design	24.0 °C WB
Tower leaving water over condensing	18.0 °C
Chiller leaving water	35.0 °C
Chiller entering water	28.0 °C

For new chilled water plants, cooling towers shall be selected at as above. This will reduce the lift on the compressors and reduce the overall power required.

Leaving condenser water temperature set point from the cooling tower shall be re-scheduled from 29.5 °C to 18 °C based on a combination of outside air temperature, time of day and charge mode of chilled water storage tank and in accordance with chiller parameters as specified by the chiller manufacturer to achieve the highest COP. Refer to Air Conditioning Control Functionality in Section 3.5.

3.4.2.16 Heated Water Conditions

For design purposes the following water temperatures are to be used:

Description	**Temperature**
Network supply water	60.0 °C
Network return water	50.0 °C
Water heater leaving water	60.0 °C
Water heater entering water	50.0 °C

Existing Boiler Temperatures – Supply Water Temperature 70.0 °C; Return Water Temperature 55.0 °C (Note that these temperatures are critical in ensuring condensation does not occur in the boiler and so shorten the life of the boiler).

New Condensing Water Heaters – New condensing water heaters provides better efficiency when operating at lower return water temperature. New condensing water heaters shall be selected with temperatures to match the system temperatures above. (Note that these temperatures are critical in ensuring failure of rubber seals associated with Victaulic joints on in-ground heating water pipe does not occur).

New Electric heat pump Water Heaters – New heat pump water heaters provides better efficiency than gas fired plant. New heat pump water heaters shall be selected with temperatures to match the system temperatures above. (Note that these temperatures are critical in ensuring failure of rubber seals associated with Victaulic joints on in-ground heating water pipe does not occur).

Special attention must be paid when modifying or extending an existing heating water system with respect to the impact on the existing plant capacity, distribution system pressure and controls. The designer shall review the design parameters of all equipment on that system to ensure design heating water temperatures and flow rates are normalised to meet the current design standard for the site and that the piping and valve configurations for the system are in accordance with the design intent of the system.

Curtin University's Mechanical Services section within PF & D maintains an inventory of heating water connected load flow rate data for boiler generation plant through to each building down to individual air handling unit coil level. To ensure accuracy of the inventory is maintained, the mechanical services engineer shall ensure that both design and as-installed flow rate data is provided to PF & D on completion of any project that results in addition or changes to heating water flow rates. The inventory for heating water systems is available to design engineers upon request.

3.4.2.17 Ductwork

3.4.2.17.1 Design Criteria

Ductwork sizing within a building shall be compliant with all of the following requirements for the index leg.

1. NCC compliant.

2. Systems < 2,000 L/s

    a. Maximum velocity of 6.5 m/s.

    b. Maximum pressure loss of 0.8 Pa/m.

3. Systems > 2,000 L/s

    a. Maximum velocity of 7.0 m/s.

    b. Maximum pressure loss of 0.8 Pa/m.

Exceptions:

1. As permitted by the NCC.

2. Performance based solutions permitted by the NCC.

3.4.2.17.2 Calculations and Modelling

NEW BUILDINGS & REFURBISHMENTS

Consultants & Contractors shall provide ductwork calculations for each system that demonstrates compliance to the above criteria. Calculations shall be in an excel spreadsheet format broken down elementally and shall include an associated schematic drawing(s) that references a numbering system in the spreadsheet to duct and component elements in the schematic. Formulas used for calculations shall be visible for inspection.

Alternatively models can be developed, in lieu of using spreadsheet(s), using standard off the shelf proprietary software. The outputs of the models shall be per the standard software report(s) and excel export.

EXISTING BUILDINGS

Consult with the Infrastructure Manager, Mechanical Services on the requirements for conducting calculations and/or models for existing buildings for minor works on a case by case basis.

Where re-use of the existing plant and ductwork is proposed the consultant must demonstrate that the ductwork systems and the associated air handling unit, cooling and heating coils etc are capable of delivering the requirements.

Where new systems are installed provide deliverables noted above for New Buildings and Refurbishments.

3.4.2.17.3 Data & Deliverables

Information to be contained in all data sets include but are not limited to:

1. IDs & OD.

2. Lengths.

3. Fittings, type and number on each length.

4. Coil, filters, PD’s.

5. Fittings flow rates.

6. Velocities & pressure losses.

7. Summated totals

8. Fan selection information (flow, head, power) including fan curve(s).

9. In all cases the native file formats shall be handed to the University as part of the practical completion deliverables.

Refer to the following documents on the University’s website:

- *Documentation Deliverables Guidelines* &
- *Standard Mechanical Engineering Data Capture_ Bentley Campus*

3.4.2.18 Pipework

3.4.2.18.1 Design Criteria - Buildings

Pipework sizing shall be compliant with all of the following requirements for the index leg.

1. NCC compliant.

2. Maximum velocity of 1.5 m/s for copper.

3. Maximum velocity of 2.0 m/s for steel.

4. Maximum pressure loss of 400 Pa/m.

5. Maximum building total pressure losses from point of building entry to point of building exit.

    a. Chilled water - 100 kPa.

    b. Heated water - 80 kPa.

    Pressure losses that are greater than those above are to be addressed via tertiary pumps installation.

Non index legs should not exceed items 2 & 3 and must ensure that they do not result in them becoming an index leg. Should this be the case the new index leg must be made compliant to the NCC and satisfy total building loss criteria.

3.4.2.18.2 Design Criteria – In Ground Network

Pipework sizing shall be compliant with all of the following requirements.

1. NCC compliant.

2. Maximum velocity of 1.5 m/s.

3. Maximum pressure loss of 200 Pa/m.

3.4.2.18.3 Pipework Calculations and Modelling

NEW BUILDINGS & REFURBISHMENTS

Consultants & Contractors shall provide pipework calculations for each system that demonstrates compliance to the above criteria. Calculations shall be in an excel spreadsheet format broken down elementally and shall include an associated schematic drawing(s) that references a numbering system in the spreadsheet to pipe and component elements in the schematic. Formulas used for calculations shall be visible for inspection.

Alternatively models can be developed, in lieu of using spreadsheet(s), using standard off the shelf proprietary software. The outputs of the models shall per the standard software report(s) and excel export.

EXISTING BUILDINGS

Consult with the Infrastructure Manager, Mechanical Services on the requirements for conducting calculations and/or models for existing buildings for minor works on a case by case basis.

Where re-use of the existing plant and pipework is proposed the consultant must demonstrate that the pipework systems and the associated air handling unit, cooling and heating coils etc are capable of delivering the requirements.

Where new systems are installed provide deliverables noted above for New Buildings and Refurbishments.

IN GROUND NETWORKS

Consultants & Contractors shall provide pipework calculations for each system that demonstrates compliance to the above criteria. Calculations shall be in an excel spreadsheet format broken down elementally and shall include an associated schematic drawing(s) that references a numbering system in the spreadsheet to pipe and component elements in the schematic. Formulas used for calculations shall be visible for inspection.

Alternatively models can be developed, in lieu of using spreadsheet(s), using standard off the shelf proprietary software. The outputs of the models shall be per the standard software report(s) and excel export.

3.4.2.18.4 Data & Deliverables

Information to be contained in all data sets include but are not limited to:

1. Pipe material & Class, Schedule, SDR, DN etc.
2. ID & OD.
3. Lengths.
4. Fittings, type and number on each length.
5. Insulation thickness and materials.

6. Coil, valves, control valves PD's.
7. Fittings flow rates.
8. Velocities & pressure losses.
9. Summated totals
10. Equivalent pump information (flow, head, power) as though the system were to be fitted with pumps for analytical purposes, including an associated pump curve.

In all cases the native file formats shall be handed to the University as part of the practical completion deliverables.

Refer to the following documents on the University's website:

- *Documentation Deliverables Guidelines* &
- *Standard Mechanical Engineering Data Capture_ Bentley Campus*

3.4.2.19 Factors, Allowances & Future Growth Provisions

All buildings are to be designed to have sufficient capacity to allow for extension or expansion of the air conditioning systems, either within the building or in adjacent buildings and vacant land plots i.e. chilled and heating water pipe sizing to, past and within buildings. The designer should reference the Curtin University Master Plan and discuss issues and options with Curtin University to consolidate the design intent that addresses future development requirements. All chilled water and heating pipe systems to each building shall, as a minimum, be designed to have 10 per cent spare capacity throughout.

The following factors, allowances and future growth provisions shall be used in calculations and the associated plant, equipment, ductwork and pipework selections and installation.

SAFETY FACTORS

Description	Rate
Space cooling loads	10%
Space heating loads	10%
Pumps	10% flow & head
Fans	10% flow & pressure

WINTER WARM UP

The following factor shall be used in all thermal load calculations:

Description	Rate
Winter warm up	30%

Heating coils within FCUs & AHUs shall be sized for the required building heating and include the winter warm up rate above. Downstream coils in VAV boxes or duct heaters shall not be used for this application.

3.4.2.20 Future Growth Provision

The following future growth provisions shall be included:

Description	Rate
Ductwork (main risers)	15% flow @ NCC compliance
Pipework	20% flow @ NCC compliance
Pumps	15% flow @ NCC compliance
Fans	15% flow @ NCC compliance
MSSB	25% physical space
BMS	25% hardware points

3.4.2.21 Noise Levels

The maximum allowable noise levels shall be in accordance with AS 2107 and as scheduled below:

Description	Level
General offices	NR 35–40
Laboratories	NR 35–40
Lecture theatres	NR 25–30
Seminar rooms/class rooms	NR 30–35
Individual offices	NR 35–40
Library	NR 35.

3.4.2.22 Commissioning Tolerances

The following tolerances for commissioning must be met:

Description	Rate
Airside systems	
• Air outlets	+0% to +10%, No diversification.
• Constant volume fans	No diversification.
• Variable air volume fans	95% minimum with a test to 100%
• Fume cupboards and the like	+0% to +10%, No diversification.
Chilled Water systems	+0% to +10%, No diversification on total.

Heating Water systems higher index of:

- AHU coil including winter warm up +0% to +10%, No diversification on total
- VAV HTGW coils, zone control +0% to +20%, No diversification.

Chilled & Heating AHU/FCU or built up units where heat recovery is fitted.

- Coil(s) sized for space load & minimum outside air including the required chilled and heating water flow. This is to ensure that there is capacity available when the heat recovery system like thermal wheels are offline for any reason.

Central CHW & HTGW plant +0% to +10%, No diversification on total.

3.4.3 CHILLED WATER SYSTEMS DESCRIPTION

3.4.3.1 Bentley Campus

The existing chilled water system has the following characteristics:

- Central chilled water plant is located in Building 117 (Central Plant – 3-off Trane centrifugal chillers and 1-off York chiller) and Building 154 (North Plant – 2-off Trane centrifugal chillers with provision to accommodate one further 4000 kWr chiller). One-off 4 million litre chilled water storage tank adjacent to B408 and directly charged from North Plant Chiller N° 2 and connects into the campus chilled water ring main.
- The chilled water storage tank is discharged during the day as a 'phantom' chiller in order to reduce campus on-peak power demand. The storage tank is charged by the Building 154 chillers at night utilising Johnson Controls Metasys Building Management Systems (BMS).
- The chilled water storage tank stores chilled water at approximately 5.0 °C. Stored water is then discharged during the day at 5.0 °C, however the tank has the facility to allow discharge water to mix with return water to enable the resetting of tank discharge water temperature up to 7 °C should it be required.
- The chilled water system is a decoupled primary water system at the central plant level with secondary variable speed pumps utilised for chilled water distribution to the campus. Some additional secondary pumps are also in use in various buildings where the operating head is significant.
- A reticulated chilled water distribution system across the campus serving most buildings utilises a 2-way control valve arrangement with 3-way valves on index legs.
- The secondary chilled water pumps are controlled via differential pressure sensors located in specific buildings as represented on the BMS.
- A cooling call is generated from each building, which enables the chilled water plant. The cooling call is typically generated via any chilled water valve that opens more than 70 per cent and the cooling call is disabled when all chilled water valves for that building are closed less than 20 per cent.

- A chilled water make-up tank is located at the highest point on the campus in Building 402.
- The chilled water plant uses the Johnson Controls BMS (B117, B154 and B408) that utilises low level and high level integration to control the chilled water generation system.
- There is a smaller chilled water plant located in Building 155 that is dedicated to Building 500 (South Plant – 3-off Trane screw chillers). This system has no physical connection to the main campus chilled water ring main. This facility is controlled by a LON-based Johnson control system and is integrated into the Johnson Controls Metasys BMS.
- B206- Dedicated air-cooled chiller operating as a standby system for B206.
- B200- A water cooled supplementary chiller is installed to provide a supplementary cooling to B200.

3.4.3.2 External Campuses

Curtin's campuses external to the Bentley Campus have the following chilled water systems:

- <u>78 Murray Street</u> – One-off air-cooled chiller with scroll compressors provides chilled water to levels 1 and 2 with the chiller controlled by a Johnson BACnet BMS that is integrated into the University's Johnson WAN.
- <u>Kalgoorlie</u> – Two-off air cooled Trane chillers that provides chilled water to Building 706.The chillers are installed at B705. It has standalone electric control. Building 701 has one-off air-cooled Carrier chiller with scroll compressors providing chilled water to Building 701 (AHU 1 only). This chiller is controlled by a Johnson BACnet BMS that is integrated into the University's Johnson WAN.
- <u>Technology Park</u> – Two-off Trane water-cooled chillers providing chilled water to Buildings 610, 611 and 614. The chillers are controlled by a Johnson BACnet BMS that is integrated into the University's Johnson WAN. The chillers are interlocked such that only one chiller can run at a time, as the power supply limitations to B612 limit the ability to run two machines together.
- <u>Midland Building 960</u> - Two off York air cooled chillers providing chilled water to the entire building.

If a new building is being planned to run off any of the existing chilled water systems, the designer shall review that system in its entirety to ensure that the existing pipe sizes are capable of delivering the design flow rates, existing pump heads and capacities are not affected, the existing chillers have the capacity, existing expansion tanks are suitable in height and size and that the new control system interfaces with the existing central plant control system. Consideration for an additional differential pressure sensor to form part of the chiller plant control logic shall be assessed for each new building.

The designer engineer shall submit a pump head calculation for the new buildings indicating the expected pressure drop and the impact on the campus current pressure setpoints.

3.4.4 HEATING WATER SYSTEMS DESCRIPTION

3.4.4.1 Bentley Campus

The existing heating water system has the following characteristics:

- Central heating water plant is located in Building 117 (Central Plant – 2-off gas-fired water heaters), Building 154 (North Plant – 2-off gas-fired water heaters) and B408 (1-off gas-fired boiler).
- Building 117, Building 154 and B408 water heaters are controlled by Johnson Controls Metasys BMS and are fully integrated.
- The heating water system is a decoupled primary water system at the central plant level with secondary variable speed pumps used for heating water distribution to the campus. Some additional secondary pumps are also in use in various buildings where the operating head is significant.
- A reticulated heating water distribution system across the campus serving most buildings utilises a 2-way control valve arrangement with 3-way valves on index legs.
- The secondary heating water pumps are controlled via differential pressure sensors located in specific buildings as represented on the BMS.
- A heating call is generated from each building, which enables the heating water plant. The heating call is typically generated via any heating water valve that opens more than 70 per cent and the heating call is disabled when all heating water valves for that building are closed less than 20 per cent.
- The heating water system is a pressurised system with a large dedicated expansion tank 'farm' located at the roof top level of Building 105. Should this facility fault, expansion automatically changes over to the default atmospheric heating water make-up tank located at the highest point on the campus in Building 402. Control of the heating water expansion system in Building 105 and Building 402 is by Johnson BMS system.
- There is a smaller heating water plant located in Building 155 that is dedicated to Building 500 (South Plant – 2-off gas-fired water heaters). This system has no physical connection to the main campus heating water ring main. This facility is controlled by a LON-based Johnson control system and is integrated into the Johnson Controls Metasys BMS.

3.4.4.2 External Campuses

Curtin's campuses external to the Bentley Campus has the following heating water systems:

- 78 Murray Street – No heating water system installed
- Kalgoorlie – One-off gas-fired boiler that provides heating water to Building 706.The boiler is installed at B705. It has standalone electric control. Building 701 has one-off gas-fired boiler that provides heating water to Building 701 (AHU 1 only). This boiler is controlled by a Johnson BACnet BMS that is integrated into the University's Johnson WAN.
- Technology Park – No heating water system installed.

If a new building is being planned to run off any of the existing heating water systems, the designer shall review that system in its entirety to ensure that the existing pipe sizes are capable of delivering the design flow rates, existing pump heads and capacities are not affected, the existing water heaters have the capacity, existing expansion systems are suitable in height and size and that the new control system interfaces with the existing central plant control system. Consideration for an additional differential pressure sensor to form part of the heating water plant control logic shall be assessed for each new building.

The designer engineer shall submit a pump head calculation for the new buildings indicating the expected pressure drop and the impact on the campus current pressure setpoints.

3.4.5 PROCESS COOLING AND HEATING

Process cooling for scientific equipment and the like shall not be connected to the campus chilled or heating water systems. Equipment used for process cooling or heating like supplementary chillers or heaters shall not be connected to the campus chilled or heating water systems.

All process cooling and heating requirements are to be provided with their own dedicated air cooled chiller(s) or heat pump water heater(s). The location of the associated cooling and heating plant shall be designed to suit the equipment airflow intakes and discharges, maintenance clearances, aesthetic and noise requirements, etc, per normal design.

3.4.6 VENTILATION REQUIREMENTS

Ventilation requirements shall be in accordance with AS1668 Part 2 as nominated by the Building Code of Australia.

In reference to toilet exhaust systems, exhaust air flow rates shall be calculated to meet the minimum requirements of AS1668 Part 2 and the Health Act. Note that where a toilet exhaust system serves more than one compartment (WC), then duty/standby exhaust fans, complete with run/fault lights and automatic changeover on fault, are required as stipulated by the Health Act. Toilet exhaust fans shall be direct drive with variable speed control for commissioning purposes.

3.4.7 VENTILATION IN PHOTOGRAPHIC DARKROOM AREAS

All fumes are to be extracted at source and systems are not to exhaust fumes by extracting past the operator's breathing zone.

As a minimum, the following ventilation rates shall apply unless otherwise specified by the manufacturer or relevant regulations:

- for Ilfospeed fixers – not less than 15 air changes/hour for mixing and processing areas
- For Ilfospeed Multigrade Developer – not less than 15 air changes/hour for mixing and processing areas
- For Hypain Rapid Fixer – not less than 15 air changes/hour for mixing and processing areas.

For any product containing:

- hydroquinone or sodium formaldehyde bisulphite provide 10 air changes per hour
- methyl aminophenol sulphate (such as Kodak Dektol Developer) provide 10 air changes per hour
- acetic acid (such as Kodak Acedic Acid 28%, Kodak Indicator stop bath) provide 10 air changes/hour. Local exhaust required
- trichloroethane (such as Kodak Film Cleaner) allow 10 air changes per hour general room ventilation.

Local exhausts are required where the following are used:

- ethoxyethanol, hydroxylamine sulphate, p-phenylene-diamene, tertiary butylamine borane, selenium oxide, platinum chloride, potassium oxalate, potassium sulphide, potassium permanganate, potassium cyanide, potassium dichromate, ammonia, mercuric chloride, acetic acid, catechin.

3.4.8 FIRE AND SMOKE CONTROL

Mechanical fire and smoke control systems shall be delivered in accordance with AS1668 Part 1, the Building Code of Australia and Curtin University's *000321 PDG Fire Safety Project Guideline*. Certification and commissioning documentation, maintenance and testing procedures, cause and effect matrices and cause and effect functional descriptions are all to be included in the operations and maintenance manuals. Fire/smoke separation is to be clearly indicated in documentation. Refer to the Fire Safety Project Guideline.

Mechanical consultants shall prepare a mechanical fire matrix and detailed fire mode functional description of the mechanical services plant as part of the project documentation. The fire matrix and detailed functional description shall be included in the operation and maintenance manuals.

3.4.9 NOISE AND VIBRATION CONTROL

The system shall be designed to minimise the transmission of noise and vibration from air conditioning and mechanical equipment (all in accordance with the relevant Australian standard and noise levels listed below). Sound attenuators and/or internally lined ductwork shall be installed where necessary to minimise the transmission of fan noise.

Chillers, pumps and all rotating equipment shall be installed with spring mounts. No rubber mounts shall be approved. Springs shall have lateral stiffness greater than 1.2x time the vertical stiffness and shall provide a minimum 50% overload capacity.

Care shall be taken to minimise transmission of vibration to the structure from mechanical equipment. Where reciprocating or rotating equipment is installed, this shall be isolated from the structure by vibration isolators. Reciprocating or rotating equipment shall be mounted on inertia bases weighing not less than 1.5 times the weight of the equipment.

3.4.10 AIR HANDLING SYSTEMS

Air conditioning shall normally be provided by the use of air handling equipment using chilled and heating water supplied from the University's Central Chiller and Water Heater Plant. Direct expansion (DX) refrigeration systems shall not be used unless it can be demonstrated that required conditions cannot be achieved by use of chilled and heating water. The use of direct expansion, window-mounted or through-the-wall room air conditioners (RACs) is prohibited except in transportable buildings or other locations such as COMMS rooms approved by the Infrastructure Manager Mechanical Services.

To achieve better control over operation, unitary-type air handling systems serving a single room or small number of similar rooms shall be provided rather than large central station air handling systems. Air handling systems serving more than one floor shall not be used. Additionally, multi-zone constant volume reheat systems and floor-mounted console style chilled and heating water FCUs shall not be used.

All air conditioning systems shall have adequate outside air (in accordance with current code requirements of AS1668 Part 2) drawn from outside the building at locations well away from discharges from cooling towers, fume exhausts, traffic, cooking areas and chemical storage areas (in accordance with current code requirements of AS3666). The separation between the outside air and exhaust openings shall comply with the requirements of AS 1668.2:2012

All air handling systems are to be of Daikin, Fan Coil Industries, G J Walker, Saiver, Skilled Air, Temperzone manufacture or approved equivalent.

Fan types shall be ECM plug fan and motor combination singularly or as a grid for new or retrofit installations. The Consultant must seek approval for alternatives that may include centrifugal forward & backward curve (later is preferred) with standard high efficiency induction motor suitable for use with variable speed drive.

Ensure access is easy and safe to all major components, including motors, fans and coils. Provide lifting points (especially to fan motors) as required to prevent damage to the equipment. Ensure there is adequate physical access in the plant rooms to manoeuvre equipment and conduct maintenance with a view to preventing manual handling injuries. Access to fire dampers shall be provided with fire damper identification labels attached adjacent to fire damper access points.

Chilled water coils shall be provided with a stainless steel 304 drip trays extending across the full coil and not less than 250mm deep.

Chilled water coils shall be selected to a maximum face velocity of 2.5 m/s and heating water coils to maximum of 3.5 m/s, to the limits of the NCC and the design criteria sections regarding air and water pressure losses through coils.

Chilled water and heating hot water coils shall have minimum 400mm separation with access panels to allow future cleaning and maintenance of the coils.

Air and water pressure drop for the chilled and heating hot water coils shall not exceed the requirements stipulated under the national construction code (NCC).

Air flow switches are to be piped across the suction and discharge sides of fans in air handling systems to indicate fan status. Alternatively, the feedback from EC motors can be used directly to indicate the fan status.

Where appropriate, air handling systems shall be configured to allow for economy cycle, warm-up cycle and night purge control routines to minimise energy consumption. Base heating including winter warm up provision shall be via heating water coils located in the air handler. Base heating shall not be undertaken by VAV reheats or branch duct reheats. Systems configured as constant volume with zoned reheat shall be avoided.

Electric duct heating and VAV box electric reheat shall not be used. Should electric heating be required to meet a specific facility application, approval must be sought through the University's Infrastructure Manager Mechanical Services.

The use of fan-assisted constant volume VAV boxes may be used as an alternative to maintain minimum airflow rates to centre zones and to make use of secondary air as 'free' heating provided that the energy savings can be justified over the increase in cost and maintenance. Cost justification in writing will be required to be submitted to Curtin University's Infrastructure Manager Mechanical Services where fan-assisted VAV boxes are proposed.

3.4.11 COMMS AND AV ROOM AIR CONDITIONING REQUIREMENTS

3.4.11.1 Design Requirements

AUDIO-VISUAL

It has been pre-determined by Curtin AV that any AV room is to be provided with 100 per cent duty and standby air conditioning.

COMMUNICATIONS

DTS shall be consulted during the design phase of the project with regards to its requirements for ventilation only (natural or mechanical), air conditioning duty only or air conditioning 100 per cent duty and standby, or specific humidity control. This assessment is to be conducted by DTS using a risk matrix that considers the type of room, value of the equipment and the consequence of communications equipment failure.

3.4.11.2 100 per cent (2N) Duty Standby Design Philosophy

The term 100 per cent (2N) Duty Standby shall apply throughout the air conditioning system design such that:

- an A/C unit failure does in no way affect another
- a controls failure of a small point controller does in no way cause both units to fail
- separately fused power supplies are provided to each item of plant
- an electrical failure within the MSSB does in no way cause both units to fail, acknowledging that a single power supply to the MSSB is acceptable
- a UPS is arranged on the power supply to the network and small point controllers to allow alarming even in the event of loss of power.

3.4.11.3 Air Conditioning

In the case that duty-only equipment is required, the equipment shall be in the form of a chilled water fan coil unit.

In the case that 100 per cent (2N) duty and standby units are required, the equipment shall be in the form of a chilled water fan coil unit and a DX system.

The use of CRAC units is acceptable for either the CHW or DX systems. However, this does not negate the need for duty and standby systems where this is a requirement by the University.

Where humidity control is required this should be within a CRAC unit using hot gas bypass & humidifier for DX units and hot water heating coil & humidifier with chilled water unit(s).

Where a DX system has been provided for duty and standby requirements, consideration for the location of the condensing unit shall be made in consultation with Curtin University and/or the Project Manager where the condensing unit is placed in a location that does not impede air flow through the unit and noise is not a nuisance to the surrounding areas.

Air conditioning units and water valves shall be provided with condensate safety trays. The air conditioning units' trays shall be in addition to the condensate tray inside the unit, and reside underneath it complete with BMS integrated moisture sensor and alarming.

APPROVED MAKES

Wall-mounted Chilled Water FCU:

- Carrier, Daikin, Saiver, Temperzone or approved equivalent.

Ducted Chilled Water FCU:

- Dakin, Fan Coil Industries, G J Walker, Saiver, Skilled Air, Temperzone or approved equivalent.

Wall-mounted DX Split FCU:

- Daikin, Mitsubishi Electric, Mitsubishi Heavy Industrial or approved equivalent.

Ducted DX Split FCU:

- Daikin, Mitsubishi electric, Mitsubishi Heavy Industrial, Temperzone or approved equivalent.

Computer Room Air Conditioner (CRAC) (CHW & DX):

- APC, Emerson (Vertiv), Stulz or approved equivalent.

3.4.11.4 ***Mechanical – Electrical Requirements***

Run relays shall be powered from the small point controller.

For the case that there is a duty-only CHW FCU, the run relay shall default to the energised position such that a failure of the small point controller or loss of power to the run relay will result in the equipment continuing to run unless fire signal is dedicated and the unit will be required to shut down. The CHW valve shall maintain its position on loss of power i.e., does not spring open or closed.

For the case that there is both a duty and standby CHW FCU and DX system, the run relay to the CHW FCU shall default to the non-energised position and the DX system run relay shall default to the energised position on failure of the small point controller or loss of power to the relays. The result shall be that the CHW FCU shall stop and the DX system will start.

UPSs shall be provided for backup power to the controls on loss of mains power. A UPS shall be provided to both the small point controller(s) and to the network controller. The utilisation of UPS(s) shall allow the continuity of communications in the form of faults and alarms to Curtin University BMS front end and pager system. Where both the network controller and small point controller(s) are located within the same MSSB, a single UPS may be utilised for all controllers. If the network controller and small point controller(s) are located in separate MSSBs, multiple UPS units shall be provided as necessary to provide continuity of communications.

All mechanical switchboards and mechanical electrical installations shall comply with the relevant Australian standards and Curtin's electrical guideline

DTS shall be consulted during the design phase of the project for advice on the duration that the BMS UPS is required to run. The UPS shall be sized accordingly to match the requirements of DTS and the number of BMS controller devices being served by the UPS. Generally, the UPS shall be sized to match the running duration of any comms and AV UPSs.

UPSs shall be maintained by the BMS contractor for the duration of the defect's liability period.

All mechanical switchboards shall be constructed to a minimum IP54 and form 2 as a minimum according to AS 61439.

On final completion of the project, the UPS shall be maintained by the BMS contractor whose BMS controls are being supported by the UPS.

Where sufficient space is available, UPSs shall be mounted inside MSSBs. Where sufficient space is unavailable inside MSSBs, UPSs shall be mounted on the wall directly adjacent to the relevant MSSB.

DX system wall controllers shall be lockable to prevent alteration of the temperature set point. Mount DX controllers on the wall within the comms and/or AV room.

Provide run and fault indication lights on the wall adjacent to the door for each system. The DX system shall be provided as standard with an interface card for connection to the BMS and to allow remote start/stop and fault indication and BMS monitoring.

3.4.11.5 Power Failure Re-establishment

Provide delay start timing for all equipment which is to be re-energised in the following order following a power outage:

- comms and/or AV Room FCU or DX unit or exhaust fan serving a comms room
- air handling units and associated return air fans (if provided)
- fan coil units and associated return air fans (if provided)
- general supply and exhaust fans.

3.4.11.6 Alarms

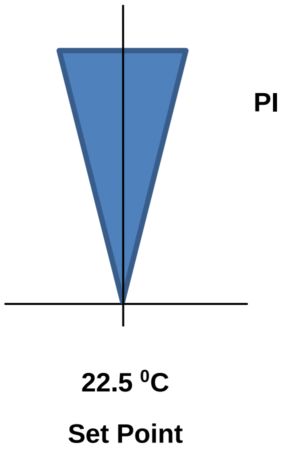
Where comms and AV rooms are put into operation before project Practical Completion, it is imperative that such rooms' environmental conditions are being monitored by the building BMS and the associated RMD systems (if installed) and are fully operational with dial-out alarming via the required alert mediums (paging, SMS, email) to the body responsible for responding to such alarms. Comms and AV rooms shall not be put into operation where this capability is not operational.

The following mismatch alarms shall disable the duty unit, enable the standby unit, raise an alarm on the BMS and on the Maintenance & Operations pager, and illuminate the fault light inside the room:

- comms and/or AV room high temperature alarm with an alarm set point of 28 °C (adjustable)
- failure of a comms and/or AV small point controller
- CHW unit fault (via DP switch across the fan)
- moisture alarm for condensate safety tray to each unit
- DX unit fault (via interface card)
- failure of network controller via another network controller or the BMS server.

3.4.11.7 *Space Temperature Control – Chilled Water*

Modulate the chilled water valve using Proportional Integral (PI) control to control and maintain the set point (22.5 °C adjustable). The valve opens as determined by the PI loop when space temperature is greater than set point (22.5 °C adjustable) and closes as determined by the PI loop when space temperature is less than set point (22.5 °C adjustable). When the room temperature is at set point the valve shall maintain its position.



3.4.12 STEAM SYSTEMS

BENTLEY CAMPUS

- One Tomlinson gas-fired steam generating boiler located in B306, nominal capacity of 400 kW.
- One Tomlinson gas-fired steam generating boiler in B308, nominal capacity of 400 kW.
- A standalone steam boiler (Fulton) is installed at B300.

The boilers serve multiple buildings each.

3.4.13 CONDENSER WATER SYSTEMS

Water treatment of condenser cooling water systems shall be in accordance with AS3666 and shall further provide the following as a minimum:

- monthly Legionella testing
- automatic dosing of chemicals associated with protection against corrosion
- automatic dosing of biocides associated with microbial control. Additionally, automatic dosing shall be set up to provide for rotation of biocides. Biocide chemicals shall be injected into the condenser water inlet side of chiller condensers. All condensers, pipework and cooling tower wetted surfaces shall

be treated by biocides including potential 'dead-legs' such as condenser bypass pipework.

Disposal of cooling tower waste water is to be in accordance with local authority bylaws and the water supply authority.

Where a BMS is available within a condenser water system plant room, automatic time scheduling of biocide dosing shall be achieved via the BMS. A dedicated web-based remote monitoring control system of Megatronics manufacture will be provided for on all condenser water systems. Remote user access shall be by way of connection to the University's intranet. If this facility is not available or proves cost-prohibitive, then remote access shall be by a dial-in GSM capability.

3.4.14 DUCTWORK AND AIR DIFFUSION

In general, low velocity systems are preferred. Ductwork shall be designed to limit duct air velocities to a maximum of 7 m/s for constant volume air conditioning systems and exhaust ventilation systems. However, main riser ducts shall be capable of handling an increase of 15 per cent in air quantity. Fans and motors should be selected with this in mind. The design engineer shall submit a duct riser summary sheet indicating that the future capacity is achieved as per these requirements.

Where variable air volume systems are deemed appropriate to provide zoning flexibility, then ductwork shall be designed to limit air velocities to 10 m/s in riser ducts and a maximum of 10.5 m/s at VAV box inlets. The velocity required at VAV inlets is to ensure satisfactory minimum airflow measurements of velocity probes. VAV boxes must be fitted with an inlet straight piece of sheetmetal duct and be a minimum of 5 diameters in length to ensure adequate non turbulent airflow onto the velocity probe.

Duct static regain should be utilised for supply air systems ONLY wherever possible in sizing the ductwork. Consultant may consider performance based approach for NCC compliance.

The requirements of the NCC supersede any criteria listed above for system duct sizing and overall system fan efficiency, and ratings of thermal insulation. NCC performance solutions may be considered to achieve lower cost outcomes with higher duct airflow velocities.

For sheet metal ductwork, aspect ratio shall not exceed 4:1 and minimum duct height shall be 150mm.

Main distribution ductwork shall be galvanised sheet metal ductwork, thermally and acoustically insulated as required to suit the application. It is the University's preference not to use rigid fibreglass ductwork but to use alternatives such as Tontine.

Duct internal insulation shall be installed with heavy duty sisalation, external insulation shall be provided with foil facing.

All flexible ductwork used for supply air or return air shall be externally insulted to reduce heat transfer. Flexible ductwork shall be in accordance with AS1668 Part 1,NCC section J and shall have early fire hazard properties not exceeding the following indices when tested in accordance with AS1530 Part 3 and AS4254:

- Spread of Flame 0
- Smoke Developed 3.

Should the installation of electric heater banks be unavoidable, the heater bank linings shall be in accordance with AS1668 and be constructed from Harditherm 700 or approved equivalent.

Ceiling diffusers shall typically be of the circular Smart Temp or Trox diffuser type however correct engineering and selection as prescribed by Smart Temp/Trox is to be adhered to. Alternatives to Smart Temp or Trox will require approval from Curtin University. Additionally, where motorised Smart Temp diffusers are installed, access to the diffuser motor for servicing is to be provided to the acceptance of Curtin University. Ceiling diffusers shall be retained in position by a threaded screw/bolt arrangement. Where it is proposed to use an alternative arrangement, approval from Curtin University's Infrastructure Manager Mechanical Services is required. All diffusers shall incorporate insulated cushion heads with flexible ductwork to spigot take-off from the main distribution duct, to allow easy relocation of diffusers as required. Where diffusers are located in roof spaces, the back surface of the diffuser exposed to the roof space shall also be insulated to prevent condensation on the diffuser. The insulation shall be glued with a suitable adhesive to prevent lifting of the insulation. All raw edges of the insulation shall be sealed.

Wall registers shall be of the adjustable blade type with opposable blade dampers (OBD) installed behind the register for ease of air balancing. The front set of blades is to be horizontal. The maximum blade spacing shall be 20 mm.

Toilet exhaust grilles shall be of Half Chevron or egg crate type.

Return air/relief air grilles are to be egg crate, half chevron or full chevron type.

3.4.15 PIPING, VALVES AND FITTINGS

Piping installations shall be in accordance with current best practice methodologies and be installed in strict accordance with the manufacturer's recommendations. All pipework shall be suitable for its respective service under the actual operating conditions with respect to temperature and pressure. The pipework installations shall ensure that adequate means are provided for taking up pipe expansion through its operating temperature ranges. Piping shall be arranged in a workmanlike manner, true to alignment and grade.

All condenser water pipe shall be seamless 316 stainless steel schedule 10 up to and including 300mm.

In general, chilled water and heating water lines within buildings shall be of Type B copper up to 150mm. Above 150mm use seamless 316 stainless steel schedule 10 up to and including 300mm, and seamed above 300mm.

For in-ground chilled water pipework situated outside of the thrust blocks, HDPE PE100 or PE80 shall be used. Seamless Stainless-steel schedule 10 piping (minimum 316) shall be used for chilled water pipework situated within thrust blocks.

All inground pipework shall have outer protection cladding made out of HDPE material and insulation injected between the pipe and the outer casing.

For in-ground heated water pipework seamless 316 stainless steel schedule 10 up to and including 300mm, and seamed above 300mm, shall be used. No Victaulic coupling shall be used anywhere underground. Victaulic shall only be used in accessible pits and plantrooms. Expansion loops shall be used for underground pipework.

Minimise the use of flange connections for underground applications, moving flange connection within accessible locations will be a preferred option.

Specific grades and standards of pipe and associated material shall be specified by the project mechanical engineering consultant in the project specification and, as a minimum, shall reference the relevant Australian standards. Notwithstanding the above, the designer shall review the total pressure of the pipework system in making recommendations of the pipe materials.

The following hold pints shall be included during the construction phase of the project.

- inspection following unloading of the materials
- inspection of the expansion loops
- inspection of the joining systems components
- Hydrostatic testing
- Inspection and back filling

Thrust blocks shall be used with all major changes in direction such as tees and elbows, change in size and the terminal ends. Design of thrust blocks shall take into consideration the test pressure and the soil type/conditions. Thrust blocks may not be required for fully welded pipework.

Mechanical &/or Civil consultants/Engineers shall provide specification and details for trenches in accordance with AS 2566.1&2. This shall include details on trench size, compaction and backfilling.

Transition from one material to another shall be made adjacent to the buildings in a pit that is always readily accessible. Valves shall be of approved manufacture and shall be in easily accessible positions.

Chilled water and heating water in ground mains pipes are to be located under paving unless funds allow their location in culvert ducts or covered walk-way ceilings. In-ground chilled water mains shall be installed to a minimum depth of 1,200 mm to the top side of the pipe while heating water pipe will be installed to a minimum depth of 800 mm to the top side of the pipe. The heating water pipe will be installed above the chilled water pipe.

Drain points (50 mm ball-type threaded valves) and air vents shall be installed in each pipe on each side of the isolation valves in the chilled water and heating water systems. The 50 mm ball-type drain valves shall be provided at the lowest point in the chilled water and heating water pipe, which allows for pipe segment drain down and as a connection point to enable the system (and pipe segment) to be flushed (see Pipework Flushing and Cleaning section). Air vents shall be of the automatic float type installed in a 'bottle' installed at the highest point within the pipework. Isolating ball valves shall be installed between each air vent and the main pipe and 13 mm drain lines shall be run from each vent to the nearest drain point. For in-ground pipework, all vents and drains shall be accessible from within the valve pit or be piped to the closest valve pit location.

Chilled and heating water network isolation valves shall be Keystone or approved equivalent.

Valves shall be of the type to suit the application, but generally be as scheduled below:

- Isolation Ball valves to 50 mm diameter
    - Wafer-type butterfly valves from 65 to 500 mm diameter
    - Gate valves from 300 mm diameter
- Throttling Plus Isolation
    - Double regulating valves from 15 to 65 mm diameter (for bypass legs across coils at index runs only)
    - Wafer-type butterfly valves from 65 to 300 mm diameter
- Modulating Control Valves
    - Belimo Characterised Control Valves (CCV) only (with manual over-ride capability)
    - PICCV may be considered for new buildings. It is not recommended to install PICCV valves with CCV valves.
- Non-return Valves
    - swing check valves
- Gauge Cocks
    - ball valves
- Pressure/Temperature Test Points
    - Binder Double Seal type.

Ensure valves and fittings are adequately spaced and distanced from bends and the like, in accordance with manufacturer's recommendations. This is particularly relevant for the installation of Characterised Control Valves, throttling valves and pressure/temperature test points. Ensure that pressure/temperature test points are located across individual coils and individual control valves without bends or other fittings in between apparatuses.

All headers are to be provided with at least one spare flanged and valved connection for future use. Typically, headers should be sized for the future capacity of the plant or at least one size larger than the main distribution pipe leaving the plantroom. Or sized to a maximum velocity of 1.5 m/s.

Ensure the layout of pipework in plant rooms does not interfere with the direct route of removal of equipment within plant rooms.

Where pipes pass through floors or walls, sleeves shall be specified and filled with appropriate sealant to suit the application. Provide a facia plate where exposed to view.

All risers shall be provided with dirt legs and drains at the bottom. Each level of pipework shall be isolated and provided with drains at the low point of each branch and at the riser.

The support of the pipe risers shall be designed for the operating weight of the riser and the expansion/contraction loads. Victaulic couplings shall be used for expansion within the risers.

All pipework shall be supported to ensure no stress to the pipework. connections to AHU and fan coil units shall have sufficient support to ensure no stress from valves and the like.

All bolts, studs to valves, water boxes and equipment especially exposed to wet conditions shall be stainless steel and, where appropriate, are to have threads coated in nickel anti-seize.

Any variation of valve types/applications from the above shall be notified in writing to Curtin University prior to the ordering of equipment.

Where an existing chilled/heating water system is to be extended, the consultant shall check and verify the capacity of the existing piping mains and plant to ensure that they are capable of meeting current and future demands. The mechanical design engineer shall advise Curtin University's Infrastructure Manager Mechanical Services of the current and future system characteristics.

3.4.16 PIPEWORK INSULATION

All in-ground heating water pipe and portions of chilled water pipe as specified shall be pre-insulated incorporating rigid polyurethane foam that is machine injected into the annular void between the carrier pipe and outer casing via an acceptable factory process. The protective outer casing shall be manufactured from high density polyethylene (HDPE) extruded in one piece. Bends, tees, reducing joins and straight joins shall be site insulated using two-part rigid polyurethane foam. All fittings shall be metal sheathed and correctly vapour sealed with a heat shrink sleeve. Site insulation shall only be carried out by trained personnel. Approvals are to be sought from the project mechanical consulting engineer and Curtin University's Infrastructure Manager Mechanical Services.

Above-ground heating water pipework insulation shall be mineral wool, rock wool or fibreglass type insulation products. Heating water insulation samples must be submitted for approval by Curtin University prior to work commencement.

For above-ground chilled water piping, polystyrene insulation complete with Sisalation vapour seal shall be specified. Insulation for valves, flanges and fittings shall be arranged for easy removal during maintenance, and shall be provided with hinged and clipping casings. Pipes must be coated with Denso bedding compound before insulation is installed to offer extra protection against moisture tracking. A complete vapour seal must be achieved via foil Sisalation sheathing over all sections of insulation with seams being fully taped and glued in all cases. Timber blocks, when used, must be properly foiled on the abutting face and have bedding compound on the mating surfaces between block, pipe and insulation preventing the migration of moisture across the block. Blocks must be 15 mm wider on each side than the strap supporting it allowing a fully vapour tight taped junction to be achieved without having to remove or loosen the strap. When possible, non-timber, thermally insulating blocks should be used to achieve a better performing joint. Block samples must be submitted for approval before work commencement.

All exposed insulated pipework in plant rooms, up to 2,000 mm above floor level or external to the building and/or internal but visible, must be fully metal sheathed using Aluminium, Zincalume or Colourbond materials as an addition to the standard vapour sealing requirements. Insulated pipework in concealed areas does not require metal sheathing. Should the consultant or contractor offer up alternative HTGW insulation products like polyolefin foam similar to Thermo break (or approved equivalent) it shall be metal clad irrespective of its location.

3.4.17 IDENTIFICATION OF PIPEWORK

All pipes shall be identified in accordance with AS1345 – 1972 for the Identification of Piping, Conduits and Ducts and AS1318, Industrial Accident Prevention Signs. 'Safetyman' adhesive labels are an acceptable method for identification of pipework. Flow direction arrows shall be provided to all chilled and heating water pipework. All pipework exposed to view outside of plantrooms and riser shafts shall be fully painted, either in accordance with colour standards contained in AS2700 or to Architect's requirements where it impacts the visual amenity of facilities and the Campus.

3.4.18 UNDERGROUND SERVICES

All underground services including pipework, conduits etc. shall be laid in sand and shall be identified by laying continuous PVC marker tape not less than 300 mm above the pipe. The marker tape shall be colour-coded, magnetic and be printed with the identification of the contents of the pipe and/or conduits. At ends of straight lengths of pipes, permanent concrete or cast iron markers located at ground level are to be provided.

All pits laid in paving are to be trafficable to medium standard as recommended by Curtin University's Properties, Facilities & Development Department.

3.4.18.1 Trees and Shrubs

Root systems of trees do significant damage to in-ground services and particularly to chilled and heating water pipes. Consideration needs to be given when planting trees near in-ground chilled and heating water pipes. Advice is to be sought from a Curtin University-approved horticultural consultant as the invasive nature of trees and shrubs is generally dependent on the type of tree/shrub being planted.

Pipes are installed typically at a depth of 1,200 mm and 800 mm top side for CHW and HTGW respectively. Trees/shrubs that have invasive root systems shall be planted such that root systems are a minimum distance of 3,000 mm to the nearest pipe edge, recognising that excavation to repair pipes at the nominated depths would otherwise necessitate removal of trees as the angle of repose of the excavation would impact on the tree and stability of the surrounding terrain.

3.4.18.2 Responsibilities

The following procedures are provided to assist designers and contractors with the requirements to be adhered to for new pipework installations that connect into the existing network. The procedures must be reviewed and confirmed on a case-by-case basis to suit the specific circumstances of the work. The purpose of the procedures is to mitigate the risk of disruption to business continuity from a partial or full loss of the chilled & heating water plant.

3.4.18.2.1 Designers Responsibility

The design engineer must consult key stakeholders within the University regarding their design. Key stakeholders could include but are not limited to:

- Manager Operations and Maintenance
- Infrastructure Manager, Mechanical Services
- Services Manager, Mechanical Services
- Other services managers and infrastructure managers

For consultations designers must develop and provide documentation to aid with informing the University.

- The proposed scope.
- Provide design documentation drawings and specifications.
- Assisting with sourcing site GPR pre-scanning and incorporate within documentation.
- Document any enabling works that will mitigate down time and risk.
- Risk assessment for connections and drain downs.
- Detailed procedure / methodology that addresses and maintains University continuity of business operational requirements and must include identification of valves for isolations and the associated impacted facilities, and again for backup isolations and worst-case scenario isolations. Back up and worst case scenario isolations refer to a need to isolate further upstream to achieve the isolation and the resulting impact and mitigation.
- Develop construction and/or staging methodology.
- Document valving, expansion & thrust block requirements.
- Include necessary procedures within the designer’s documentation.

3.4.18.2.2 Contractors Responsibility

The Contractor must consult key stakeholders within the University regarding the construction phase works and associated documentation. Key stakeholders could include but not be limited to:

- Manager Operations and Maintenance
- Infrastructure Manager, Mechanical Services
- Services Manager, Mechanical Services
- Other services managers and infrastructure managers

For consultations designers must develop and provide documentation to aid with informing the University.

- The proposed scope.
- Provide construction documentation drawings and specifications.
- Conduct site GPR pre-scanning and provide survey documentation.
- Risk assessment for connections and drain downs.
- Construction and/or staging methodology.
- Enabling works that will mitigate down time and risk.
- Document valving, expansion & thrust block requirements.
- Include agreed procedures within the designer's documentation.

3.4.18.2.3 Documentation & Review

The following documentation shall be provided by the Consultant and during the design phase, and more detailed information by the Contractor 4 weeks prior to commencement of any construction works.

- Shop drawings (Plans, sections and details) of the scope of work and cut in connections that include the following:
    - Pipework routes.
    - Thrust blocks.
    - Valves, valve footings, pits and pit footings.
    - Drains and air bleeds.
    - Coordination with other in ground services.
- Site survey documentation.
- University Planned Works Notification or other such alternative where the work may be within the contractors controlled construction site.
- Detailed risk assessment with pre and post risk mitigation strategy risk ratings that address University continuity of business operational requirements.
- Detailed procedure / methodology that addresses and maintains University continuity of business operational requirements and must include identification of valves for isolations and the associated impacted facilities, and again for backup isolations and worst-case scenario isolations. Back up and worst case scenario isolations refer to a need to isolate further upstream to achieve the isolation.
- Detailed resourcing plan that ensures health and safety of the contractor, while meeting the operational requirements of the University, noting that cut ins will be conducted after hours or during weekends. Commitments and agreements on resourcing are critical to ensuring the continuity of business operational requirements.
- Estimations of drain down water volume.

The purpose of the above is to permit the University the opportunity to review and provide input and or supporting resources. The review will also include an impact assessment on the infrastructure and business operational requirements including but not limited to:

- Determination of business-critical impacts.
- Critical building identification and circumstances for load shedding or requirements for temporary arrangements.

3.4.19 PIPEWORK PRE-WORKS TESTING

The following pre-works should be evaluated and conducted as appropriate:

3.4.19.1 Isolation Valve testing

For a variety of reasons isolation valves condition can vary and prior to conducting a cut in or conducting a water leak repair, the following pressure-based testing with a partial drain down must be conducted.

Step 1

- Test the nearest valve sets up stream and downstream of the location being cut into or repaired.
- Check for the installation of appropriate drain and vent valves and if not installed, then install them via a wet tap. Ideally the designer has already established the need and has documented this.
- Install temporary pressure gauges on each side of the valve(s) being tested.
- Close the valve(s).
- Conduct partial drain down to create pressure differential ≈100 kPa.
- Check pressures periodically over a few hours.
- If there are no pressure changes, then the valve test is satisfactory.
- If there are pressure changes, then one of the valves or both is a fail.
- Go to step 2 unless time availability requires another day for step 2 to occur.

Step 2

- Close the nearest valve sets up stream and downstream of the location being cut into or repaired.
- Close the isolation valves that are next in line both upstream and downstream.
- Conduct partial drain down to create pressure differential ≈100 kPa.
- Check pressures periodically over a few hours.
- If there are no pressure changes, then the valve test is satisfactory.
    - Open each upstream and downstream valve, one at a time. As each valve is opened check whether the pressure changes. The purpose of this is to determine which valve(s) had previously failed. Once this is determined, re-open all valves and return system to normal.
    - Contractor to report the findings and seek instructions from the University for one of the following:
        - Replace failed valves first and pressure test accordingly.
        - Double isolate for the cut in and not replace failed valves.
        - Double isolate for the cut in and replace the failed valves concurrently.

    - Depending on the outcome of the instruction, planning for the cut in can commence.
- If there are pressure changes then this indicates multiple in series valve failures. Stop and seek further instructions from the University, because the implications of repeating this test by going further upstream again could have significant business impact.

During the valve testing it is important that the University ensure that the chilled & heating water plant is operating as required and delivering water to the network and that they are monitoring the critical infrastructure on Campus. The designers / contractor may also be given view only access of the BMS systems if the responsibility for monitoring the central plant falls to the designer/contractor to do so.

In all cases the Contractor must discharge waste water from the partial drain down or full drain to the sewer and not to ground. In the case of a full drain down, the contractor shall meter the discharge to sewer and report the volume to the University.

3.4.19.2 Records to be kept

Throughout the pre-works the contractor must maintain the following records and provide them to the University:

- Photos of pressures relating to valve(s) testing that prove they are satisfactory or otherwise.
- Condition assessment photos.
- Identification of the valves tested and pass/fail status.
- Identification of the failed installed valves manufacture, type, size, etc.
- Any other records that may be requested at the time.

3.4.20 PIPE WORKS – CONSTRUCTION

3.4.20.1 General

Commencement of construction must not occur prior to the University's approval of the Contractors documentation / submittals for the work.

All cut in works are required to be completed after hours and over a weekend and if required conduct the works 24 hours / day with teams working in shifts over a weekend. Early commencement of works may be approved subject to the time of year and external ambient conditions, and the impact on central energy plant from the works.

The contractor must have the works completed, and if central energy plant is interrupted, it shall be returned to normal by Midnight Sunday. The term completed refers to the inclusion of thrust blocks (if required), pressure testing and pipework cleaning, flushing and dosing.

The Contractor shall be on site at all times during the works to supervise and provide instructions to the sub-contractors undertaking the works, and for communications with the University.

It is a requirement that there be isolation valves adjacent the cut in, that prevent the new service line from being opened to the network until that service line has had its pressure testing, cleaning, flushing and dosing.

3.4.20.2 Pipe Pressure Test

The contractor shall undertake pressure testing of the existing pipework where the cut in is made. Either concurrently or separately the contractor shall undertake pressure testing of the new service line installed. Irrespective, joining isolation valves shall remain closed for the testing and cleaning, flushing and dosing.

The following requirements apply for pressure testing new and existing pipework.

- Hydrostatic pressure test for a 24 hour period. Shorter periods may be considered subject to agreement with the University.
- Test pressure shall be either 1,000 kPa or 1.5 times the supply water operating pressure at the CEP, whichever is the greater.
- The pressure testing shall be witnessed by the University at commencement and final reading.
- The contractor must ensure it has bled all air out of the sections of pipe to be pressure tested.

Should the testing fail, undertake rectifications and retest until successful.

Special notes:

- When pressure testing polyethylene (PE) pipework that is unconstrained, the PE pipework will expand as the pressure is increased within the pipe. Prior experience on a 400 mm dia PE pipe is that it can take 12 or more hours for the test pressure to be reached. The contractor must include for 24 hour attendance as needed to achieve the required pressure. Where PE pipework is constrained by a prefabricated pipe/insulation system with an outer casing the same pressurising effect does not occur as much.

3.4.20.3 Pipework Flushing, Cleaning and Dosing

The contractor must engage the University incumbent water treatment company and pay all costs. Designers must obtain the details of the water treatment company from the University and include the same in tender documents.

3.4.20.3.1 Scope

All new pipework installations, repairs and modifications are required to be pre-flushed, cleaned and dosed prior to systems being opened to the Campus ring main. The pipework flushing, cleaning and dosing shall comprise the following activities:

- pre-flushing
- chemical cleaning
- final flushing
- final filling
- dosing.

3.4.20.3.2 Procedures

The following flushing and cleaning procedures shall be conducted, as a minimum, in the following order:

- Make all necessary applications to the Water Authority for discharge of chemicals to sewer or other means in accordance with all statutory requirements.
- Set consumption meters on temporary water supply and drains to sewer. Record the consumption values and discharge values to suit.
- While filling the pipework, at no stage shall the site be left unattended. The water meter shall be checked periodically and if the amount exceeds the expected fill volume, cease the fill and determine if there are any issues that need attention. Recommence fill once issues are resolved. *Do not open the network to provide the water required.*
- Fill all pipework with clean water and circulate in accordance with the minimum flushing velocities as outlined in the consultant's specifications or BSRIA pre-commissioning cleaning of pipework guideline.
- Advise the system volumes to the incumbent water treatment company.
- Inject and circulate cleaning agent and passivator (provided by the water treatment company) to the system. Make application to the Water Authority for discharge of chemicals in accordance with all statutory requirements.
- Remove water from the systems and flush with clean water to remove cleaning agents.
- Conduct a final fill with clean water and submit a sample to the water treatment company.
- On acceptance of the clean final fill test results, dosing chemicals shall be provided by the incumbent water treatment company and injected into the system.
- Circulate through the system to the satisfaction of the incumbent chemical water treatment company.
- Provide a sample to the water treatment company for acceptance testing.

3.4.20.3.3 Requirements

Water quality for HVAC systems shall minimize corrosion, scale build-up, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

All chemicals used for cleaning and dosing shall be provided by the incumbent water treatment contractor. System volumes shall be provided to the contractor to allow correct quantities of chemicals to be determined. The contractor shall be advised of all materials used within the piping system to confirm compatibility with treatment and cleaning chemicals.

Water used for filling of pipework segments for pressure testing and final filling before opening the segment to the main campus system shall be sourced from site scheme water connection points and shall be metered.

Water drained from the pipe through flushing and cleaning shall be discharged to sewer and metered accordingly.

Water consumption & discharge values are to be provided in writing to the project Responsible Officer who will advise Curtin University's representative responsible for University water usage.

Note – water is not to be sourced from the existing chilled and heating water systems or from the campus fire water system. Access to the fire water system will activate the campus booster pumps, resulting in the generation of an alarm to Campus Security.

3.4.20.3.4 Acceptance Testing

FINAL FLUSHING

The following performance criteria shall be met prior to the final dosing of the new pipework's:

- pH: 8–10
- No visible turbidity.

FINAL DOSING

The following performance criteria shall be met prior to the new pipework being opened to the campus:

- pH: > 8.8
- TDS: < 5000 ppm
- Inhibitor: > 100 ppm.

3.4.20.4 Records

Submit the following documentation package and include it within the operation and maintenance manuals:

- Valve pre-testing results and reports.
- Pipe pressure test results report.
- Pipe flushing report with photos of samples.
- Final fill water report with photos of samples.
- Post chemical application report with photos of samples.
- Chemical treatment reports.
- Copies of the water treatment company's final test certificates shall be included within the operation and maintenance manuals illustrating final readings in accordance with the targets set out above.
- Survey drawings of the final arrangements of the pipework installation.
- Update construction drawings to as built.

3.4.20.5 Post Works Review

If required by the University the designer and/or the contractor will be invited to participate in a lessons learnt meeting / workshop. The purpose of this is to understand what went well and what could be changed to improve the delivery while reducing risk to the University.

3.4.21 PLANT AND EQUIPMENT

3.4.21.1 Air Cooled Condensers

Where air cooled condensers are proposed, they should preferably be of the vertical air flow type with air drawing through the coil.

If condensers with horizontal discharge are located within a plantroom, they shall be installed facing directly to outside and discharge directly to outside or via weatherproof louvres. Condenser fans shall be selected with static to overcome the pressure drop from the louvres.

3.4.21.2 Air Handling Plant

Air handling plant associated with variable air volume boxes shall incorporate variable speed drives to control supply air fan speed to suit the static pressure set point.

Constant volume air handling plant shall incorporate variable speed drives for commissioning of the fan air flow and to adjust the airflow due to increases in filter DP.

Air handling units shall be constructed from double skin sandwich panels with a minimum wall thickness of 50mm.

Cooling and heating coils shall have a minimum of 400mm separation with access panels to allow for future maintenance.

All air handling units shall be provided with LED lights in each compartment. The lights shall be wired to external switch. All wiring shall comply with AS3000.

Pressure tapping ports shall be provided on each compartment of the air handling units.

Economy cycle dampers that will also be used in the night purge control routine shall be provided where appropriate and on units greater than 36 kWr in capacity. Air handling units shall incorporate a motorised minimum outside air damper which shall close on early morning warm-up cycle.

In systems that do not have DCV the minimum outside air must be maintained making use of a velocity probe within a suitable length, nominally 5 diameters of straight sheetmetal duct that is fixed to the outside air motorised damper.

Where relevant the designer shall consider the use of measures to reduce the impact of air-borne disease and AHU plant installations shall include a suitable remedial measure like UVGI, suitable air filtration (Minimum F7). Such measures shall be done in consultation with the mechanical infrastructure manager.

3.4.21.3 Belt-driven Equipment

All installations utilising exhaust fans shall be direct drive. Where installations have no option but to require belt drive means, the installation shall have a minimum of two vee belts and the pulleys shall be equivalent to Taperlock.

3.4.21.4 Chiller Sets

Vapour compression chillers shall be of Carrier, Trane, York, or Daikin manufacture while absorption chillers shall be of Broad manufacture. Generally, chillers are preferred to be the low-speed multi-stage type with no gearbox. Water-cooled helical screw-type chillers are the preferred option up to 2,000 kWr while centrifugal chillers above 2,000 kWr shall be specified. Where water-cooled type chillers are to be provided, particularly helical screw-type chillers, regardless if they are lead or lag, they shall incorporate condenser water throttling/control for cold condenser water starts, in accordance with the manufacturer’s recommendation. Air-cooled chillers up to 1,000 kWr will generally utilise scroll compressors with a minimum of two refrigeration circuits with multiple compressors per circuit providing flexibility in staging, stable operation at low load and redundancy such that, should one circuit fault, the other continues operation.

Air cooled chillers shall incorporate low noise EC motor fans. Air cooled chillers shall be capable of turning down to 25% without the use of hot gas bypass.

When selecting an air-cooled chiller, designer shall pay attention to the noise level and ensure that the noise level for the selected chillers complies with the requirements of the project as advised by the project acoustic engineer. Low noise fans and additional attenuators or acoustic enclosures shall be considered in the design of air-cooled systems.

New chillers in general shall operate on low GWP and ODP refrigerants. Using of HFO refrigerants is the preferred option. Selection of refrigerants shall be made in consultation with the university infrastructure manager.

Designer shall ensure compliance with AS/NZS 60079.10.1:2009 when selecting a refrigerant. Machinery rooms with group A2L, A2, B2L, B2, A3 and B3 refrigerants, where it is possible for the concentration to exceed the practical limit or RCL (20 % of LFL), or for a flammable atmosphere to exist at any location, shall be assessed for hazardous areas in accordance with AS/NZS 60079.10.1.

Chillers with capacity above 1500 kW shall be provided with active harmonic filters to comply with the AS/NZS 61000.

Water cooled chillers with capacity of 2000 kW and above shall have marine water boxes to facilitate future maintenance.

Chiller requirements other than those specified here require approval by the University’s Infrastructure Manager Mechanical Services.

Chiller condenser vessel tube-sheets shall preferably be constructed from stainless steel. Where mild steel tube-sheets are supplied with new chillers, the tube-sheet shall be treated with a protective coating such as ‘Corocoate’. Where Corocoating of tube-sheets and water boxes is not provided, the application of a plastic epoxy-type coating to the tube-sheets and water boxes shall **NOT** be applied. In such cases, cathodic protection through the application of sacrificial anodes shall be provided as a minimum along with best practice application of condenser water anti-corrosion inhibitor treatment. Treatment of tube-sheets and the cathodic protection type, along with maintenance requirements, shall be documented in plant operations and maintenance manuals.

Chiller ancillary electrical components such as contactors, contact sets, coils and relays etc., shall be freely available 'off the shelf' in Australia. In turn, power and control circuit voltage must be of a standard that allows the procurement of 'off the shelf' replacement component parts within Australia.

Chillers shall incorporate control modules, such as BacNet,which allow remote chiller plant management and monitoring. Control functions shall facilitate chilled water reset, chilled water throttling valve control, chilled water bypass control and condenser water reset and/or condenser water throttling valve/bypass valve control.

Where a BacNet high-level interface is provided, the control system shall be configured to:

- monitor refrigerant temperatures and pressures
- monitor percentage compressor loading
- monitor compressor Amps and run times
- allow variation of percentage load limit
- identify low-level and high-level alarms such that, on failure of one compressor, the compressor is rotated to lag position, allowing the chiller to continue operation until a major fault isolates that chiller.

The cooling capacity selected for the chiller shall take into account the staging capacity of the chiller plant to ensure a sequential and lineal grade of capacity increase and decrease. The make and model of the chiller/s to be specified shall take into account Coefficients of Performance (COPs) at part load, varying chilled water supply temperatures and varying condenser water temperatures based on an integrated part load value (IPLV) assessment. Life-cycle costing of operating and maintenance profiles over 20 years shall be forwarded to Curtin University for verification prior to the consultant issuing a tender specification.

3.4.21.5 Chilled Water Drinking Fountains

Chilled water drinking fountains shall be provided on each floor and comply with needs for people with disabilities. Each fountain shall have two taps with one being a spout suitable for filling of cups and bottles.

3.4.21.6 Cooling Towers

Cooling towers shall be of BAC (Baltimore Aircoil), EVAPCO manufacture or approved equal. Cooling towers shall be constructed of fibreglass, Stainless steel 316, or other approved non-corrosive material and in accordance with requirements contained in AS3666. Cooling tower sumps and condenser water take-off pipe assemblies shall be of fibreglass or non-corrosive material and shall be completely free draining, that is, build-up of sediment because of general maintenance and cleaning of towers, cannot occur. Cooling tower construction shall allow all wet surfaces to be exposed to chemicals associated with water treatment at all times. Cooling tower construction shall not allow the development of bio-film barriers that will affect water treatment effectiveness. Hot dipped galvanised ladder-access platforms shall be provided that enables safe working access to all serviceable components/areas of the cooling tower.

Where new cooling towers are provided, they shall incorporate an automatic cooling tower cleaning filtration system complete with basin cleaning nozzles to the approval of Curtin University's Infrastructure Manager Mechanical Services. The filter type used with this type of system shall be a Filomat Auto Rinsing Screen Filter as manufactured by Filomat.

The selection of a cooling tower shall be undertaken in conjunction with the selection (or matching) of the associated chiller to ensure COPs at design and part load conditions are achieved. Cooling tower fans shall incorporate variable speed drives, suitably controlled to maintain design condenser water temperature to each cooling tower basin. Tower flow and suction header pipework shall be configured to ensure that water distribution through and from the towers is uniform across all towers This will necessitate careful consideration by the design engineer particularly in relation to the suction header by ensuring there is sufficient head that will provide even draw from each cooling tower. For multiple cooling towers a balance line shall be provided and sized according to the manufacturer recommendations.

Cooling towers shall be cross flow or counter flow induced type. Forced draft cooling tower shall not be used.

Cooling towers shall be supported as per the manufacturer's recommendations. Towers shall be bolted down to the holding structure.

Large cooling towers shall be provided with davit arm to facilitate the future replacement of motors.

New cooling tower installations that reside with existing must be laser aligned to ensure that the water levels between towers are at the same level to the mm.

Disposal of cooling tower waste water is to be in accordance with local authority bylaws and the Water Authority's requirements. Where possible, Curtin University sustainability objectives require consideration by the design engineer for the reuse of waste water. The option of discharge to sewer as trade waste must be maintained. Refer to the *000346 PDG Services Metering Guidelines* for requirements on cooling towers water and waste metering.

3.4.21.7 Exhaust Fans – Roof-mounted

Roof-mounted exhaust fans shall be the direct drive type and utilise speed controllers or variable speed drives as required, depending on the fan motor size to achieve required air flow rates. The use of belt-driven fans is not the preferred option and, if a belt-driven fan is proposed, then it shall be subject to approval by Curtin University's Infrastructure Manager Mechanical Services.

3.4.21.8 Evaporative Coolers

Evaporative coolers shall be constructed of aluminium similar to 'Bonaire' or approved equivalent.

Evaporative coolers shall be provided with ultra-quite fans. The units shall be provided with auto draining kit. Motors shall be suitable for VSD operation.

3.4.21.9 Fans

EC Plug Fans are preferred for use in air handling plant with a focus on energy efficiency and system redundancy. Where fans are centrifugal fans they are to be of approved manufacture with backward or forward curved aerofoil-shaped blades to suit the application.

EC Plug fans shall be of EBM-Papst, Rosenberg or Ziehl Abegg manufacture or approved equivalent.

Axial, centrifugal, mixed flow, fans shall be of Fantech manufacture or approved equivalent.

3.4.21.10 Filters

Filters shall be AAF, CAMFIL, SW Hart, or other approved equivalent and conform to the minimum filter efficiencies as outlined in AS1668 Part 2 and, as a minimum, F7 shall be used as per AS1324.1. The following is a guide to the type of filters to be specified:

- air handling plant above 1500 L/s shall utilise Pyracube, Four Peak or deep bed-type filters
- air handling plant under 1500 L/s shall utilise V-Form extended media
- dry media filters shall be of the disposable type.

Outside air intakes for large air handling systems shall be provided with pre-filters located behind the plant room air intake grille. Pre-filters shall be G4 panel-type filter

HEPA filters shall be provided with geal seal, HEPA filters shall comply with AS 4260

Filter bank pressure drop shall be measured and trended via a differential pressure sensor monitored by the BMS. Non-critical alarms will be raised via the BMS alarm log requesting maintenance attendance when the filter reaches its full holding capacity. Magnahelic gauges shall be provided to sense filter bank pressure drop only where the criticality of the system necessitates local monitoring or where connection to the BMS is not possible. Magnahelic gauges shall indicate the pressure at which filters shall be cleaned/replaced.

3.4.21.11 Fume Cupboards

Acceptable fume cupboards are those manufactured by Johndec, Labsystems or approved equivalent. Approved equal means as approved by the University's Infrastructure Manager Mechanical Services.

The requirements for fume cupboards are presently under review pending the outcome of a detailed audit being undertaken by the University as part of its HAZMAT program. It is anticipated that this section will be substantially updated once the audit of fume cupboards is finalised, which is expected to be approximately 12 months from the date of this guideline. In the interim, design of all new ducted fume cupboards and recirculating cupboards must be done in consultation with Curtin's Infrastructure Manager Mechanical Services.

Manifolded fume cupboards is an option that may be considered by Curtin university. In case this option is proposed, the consultant shall consider the following

- installation cost
- system redundancy
- Spatial
- Future proofing

Exhaust ductwork from the fume cupboards shall be PVC or stainless. PVC ducts shall be joined by hot air welding or using glue.

Fume cupboards shall be labelled in accordance with AS 2243.8

Fume cupboards shall be provided with either a variable speed exhaust fans linked to the sash operation or fixed speed fans with bypass grilles. All cupboards shall be provided with a touch control system.

The exhaust system shall maintain a face velocity of 0.5 m/s across the open sash.

A high sash alarm shall be provided with an audible alarm. All cupboards shall be factory wired and tested before delivered to site. Fume cupboards with scrubbers shall be provided as required for the specific service such as the use of perchloric and hydrofluoric acids.

The chemical fume extraction fans shall be constructed for the purpose of corrosive fume extraction. The casing should be moulded in one piece with no seams or joints. Fan motors shall be located outside the air stream. The fan housing shall have a drain point to allow drainage of the rain water. Motors shall be MEPS compliant with minimum IP55 rating.

Design of fume cupboards shall be in accordance with the relevant standards specifically AS 2243 and shall consider their intended use together with the chemicals and other hazardous substances intended to be used in them.

3.4.21.12 Heater Banks

Hot water space heating shall be provided by the Campus centralised heating water system. Electric heater banks can only be used where other alternatives are cost-prohibitive based on a full life-cycle cost analysis. Electric heater bank control shall utilise pulse width modulation for the staging of the heater banks as described in the Controls section of this document. Electric duct heaters shall comply with the requirements of AS 3102. They shall be provided with air flow switch, solid state relay and temperature cut out switch.

3.4.21.13 Space Heating Water Heaters

Space heating water heaters shall be forced-draught high-efficiency condensing boilers.

Water heaters shall have waste condensate neutralisation and cooling arrangements before discharging to sewer.

Water heaters shall be fitted with OPSO regulators with either a pressure relief valve piped to atmosphere or a regulator with internal relief.

3.4.21.14 Future Space Heating Water Heaters

The University is seeking to move away from gas fired appliances to electric. Future CEP water heaters requires assessment by the consultant and may include:

- Water cooled chiller(s) with heat pump capability that provides heated water temperatures noted in the Design Criteria section.
- Standalone heat pump(s) that provides heated water temperatures noted in the Design Criteria section.

Air cooled heat pump chillers and polyvalent chillers shall not be used.

3.4.21.15 Motors

Shall be totally enclosed fan-cooled (TEFC) and normally be limited to 1,450 rpm maximum. Motors for variable speed operation shall be selected for sufficient dissipation of localised motor heat when running at low speed. High-efficiency motors shall be specified. Motors over 4.0 kW are to be soft start where a VSD is not in use. All motors shall be MEPS compliant and have a minimum of 10% future capacity.

3.4.21.16 Pressure Vessels

All pressure vessels shall comply with AS1200.All equipment supplied to the University that contains a pressure vessel (including chillers) shall be registered in accordance with relevant Australian standards, legislation and Worksafe WA requirements. Pressure vessels will be stamped with the Worksafe WA plant registration number with pressure relief valves tagged with their next due calibration/renewal date as required under the registration.

In addition to statutory requirements, copies of registration certificates and inspection reports/datasheets shall be included in operations and maintenance manuals with a separate copy issued to Curtin University’s Infrastructure Manager Mechanical Services.

Examples of equipment that contain pressure vessels that may be required to be registered include, but are not limited to, the following:

- chillers – evaporator and condenser vessels
- boilers (steam)
- air compressors

- vacuum systems
- autoclaves.

Inspection, certification and maintenance requirements of pressure vessels shall be detailed in Operations and Maintenance Manuals.

3.4.21.17 Pumps

Pumps shall be Grundfos, KSB or approved equivalent.

Pump selections shall comply with all the requirements of NCC section J. all pumps shall be supplied with variable speed drives regardless of if they are designed as variable speed or constant flow pumps.

Pumps generally shall be provided with inertia bases complete with seismic spring.

Close-coupled pumps may be used up to 30 kW. Beyond 30 kW, pumps shall be decoupled. Impellers shall be bronze; casing above 25 mm – gunmetal; below 25mm – bronze; shafts shall be 316 stainless steel minimum. All seals shall be mechanical seals.

Chilled water pumps shall be provided with stainless steel tray under the pump. All pumps shall be selected within 5% of the maximum efficiency point. Trays under the pump shall be provided with 25mm socket for drainage, drainage shall be terminated using DN25mm copper pipes.

Pumps shall be either DIN or ISO type. Preference to select all pumps at maximum speed of 1450 rpm for stable operation. However, 2900 rpm shall be considered for systems with low flow rates and high pressure requirements.

All motors shall be selected with non-overloading power characteristics

3.4.21.18 VAV Boxes

VAV boxes shall be Celmec, Johnson or approved equivalent.

Depending on the design, variable volume boxes using a single primary air system are preferred. Subject to justification to and approval by Curtin University’s Infrastructure Manager Mechanical Services, the use of series or parallel-type fan-assisted VAV boxes <u>may be</u> considered but is not preferred. Where fan-assisted VAV boxes are used, they shall incorporate a fan air flow or pressure switch which shall be suitable for low air pressure at minimum airflow. The airflow/pressure switch shall be interlocked with any electric trim duct heaters (noting that electric heating should be avoided).

Induct and breakout noise from VAV boxes shall be reviewed by the project acoustic engineer and any additional treatment shall be included in the mechanical documentation.

The size of each VAV box shall be selected to suit the design minimum/maximum airflows and control ranges of the box in accordance with manufacturers’ recommendations. Test certificates indicating performance testing and QA/QC checks shall be included in the operations and maintenance manuals.

3.4.21.19 Variable Speed Drives

Variable speed drives (VSDs) shall be of ABB, Danfoss manufacture or approved equivalent.

Installation of VSDs shall be in accordance with current standards as provided by Standards Australia and relevant legislation.

Curtin University's Building Management Systems shall control the VSD. The BMS shall provide a minimum input/output (I/O) interface to the VSD as follows:

- one analogue output to ramp the VSD proportionally (0 – 10 vdc)
- one digital output to provide isolation contactor and VSD-enable (24 vac)
- one digital input providing the BMS with VSD fault status (dry contacts).
- Fire signal input to stop the system during the fire

Variable speed drives shall be installed according to the manufacturer's recommendations. Noise from VSD's shall be addressed and eliminated.

All VSD's shall be provided with BACnet high level interface and be connected to a BMS.

DDC control wiring shall be such that the VSD can be enabled/disabled via a Manual/Off/Auto switch located on the Mechanical Services switchboard. The VSD can be further controlled on the VSD by use of local control functionality.

The DDC-enable input on the VSD shall be provided with a 'bridge' (where required) to give a permanent enable on the VSD.

The DCC-enable signal shall not be removed until after the analogue output signal to the VSD is equal to or less than a value of 0 per cent and a minimum time has elapsed that is equal to or greater than the ramp-down time as set on the VSD plus 15 seconds.

Should the VSD experience a fault condition, the VSD diagnostic display shall be retained so that it can be interrogated for fault-finding purposes.

VSDs will not be used on EC Plug Fans. Such fans should connect directly to the University's BMS via BACnet connectivity and be controlled accordingly as stipulated by the fan manufacturer.

All VSDs shall be earthed to comply with AS3000.

3.4.22 INSTRUMENTS

All instruments shall be calibrated to read in the SI system of units. Dial gauges shall be 100 mm minimum diameter and shall be installed to allow the gauge to be zeroed when not in use. The range of the instrument shall be suitable for the application i.e. normal operating point equal to 80 per cent of full scale deflection.

All buildings shall incorporate flow meters in the chilled and heating water building return mains pipe to facilitate thermal energy consumption recording and reporting.

Thermal metering shall be installed strictly in accordance with *000346 PDG Services Metering Guidelines*.

3.4.23 AIR CONDITIONING ELECTRICAL SYSTEMS

3.4.23.1 General

Switchboards and motor control centres shall be constructed in accordance with requirements outlined in the Electrical Services section of Curtin University's Project Delivery Guidelines.

Switchboards, panels and the like for mechanical services power, control & BMS must not be located outside. All boards are to be located internally and in an appropriately secured location. Locating a switchboard or panel outdoors must be an absolute last resort. In the event a switchboard or panel is located outside all components associated with the board and inside them shall be ruggedised (Electrical, Controls & BMS).

Permanent, clearly legible Traffolyte labels shall be fixed to all internal and external controls.

Fire alarm relays shall be provided in accordance with the requirements of AS1668 and AS1670 as applicable.

A minimum of 25 per cent spare capacity shall be provided in all switchboards, sub-boards and control panels to allow for future extension. High- and low-voltage cable and controls (DDC) shall be separated within cubicles in accordance with AS3000.

Where HRC fuses are in use, a minimum of three fuses of each size and type shall be specified as spares and shall be contained in holding clips on the inside of switchboard cubicle doors.

Special Note AS3000: New or upgraded MSSBs that are 125 Amps or above requires different switchboard room access requirements. This means that clearances and room access paths and door dimensions must comply with AS3000. The purpose of the provision is to ensure that a person injured by electrocution can be retrieved safely.

Switchboards shall be designed with reference to the correct fault rating. Switchboards shall have electric meters to meet requirements under NCC section J8. HVAC equipment can be grouped such as airside and waterside equipment are separately metered. Any equipment with load exceeds 20 kVA shall be metred separately.

Mechanical switchboard shall be constructed to minimum form 2. Where switchboards are located outside the building, they shall be minimum IP55 and shall be provided with rain/sun shades.

Where controllers are housed within the same switchboard they shall be located in a separate compartment with a separate access door.

Switchboards shall be provided with lockable doors keyed to Curtin standards for electrical switchboards.

Active or passive harmonic filters shall be provided as required by the project team. Filters to meet requirements of AS 6100.

The following references shall be considered during the design of the mechanical electrical systems

- Curtin University standard electrical specification
- Curtin University Electrical design standard brief
- Curtin University Electrical Switchboard Brief
- Curtin University Minor electric works spec

Hours-run meters shall be provided on all items of equipment that are duplicated or run in parallel, and where else considered necessary, unless controlled by a direct digital control system, in which case the control system shall record operating hours.

The strategy for measuring and tracking energy use by mechanical services systems will require greater detail and consideration of requirements outlined in the Sustainability and Electrical Services sections of Curtin University's Project Delivery Guidelines.

Provision shall be made to override local start-stop controls by means of BMS control where specified.

All cables shall be run on a cable tray and terminated strips. Cables shall be identified by numbered ferrules at each termination.

Heater banks shall be controlled by BMS, irrespective of air conditioning controls, for energy load shedding.

Heater protection thermostats, complete with fault lights (visible from within the occupied space), shall be provided to all heaters, including those associated with VAV boxes. Air flow switches shall be incorporated in all electrically heated air systems.

Electrical drawings shall be prepared with Circuit Reference Numbers to indicate the number of contacts and their location.

3.4.23.2 EC Motor Fans – Specific Requirements

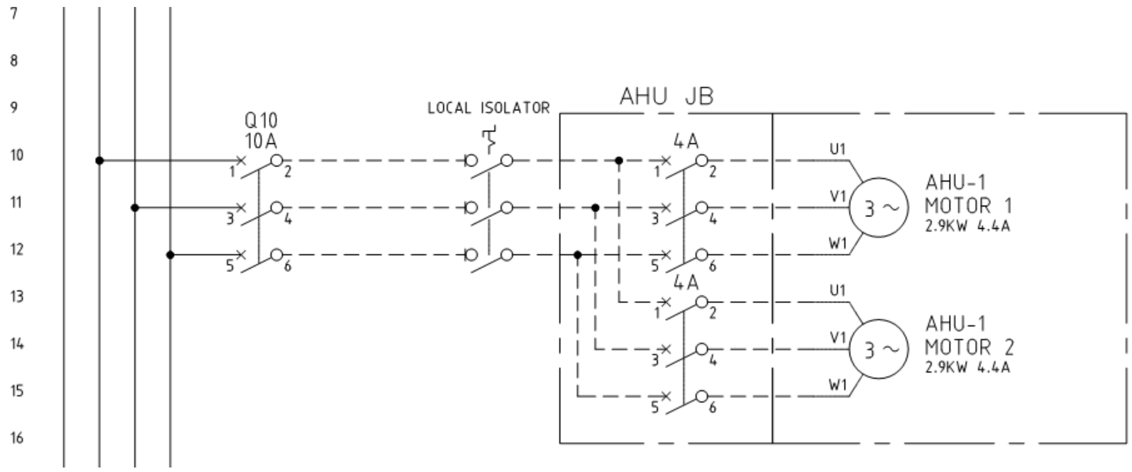
This section relates to air handling systems that contain one or more EC motor fans. The objective is to provide guidance on the standardisation of wiring requirements that meets AS wiring rules, manufacturers' requirements and Curtin operational requirements.

WIRING ARRANGEMENTS

Electrical wiring to EC fans shall comply with AS3000 and the manufacturer's requirements. For systems containing more than one EC motor in a unit:

- power from the MSSB to a single isolator switch
- power from the isolator to a sub-panel, fitted external to the unit, containing a circuit breaker for each fan.

Example diagram:



Irrespective of the number of fans per unit, consideration must be made for CTs on the power supply to each fan to aid with run and fault monitoring, interfaced to MSSB and BMS, particularly for manufacturers who do not provide HLI run/fault information and more prevalent on multi fan units.

SWITCHBOARD REQUIREMENTS

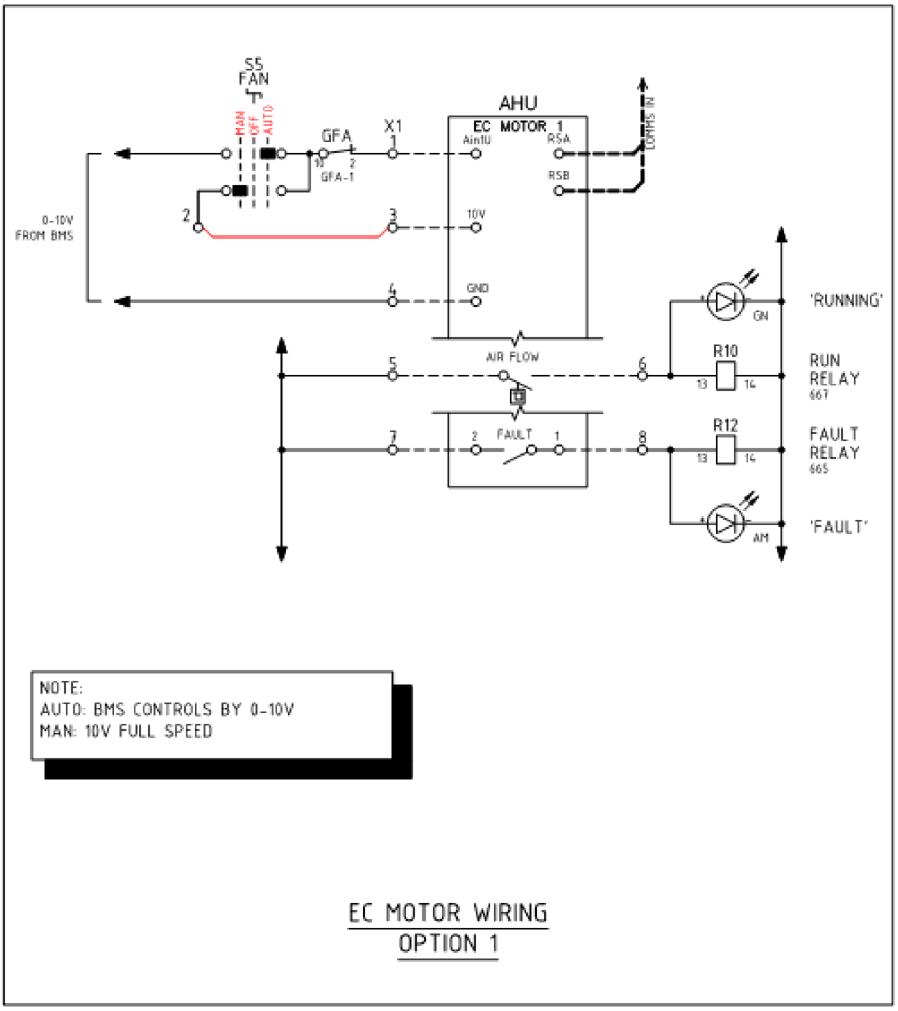
Standard requirements for fan interfaces on MSSB include:

- Manual/Auto/Off or Off/Auto switches
- Run and Fault lights.

How the above is achieved will vary between manufacturers of EC motor fans. The consultant must determine the appropriate solution(s) as it may relate to specific installations, where necessary in consultation with Curtin University.

Three key options shall be considered, with examples outlined below. The examples relate to single fan units and consideration must be made to achieving the same outcomes with units containing multiple EC motor fans. This may require manufacturer-specific HLI or third-party vendor HLI be installed to provide fan fault or run indication/status noting that air differential pressure sensing across fans may not be adequate.

Option 1 – Fixed Speed in Manual setting where variable fan speed is not required

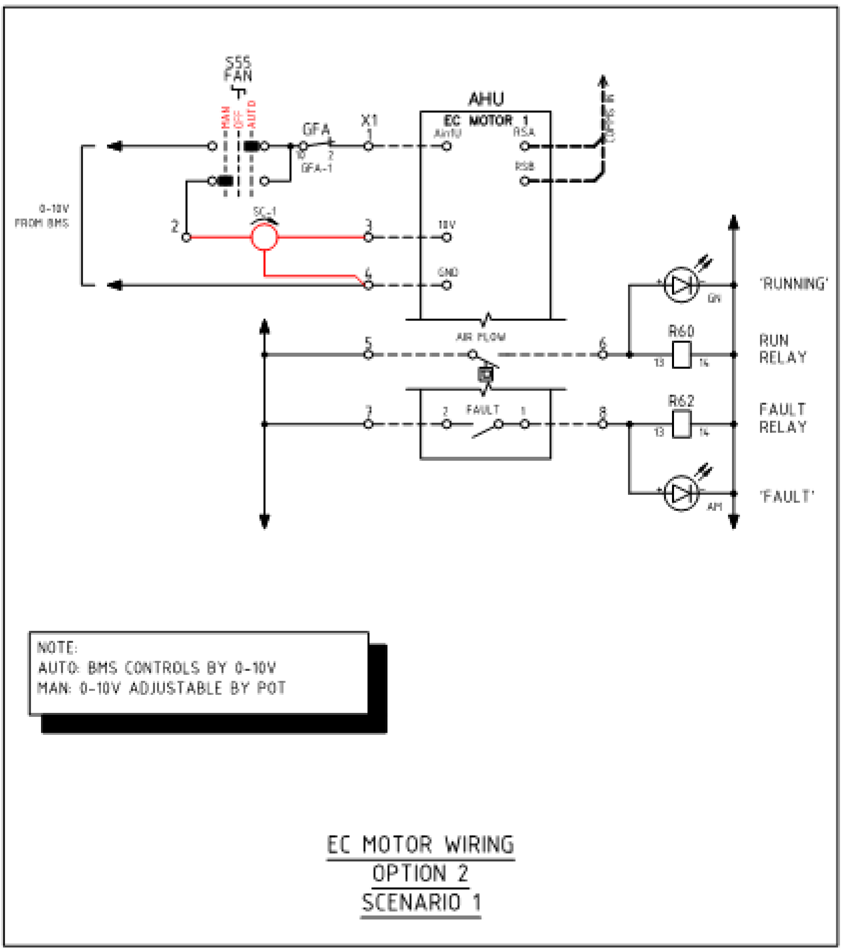


- MAN/OFF/AUTO SWITCH AT MSSB
- MANUAL POSITION = FULL SPEED
- FAULT STATUS ONLY IF AVAILABLE

- EBM-PAPST
    - FAULT STATUS AVAILABLE
    - NO RUN STATUS
    - RUN STATUS VIA AIR FLOW

- NICOTRA
    - NO FAULT STATUS
    - NO RUN STATUS
    - RUN STATUS VIA AIR FLOW
    - FAULT STATUS VIA MIS-MATCH

Option 2 – Scenario 1 – manual position via 0–10V POT – 10v from EC motor (for most installations)



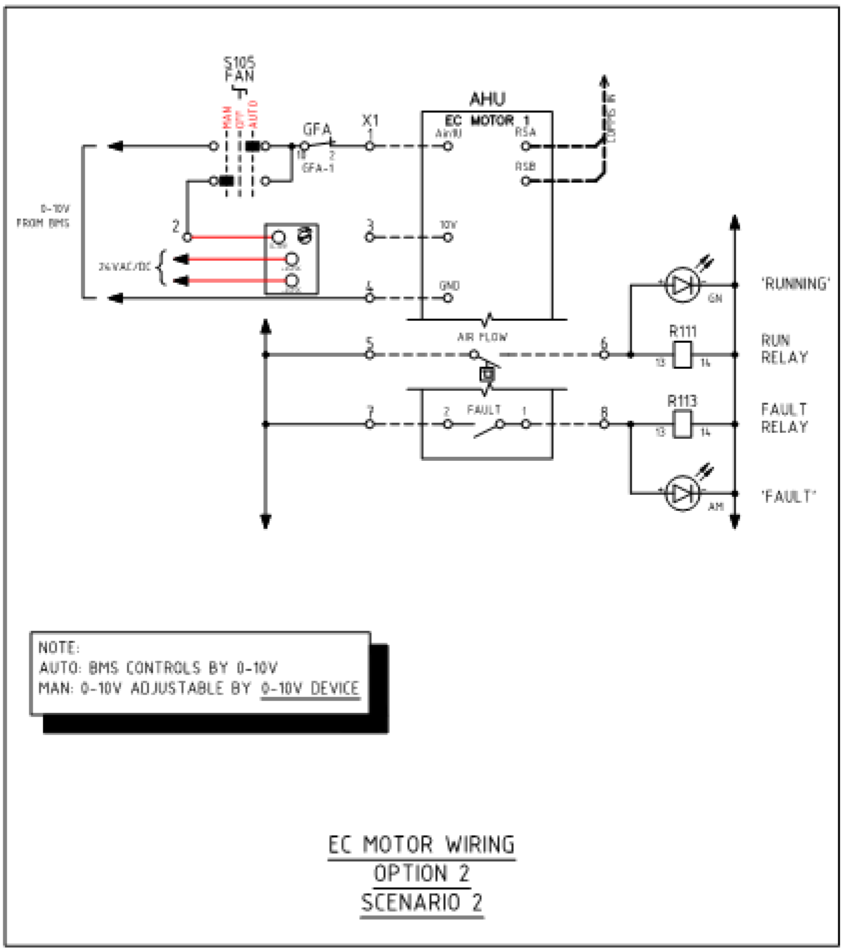
- MAN/OFF/AUTO SWITCH AT MSSB
- MANUAL POSITION = ADJUSTABLE SPEED VIA 0-10V POT
- FAULT STATUS ONLY IF AVAILABLE

- EBM-PAPST
  - FAULT STATUS AVAILABLE
  - NO RUN STATUS
  - RUN STATUS VIA AIR FLOW

- NICOTRA
  - NO FAULT STATUS
  - NO RUN STATUS
  - RUN STATUS VIA AIR FLOW
  - FAULT STATUS VIA MIS-MATCH

- MOST COST
- REQUIRE MORE SPACE FOR 0-10V POT IN THE MSSB

Option 2 – Scenario 2 – manual position via 0–10V using independent 0–10v device, refer to Belimo examples below



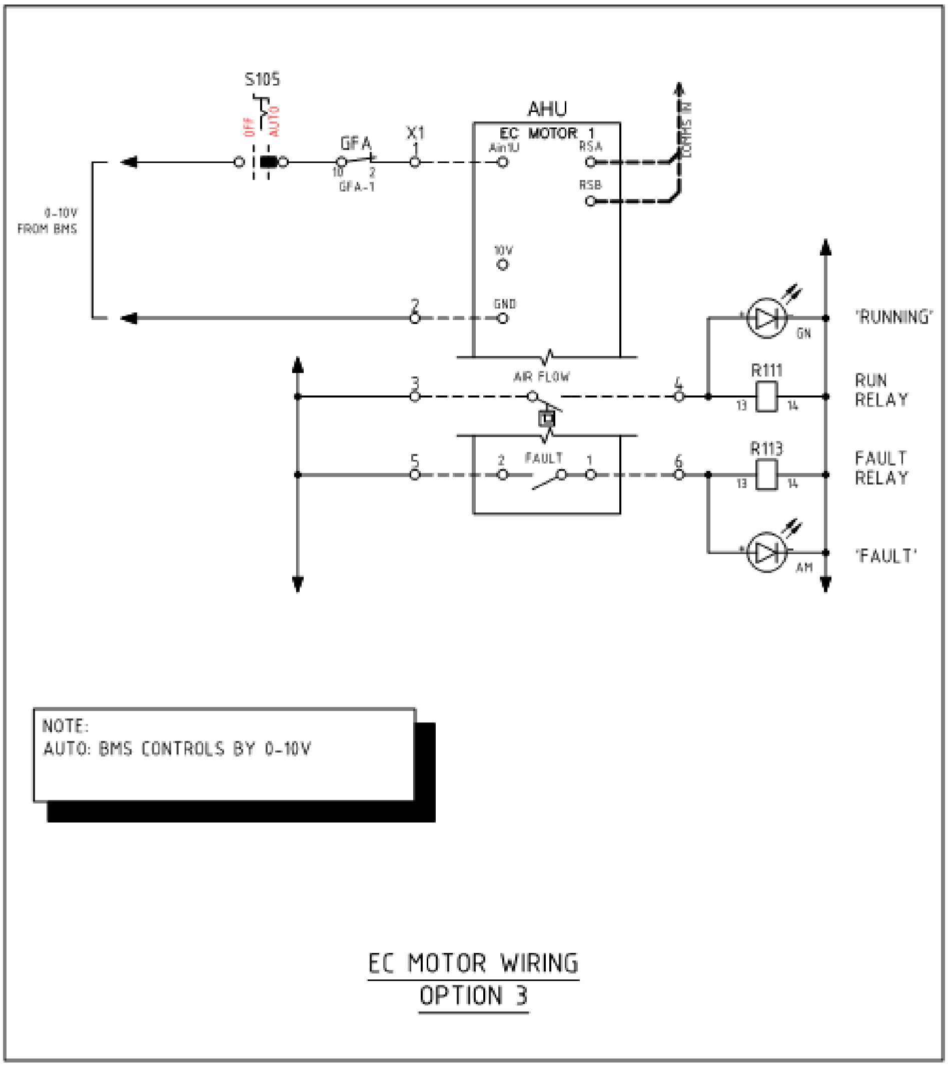
- MAN/OFF/AUTO SWITCH AT MSSB
- MANUAL POSITION = ADJUSTABLE SPEED VIA 0-10V DEVICE
- FAULT STATUS ONLY IF AVAILABLE

- EBM-PAPST
  - FAULT STATUS AVAILABLE
  - NO RUN STATUS
  - RUN STATUS VIA AIR FLOW

- NICOTRA
  - NO FAULT STATUS
  - NO RUN STATUS
  - RUN STATUS VIA AIR FLOW
  - FAULT STATUS VIA MIS-MATCH

- MOST COST
- REQUIRE MORE SPACE FOR 0-10V DEVICE

Option 3 – No manual function (critical applications)



- OFF/AUTO SWITCH AT MSSB
- NO MANUAL OPERATION
- AUTO POSITION = 0-10V VIA BMS
- FAULT STATUS ONLY IF AVAILABLE

- EBM-PAPST
  - FAULT STATUS AVAILABLE
  - NO RUN STATUS
  - RUN STATUS VIA AIR FLOW

- NICOTRA
  - NO FAULT STATUS
  - NO RUN STATUS
  - RUN STATUS VIA AIR FLOW
  - FAULT STATUS VIA MIS-MATCH

Where POTs are provided with independent devices, one of the following may apply as needed for either field mounting or MSSB panel mounting, referencing Option 2 Scenario 2 above:

- Belimo SGA24 type or equivalent for surface mounting

- Belimo SGE24 type or equivalent for control cabinet mounting (DIN Rail)

- Belimo SGF24 type or equivalent for front panel mounting

The consultant shall determine the appropriateness of which is to be used to suit

BMS INTERFACES

In all cases BMS controls are required to interface to the fans for the following as a minimum:

- stop/start
- control of fan speed 0–10V
- fan run and fault to suit HLI and/or airflow DP.

FIRE MODE REQUIREMENTS

Fire mode control shall be in accordance with AS1668, NCC and any specific requirements made under a fire engineering brief.

3.4.23.3 Dirt Separator/De-aerator Tank Control – Specific Requirements

This section relates to the control of Automatic Dirt Separator (ADS) blow-down valves where installed. Under no circumstances shall automatic control of the valves be installed. The following control arrangement shall be provided to facilitate manual operation:

- Provide a spring-return On/Off rotary switch for power supply to the transformer that serves the ADS purge valves (this would be in the off position with no power supply as a default).
- Provide a manual depress-and-hold push button to activate the purge valve of each ADS unit (again, in off position with no power supply as a default).
- Provide clear operational labelling on the panel.
- ADS units shall have spring-return purge valves.

This arrangement is aimed at requiring a two-handed operation to activate an ADS purge valve to ensure that the system could not be inadvertently left with the ADS purge valve open.

Where two purge valves are controlled from one panel i.e. an ADS for chilled water and an ADS for heating water, provide one rotary power switch and one push button per system i.e. so they are not common to each.

3.4.24 IDENTIFICATION, LABELLING & DATA CAPTURE

3.4.24.1 General & Equipment

All items of equipment shall be identified with engraved Traffolyte labels in accordance with the University's CMMS asset coding structure, as contained in Curtin University's Documentation Deliverables Guidelines and associated Reference Documents and more specifically FM Asset Register.

CMMS equipment labelling codes shall be referenced on all as-constructed drawings. The labelling standard must be adhered to.

To obtain CMMS equipment codes for the labels, the consultant/contractor will need to submit an equipment list in Microsoft Excel to the Technical Officer for allocation of codes from which the contractor can then have the labels made.

Thermometer bulbs, pressure gauge tapings and remote sensing points shall be labelled to indicate their function.

3.4.24.2 Pit and Valve Identification Labelling.

All chilled and heating water valves within pits and the first set of building isolation valves that reside inside the building shall be identified and labelled. All pits shall be labelled, and lids painted.

3.4.24.2.1 Labelling

The FM Asset Register contains the new pits and valves identification numbers using the following:

1. Building / Area – This is the new grid reference that the pit / valves reside in.
2. Asset Type
    a. Mechanical Services PIT.
    b. Chilled Water Valve.
    c. Heated Water Valve.
3. Level
    a. All inground services are level 00.
    b. Services in buildings commence at 01 except for B408 & B418 which has a building level of 00.
4. Count of asset type (per level) – sequential numbering 0001 to 000*.

3.4.24.2.2 Pit Lids Labelling & Painting

All pits to be labelled on the top of the pit lid and underneath the pit lid per the Curtin Labelling Standard as Type 2 and the following:

- Material: Stainless steel with dielectric separation protection.
- Information Pit, Equipment ID

  CHW valves, Equipment ID

  HTGW valves, Equipment ID

  Bar Code(s)

  Confined Space (Y/N) – This may be deleted if information is not available.

  HazMat (Y/N) – This may be deleted if information is not available.
- Font: Gothic

- Plate Size: At least 50mm x 50mm to suit the height and width of the text
- Characters: 5mm
- Colour: N/A.
- Engraving: Stamped or Chemical Etching
- Fixing: Counter sunk screws, material to match pit lid material.

All pit lids to be painted and be suitable for conditions as follows:

- Area: Entire Lid.
- Colour: Dark Red, RGB: 139, 0, 0 / HEX: #8B0000
- No of applications: Manufacturer recommendations for the conditions.
- Conditions: Permanent exposure to sun and weather.

  Regular reticulation in garden beds.

  High use foot and vehicle traffic in paths and roads.
- Type: Equivalent to Freeway line marking.
- Pre-treatment: Clean thoroughly and apply suitable bonding coat(s).

3.4.24.2.3 Valves Labelling

All valves to be labelled per the Labelling Standard as Type 2:

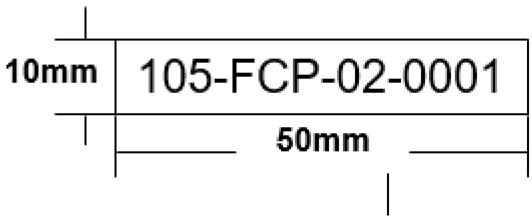
- Material: 316 Stainless steel.
- Information Equipment ID
- Font: Gothic.
- Plate Size: 50mm x 10mm.
- Characters: 5mm.
- Colour: N/A.
- Engraving: Stamped or Chemical Etching.
- Fixing: Chain - 316 Stainless steel.

TYPE 2 LABEL, EXAMPLE 1 – PIT LID

Size to suit wording and fixings.

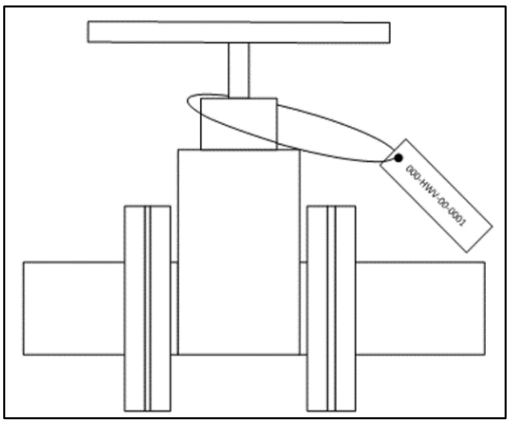
N5E-MSP-00-0001
N5E-CWV-00-0001
N5E-CWV-00-0002
N5E-HWV-00-0001
N5E-HWV-00-0002
Confined Space (Y/N)
HazMat (Y/N)

TYPE 2 LABEL, EXAMPLE 2 – VALVE



EXAMPLE VALVE LABELLING FIGURE

The example figure uses Type 2 labels with a hole, secured to the valve with a corrosion resistant chain.



3.4.25 ENERGY AND WATER MANAGEMENT

At preliminary design stage, subject to the extent of works to be conducted, but where new plant is proposed to be installed, and as part of the life-cycle costing of the selected plant, the consultant shall advise Curtin University's Responsible Officer of the estimated energy consumption profiles over a 12-month period and the energy modelling scenarios. The consultant design engineer is to identify, nominate and/or investigate all scenarios for limiting energy consumption and greenhouse gas emissions. Options, as a minimum, shall be considered best practice with a proven history.

On all new buildings and major and complex projects, the consultant shall be responsible for monitoring and reporting on the operation and control of the air conditioning plant for a period of 24 months after practical completion. This work shall form part of the consultant's brief for the design and documentation of the project. This shall include regular site visits or remote dial-in to the site to observe operation and performance of plant, make modifications to the control logic of the plant and equipment to improve efficiency and reduce operating costs. The consultant shall instruct the contractor to make all necessary changes at no cost to Curtin University, as required to achieve efficient operation of the plant. The consultant shall submit plant performance reports, energy consumption profiles and sign off on the operation and control of the plant and equipment every three months throughout the 24-month tuning period, to the approval of Curtin University.

The consultant, contractor and BMS contractors shall work collaboratively to achieve energy performance and operational performance improvements. Performance analysis reports shall be submitted one week prior to the anniversary of the reporting period from the date of practical completion at monthly or quarterly intervals as required to suit specific project needs.

The consultant will arrange for Performance Review meetings which shall include Curtin University, consultant, contractor and BMS contractors as a minimum. Review meetings shall occur no later than one week after the anniversary of the reporting period from the date of PC at monthly or quarterly intervals as required to suit specific project needs.

The contractor and/or the consultant shall develop the template for the performance reports and submit the template for approval within two weeks of practical completion.

In developing the information for the templates required the consultant/contractor must consider key performance indicators and the means to test and validate performance improvements.

Reports must be analytical in nature and not just a presentation of data without any meaningful analysis. The performance reports will by necessity require involvement of consultant, contractor and BMS contractor to develop and implement.

The mechanical design engineer shall work with other engineering/design consultants to ensure that all energy and water monitoring equipment is suitably specified and installed to provide for all forms of energy and water consumed for the building and is reported upon using the University's standard reporting system for energy and water (iEnergy). This shall include but not be limited to:

- ambient temperature
- chilled water consumption (entering water temperature, leaving water temperature, chilled water flow rate)
- heating water consumption (entering water temperature, leaving water temperature, heating water flow rate)
- gas consumption
- electricity consumption
- hot water consumption
- energy consumption/production from miscellaneous sources such as bore water, geothermal, solar hot water, wind, photovoltaic, etc.

Throughout the 24-month 'tuning' period, the consultant shall ensure that the operations and maintenance manuals are upgraded to reflect any changes that have been undertaken since project Practical Completion. This will include the insertion of an Issues Register that forms a log of the issues and actions taken over the course of the tuning period.

All changes to the control system during the tunning period shall be documented and updated in the BMS operation and maintenance manual.

Central Energy Plant (CEP) – Energy and Water Management and BMS

General

Any work being undertaken on Curtin central energy plant (CEP) on any campus must ensure that existing energy and water management graphics and data are integrated, updated, validated and certified by the Consulting Engineer, Contractor and BMS Contractor.

Energy and Water Management Arrangements

The types of energy management arrangements can include but are not necessarily limited to:

- co-efficient of performance (COP)
- 'Authority' level meter gas and electrical (if dedicated to the plantroom)
- plantroom-level gas, electrical and thermal energy metering required for COP
- component/equipment-level gas, electrical and thermal energy metering required for COP
- campus power as integrated to the Struxureware Metering system
- water use
- waste discharge

- BMS alarms on out-of-range or mismatch between recorded data, e.g. boiler has thermal output, but no gas being recorded and vice versa.

CONSULTANT

The Consulting Engineer shall:

- clearly specify the works to be integrated and any amendments to the graphics, programming and reporting
- review contractor submittals prior to construction to validate the BMS Contractors amendments
- undertake a thorough BMS review and validate that the works have been undertaken and are correct and provide certification of it.

CONTRACTOR

The Contractor shall check the BMS contractor's works prior to requesting consultant review of the works. The Contractor shall provide a copy of their validation process and certification of BMS oversight to the Consulting Engineer prior to the request or as part of the request.

BMS CONTRACTOR

The BMS Contractor, as custodian of the BMS system, shall ensure that the BMS systems are:

- upgraded
- clearly document the changes via updated functional descriptions and operation and maintenance manuals
- validated
- programmed
- have graphics complete and correct
- have test data and information supplied.

The BMS Contractor shall attend reviews by both the Contractor and the Consulting Engineer and do all things required to ensure that the Energy and Water Management systems are fully functional, irrespective of the project specifications and shall allow to do so as part of their tender.

BMS contractor shall review the specification and function description and report back on any discrepancy between the consultant specification and requirements of Curtin university. BMS contractor will be fully responsible for compliance of the BMS package including any type/brand of equipment and instrumentations.

Prior to commencing work on site, the BMS Contractor shall submit:

- QA documentation demonstrating the processes for capturing, modifying and recording BMS amendments in general and specifically for the energy and water management
- functional description documentation that clearly highlights amendments
- reporting documentation that clearly highlights amendments
- any other submittals required by the Consulting Engineer or Contractor.

Defects Liability Period

During DLP, issues with metering and data shall be addressed as a Priority 2 alarm and be attended to in accordance with Priority 2 alarm requirements.

Operations and Maintenance

When engaged for operational changes and maintenance the above processes shall also be followed to ensure that the systems are kept in operational condition and documentation is kept current. Where there is no consulting engineer or contractor involved, the BMS Contractor will assume those roles.

During maintenance, issues with metering and data shall be addressed as a Priority 2 alarm and be addressed in accordance with Priority 2 alarm requirements.

Return to Site

Should there be corrupted or unusable data as a result of failure in the above, the Consultant, Contractor and BMS Contractor shall return to rectify and backfill the corrupted data at their own expense, even if it is discovered outside of a nominated project DLP.

3.4.26 COMMISSIONING

3.4.26.1 Seasonal Commissioning

Commissioning of the building air and water systems can occur at any time whether it is conditionally suitable or not. Subject to when systems are commissioned should one, the other or both fall within unsuitable conditions, then provisional commissioning shall be undertaken and a final validation adjustment under conditions that are suitable e.g. summer for cooling and winter for heating.

In the first instance it is always preferable to commission the systems to achieve the required design values during the commissioning phase of a project.

3.4.26.2 Chilled and heating water

The chilled and heating water network operates to the following system differential pressures (DP), with the DP varying depending on the return water temperature and responding to system valves opening and closing.

- CHW – 100 to 120 kPa
- HTGW – 100 to 120 kPa

It must be understood that the system is dynamic and pressure fluctuations occur as a result. Equally demand in winter is low for cooling and demand in summer is low for heating and the central energy plant response to changes is low because overall demand is low and may therefore be unsuitable or part thereof.

Manual intervention may be provided by the University but is not guaranteed, and the Commissioning of the chilled and heating water systems within a building is required to be conducted to the following procedures and timelines.

3.4.26.3 Notifications

Provide 10 working days notice to the Services Manager for Mechanical Services and the Infrastructure Manager for Mechanical Services, for a commissioning or scanning event requiring flow and pressure from the chilled and/or heating water network and arrange a planning meeting. The notification must include the following documentation:

- Summary of component flow rates and a sum total.
- Identify the building pressure drop at design flow.
- Dates and times & duration of the proposed commissioning.

This notification allows Curtin Operation and Maintenance personnel to determine if there are any other activities on campus that could impact the commissioning and to provide reverse advice. It also permits an evaluation on whether manual intervention will be necessary to facilitate the commissioning or if qualified agreement is provided.

3.4.26.4 Procedures

ESTABLISH PRESSURE CONSISTENCY.

1. Open the building valves being commissioned and allow the network pressure to stabilise (1-2 hours).
2. Trend log the pressures/DP at the building being commissioned using an existing pressure DP or new DP.
3. Conduct an initial balance and scan of the water flows and determine the index leg if pressure stability is suitable.
4. Submit results for review and Consultant to provide recommendations.
5. Reach a resolution with the University on the recommendations.

POST ESTABLISHMENT OF PRESSURE CONSISTENCY.

Assumes a form of pressure consistency is in place.

1. Open the building valves being commissioned and allow the network pressure to stabilise (1-2 hours).

2. Trend log the pressures/DP at the building being commissioned using an existing pressure DP or new DP.

3. Conduct the balancing and scan of the water flows and validate design compliance.

4. Submit results for review and Consultant to provide recommendations.

SUBSEQUENT TESTING & WITNESSING

Assumes that design flow rate validation is achieved, and the design consultants have witnessed and signed off.

1. Arrange for witnessing by the clients independent commissioning agent (if engaged) and Curtin university stakeholders.

3.4.26.5 Requests for CEP Pressure Increase

At its discretion Curtin University may agree to requests for increases in CEP delivered pressure, within the existing operating range. Requests for pressures in excess of 140 kPa will not be accepted.

3.4.26.6 Seasonal Adjustments

Where an agreement has been reached to accept an interim commissioned system, the contractor must return when conditions are optimum to achieve results and conduct a final water balance, following the procedures above.

3.4.27 PRACTICAL COMPLETION

The consulting engineers shall ensure that representatives from Curtin University's PF & D Mechanical Engineering Department are included in the project Technical Review Group and that design and development of mechanical services, and the selection of equipment is undertaken in conjunction with these University representatives.

Prior to issuing to tender, the consultant shall issue to Curtin University's Infrastructure Manager Mechanical Services one set of preliminary tender drawings and specifications for review and comment.

At practical completion, the consultant shall forward all commissioning data to Curtin University's Infrastructure Manager Mechanical Services for review and comment by the University. The consultant shall also coordinate the defects inspection to be carried out with a representative of the mechanical consultant, the mechanical contractor and Curtin University's Mechanical Engineering section.

3.4.28 DEFECTS LIABILITY PERIOD

The mechanical consultant and mechanical contractor shall ensure that all new plant and equipment is serviced throughout the duration of the defects warranty period in accordance with the plant and equipment's specified maintenance requirements. The mechanical consultant shall stipulate maintenance requirements, including frequencies, in the project specification. Maintenance service sheets for all items of equipment are to be reviewed by the consultant before being forwarded to Curtin University for its review and comment.

The mechanical consultant shall specify that the contractor is to deliver maintenance reports when they are due for each month or quarter. The consultant, after review, shall submit these reports to Curtin University. This ensures that maintenance is conducted when it is due and not left unattended.

At the end of the 12-months defects warranty period, a final inspection shall be carried out by the mechanical consultant, mechanical contractor and a representative from Curtin University's Mechanical Engineering section. A copy of all service sheets shall be forwarded to Curtin University's Infrastructure Manager Mechanical Services for its records one week prior to the scheduled final inspection meeting.

On applicable projects and on completion of the defects warranty period, the consultant shall continue monitoring the operation and performance of the air conditioning plant and initiate improvements and modification as required up to the end of the 24-month energy reporting period that commences from Practical Completion to the approval of Curtin University's P F& D Mechanical Engineering Department.

3.4.29 OPERATIONS AND MAINTENANCE MANUALS

The Mechanical Design Consultant shall ensure that one complete set of electronic operations and maintenance manuals are checked, completed and approved by the consultant before being forwarded on to Curtin University for review, comment and acceptance. Upon acceptance and subject to changes identified by the consultant and Curtin University, the consultant shall ensure that two full and complete electronic sets of the project operations and maintenance manual is forwarded to Curtin University for its records. One of the two copies of the manual shall be provided in PDF format with the second copy in an editable version in Microsoft Word. In addition to PDF versions, drawings shall be provided in AutoCAD in DWG format. All documentation shall be compiled in accordance with the University's protocol for AutoCAD drawings, as described in the *Documentation Deliverables Guidelines*. BIM models shall be provided as agreed with Curtin's Drawing Management office at the time of project schematic design.

The operations and maintenance manuals for mechanical services shall be formatted as follows such that if it was to be printed, it would be representative of a traditional hard copy operation and maintenance manual:

- be a three-ringed binder, navy blue in colour and A4 in size
- have a manual front cover and spine title and associated detail that shall be printed in gold leaf lettering. (See Appendix 3 for the typical layout of the titles

and headings for the manual front cover and spine. Note that there is a standard layout for all projects, except for site in-ground chilled and heating water projects. These projects have a specific requirement as illustrated in Appendix 3.)

- consist of one or more binders as required to accommodate all the information on the project services and identified accordingly as Volume 1, Volume 2 etc.
- identify the Builder, Architect, Consultant and Mechanical Contractor
- identify the date of Practical Completion
- incorporate a description of the works undertaken, description of operation, equipment schedules, functional description of the control system including flow diagrams and point schedules, manufacturers' data, commissioning data, maintenance procedures, fire testing procedures and as-constructed drawings. As a minimum this detail shall be set out in sections as follows:

Contents
Used in Chilled and Heating Water in ground pipework projects only. Refers to Operation and Maintenance Manuals in terms of the number of volumes (see Appendix 3)

Index
Contains index detail

Introduction
A brief commentary on what the project intent is

Description of Installation
A detailed description of the scope of work

Design Criteria
A detailed description of the design criteria used for the project including but not limited to those described in Section 3.4.2 and thermal performance information of the building materials for walls, floors, slabs, roofs, etc and thermal performance of all glazing types:

Functional Description
A detailed description explaining the sequence of events that demonstrates how each element of the project operates and achieves its intent.

Fire Mode Functional Description

A detailed description explaining the sequence of events that the system is required to operate in, during a fire alarm. It must include a cause and effect matrix, architectural plans and sections showing fire/smoke compartmentalisation.

Building Management System
Includes functional description, control logic diagrams, I/O schedules, alarming detail, graphic page detail where required etc.

Manufacturers' Literature
Includes manufacturers' product manuals and the like that contains the specification detail relevant to ALL plant, equipment and instruments installed on the project.

Maintenance
Maintenance schedules relating to installed equipment/systems as recommended by the manufacturer.

Commissioning Data
Contains all 'as installed' performance data relating to the project such as chilled and heating water flow rates, air balancing figures, pump and fan curve data, certificates, and plant registration data etc.

As-constructed Drawings
A1 printed capable copies of all drawings taken from project AutoCAD files representing 'as installed' mechanical services, mechanical electrical wiring diagrams and electrical schematic drawings incorporating control system interface.

Include the building management control system (BMS) documentation, which shall be incorporated into the operations and maintenance manual. A separate control manual will result only where a project is solely a controls-based project and upgrading an existing building operations and maintenance manual is not practical. A separate controls manual will only be approved by the project consultant and once Curtin's Infrastructure Manager Mechanical Services has been consulted.

3.5 PIPED PRESSURE SERVICES

3.5.1 INERT GASES

While gas services are typically delivered by the mechanical consultant, this will be undertaken in close consultation with and direction from the project dangerous goods and hazardous substances consultant. Refer to the Guidelines and associated Reference documents in the Hazardous Substances and Dangerous Goods section of the University's online Project Delivery Guidelines portal.

3.5.2 COMPRESSED AIR

Compressed air shall be supplied from air compressors within the building. Compressors shall be oil-free, of Atlas Copco, CompAir, BOGE manufacture (or other approved equal), liquid ring or screw to suit University service requirements.

They shall be mounted, together with their motor, on an integral steel base and shall be effectively isolated from the structure. Tank-mounted compressors are also acceptable.

The compressor shall be effectively silenced. Air cleaners shall be substantially mounted. Unless otherwise called for, compressed air shall be supplied at 200 kPa at the bench outlet (confirm requirements with the client department).

Compressed air system shall be provided with high level interface to monitor the system and report alarms to the BMS system.

Pipework shall be copper or stainless steel and shall be silver soldered or joined using press fittings and shall grade to automatic drains with collection tundishes. Isolation valves shall be of the diaphragm, quarter-turn ball, globe or needle-type and they shall be a standard product freely available in the marketplace.

An aftercooler or refrigeration type dryer shall be used with all compressed air systems

An air receiver shall be provided to limit the number of starts per hour of the compressors. The receiver shall be provided with all necessary gauges, safety valves, pressure stats and automatic drains for automatic operation. The compressed air system shall be complete with mains-to-system air regulators. At the base of all risers and low points in the distribution system water traps shall be fitted having automatic discharges similar to Spirax, Norgen or SMC and complete with collection tundishes.

The complete installation is to comply with relevant Australian standards.

3.5.3 VACUUM

Vacuum shall be supplied by means of vacuum pumps within the building. Vacuum pumps shall be BUSCH or equivalent manufacture, water ring pumps capable of passing fluids from the system without damage to the pump, fitted with bacteria filters where appropriate. Vacuum pressure shall be specified based on the application and the requirement of the user group.

Vacuum pumps shall be mounted, together with their motor, on an integral steel base mounted on an inertia base equal to 1.5 times the weight of the vacuum pump and its ancillaries and shall be effectively isolated from the structure. Water seals with safety interlocks shall be provided to each pump.

Pipework shall be solvent joint Class 18 PVC pressure pipe or Type B copper depending on the service. Plugged tees shall be used in place of bends to allow for cleaning of piping, however at the base of all droppers and at the low points in graded horizontal pipework glass removable catch pots with full pipe diameter inlet valves shall be fitted. Isolating valves shall be of the diaphragm or quarter-turn ball type.

A vacuum tank shall be provided to limit the number of starts per hour of the vacuum pump(s). The tank shall be provided with all necessary gauges, safety valves, pressure stats for automatic operation.

Vacuum system shall be provided with high level interface to monitor the system

All pipework is to grade to liquid collection catch pots.

The complete installation is to comply with relevant Australian standards.

3.5.4 IDENTIFICATION OF PIPEWORK

All pipework shall be identified with their names and colour codes as listed.

The ground colour shall be applied over the full length of the pipeline or over a length of pipeline of not less than 450 mm where adhesive labels are used. The location of identification marking shall be at intervals of not more than 3 metres (not less than 1 per floor in vertical pipework) and preferably adjacent to branches, junctions, valves, walls and control points. Such markings shall be placed so that they are easily seen from all approaches.

Service labels, where applied, shall be over a length of not less than 200 mm at locations and intervals as specified for ground colours.

The direction of the flow shall be indicated by an arrow adjacent to each service label. An approved adhesive label shall be used for identification and indication of the direction of flow of pipework.

3.6 COLOUR CODING – PLANT AND EQUIPMENT

3.6.1 GENERAL

Where colours are not specified for particular items of plant, the University shall be consulted before colours are nominated. All pipework, valves and fittings in plant rooms, ducts and wherever exposed to view shall have the colours applied over their entirety. Pipework identification shall be achieved throughout by use of Safetyman pipe markers and labels to indicate contents and flow.

Colours are to be selected from:

- AS2700 – Colours for General Purposes
- AS1345 – The Identification of Piping Conduits and Ducts.

3.6.2 SUPPORTS

Ace Unistrut Mounting Brackets, MS Angle Supports and Hanger Rods are to be painted 'Black' where exposed.

3.7 ALARMS ATTENDANCE PRIORITISATION

The University has the following **Operational** alarm attendance prioritisation, being remote monitoring device(s) (RMD) SMS priority, and two BMS alarm priorities. Please also refer to BMS section 3.9.6.26 Alarms & Alarm Priority for more details for the BMS alarms.

3.7.1 ALARM PRIORITY 1 ATTENDANCE

The requirement for a remote monitoring device (RMD) is to be determined by the consultant via stakeholder consultation.

Where a stakeholder could be a specific faculty with the faculty responsible for maintenance of the RMD & attendance to alarms, ensure that the Mechanical Service Manager & Mechanical Infrastructure Manager are included as stakeholders for Inform/Involvement.

Where the stakeholder is PF&D with the responsibility for maintenance of the RMD & attendance to alarms, ensure that Mechanical Service Manager & Mechanical Infrastructure Manager are included as stakeholders for Involvement.

Therefore, depending on the requirements, the alarm(s) are issued to either:

- A responsible faculty member(s), where the faculty are responsible for attendance. Examples include but are not limited to the following:
    - High temperature alarm in a glasshouse.
    - Negative 80°C freezers, self-contained or a room.
    - etc.

  or

- Operations and maintenance, where O&M are responsible for attendance. For example, a high temperature alarm for the B408 thermal energy storage tank, comms room, in built freezers, HW feed and expansion tanks, etc.

In both cases the SMS is sent direct to a third-party provider who then sends an email to the nominated email addresses. Obtain the provider details from the University.

Refer to Section 3.8 for further information for remote monitoring device requirements.

3.7.2 ALARM PRIORITY 2 ATTENDANCE

Any system control or monitoring point BMS text alarm.

Refer to Section 3.9.6.26 for further details.

3.7.3 ALARM PRIORITY 3 ATTENDANCE

Any other BMS system control or monitoring point alarm.

Refer to Section 3.9.6.26 for further details.

3.8 REMOTE MONITORING DEVICE (RMD)

3.8.1 GENERAL REQUIREMENTS

RMD's shall include but not be limited to the following:

- Halytech Spider unit or approved equivalent.
- Internal UPS backup battery for power failure functionality.
- A controller complete with software and password protected.
- Onboard display.
- 8 universal inputs.
- 8 configurable alarms.
- 8 digital outputs.
- Connection to a 240V power supply.

- IP terminal connection point for IT cabling to connect to.
- Be compatible with 4G & 5G. Compatibility with 4G only may be considered by the University however it is not preferred.
- Capable of sending able, via SMS direct to a third-party provider who then sends an email to nominated email addresses.
- The system is to alarm and notify via SMS when monitored point(s) fault.
- The system is to alarm and notify via SMS where Spider unit main power is lost.
- The system is to alarm and notify via SMS once weekly to indicate healthy status.
- Permit two way communication to allow users, emails, and numbers to be changed via remote location.
- SIM card (to be supplied by the University).

3.8.2 LOCATING RMD'S

RMD's shall be in locations that have strong mobile reception. Telco mobile reception shall be validated with commissioning and where it is found to be unsuitable shall be relocated including associated service connections, at no cost to the University.

Examples of installations that are not suitable include; basements, faraday cage, and areas with high electromagnetic interference.

3.8.3 COMMISSIONING

Commissioning of the RMD is to include bit not necessarily limited to:

- Connected sensors are accurate and calibrated to suit.
- The issuance of the messages and alarms for each communication mechanism (SMS, IP, etc) and validate that the message or alarm is received by the intended recipient(s).

3.8.4 RECORDS

Provide as constructed records for the RMD installation per S3.4.29, Appendix 3 and the following:

- Screen shots of the programming.
- Unique Username and password.

3.9 BUILDING MANAGEMENT CONTROLS (BMS)

3.9.1 GENERAL

Building Management System (BMS) direct digital control system shall be fully 'native' BACnet-compliant and shall be structured to provide seamless communication and access via Curtin University's existing WAN across the existing Schneider Electric StruxureWare or Johnson Metasys LANs.

The new control system shall be Microsoft Windows-based and be compatible with the current version used by Curtin University. The control program software and associated graphics shall be loaded onto Curtin BMS servers and workstations as required and as determined for each project by Curtin University. All user program licences and rights shall be provided.

Provide an Ethernet TCP/IP and/or BACnet IP communication network via the WAN between controllers and all communications cabling and repeaters as necessary for the installation specified and to maintain the integrity of the existing BMS LANs.

Controllers for the connection of field inputs shall be field-mounted, in new control panels or in existing control panels if suitable, generally adjacent to the existing mechanical services switchboards. Provide new power supply to the controllers with dedicated circuit-breaker and controls transformer per control panel, to suit the installation. Controllers shall be fully BACnet compliant and shall have standalone capabilities capable of continuing on last set of instructions should the communications trunk be cut. Controllers shall incorporate battery backup for 72 hours without loss of program or trend data. On restoration of power, the controllers shall be sequentially restored automatically and provide any automatic downloading of information by way of duplex communication between the controller and the operator's terminal. The controls contractor shall allow spare capacity and flexibility of the control system by providing an additional 20 percentage points for each analogue and digital input and output over and above all utilised control points together with additional memory capacity to suit. Each installation shall cater for a minimum 20 per cent spare capacity on conclusion of the installation.

Each group of controllers shall be provided a 240-Volt power supply from the adjacent switchboard and shall incorporate an isolating transformer, filters and under voltage/over voltage protection to prevent equipment failure due to power supply disturbances. Provide lightning protection of the communications cables where copper LAN cable is run between buildings.

Provide point controller manual overrides for the manual operation of chillers, cooling towers, condenser fans, cooling towers, pumps, air conditioning units, ventilation fans and the like.

All communication cabling shall be a minimum of 0.8 mm^2 multi core twisted and shielded cabling to eliminate interference

Provide all interface cabling and conduits from controllers to terminal devices, between controllers and from controllers to terminals in the mechanical services switchboards, all in accordance with AS3000.

The DDC software shall be specifically designed for the HVAC control functions as specified and operate in a Microsoft Windows environment. The software shall include:

- communications software
- software control logic as specified
- time and event functions
- multi-level password access
- alarm display
- automatic dial out on recipe of high priority alarms to any or all of six telephone numbers in rotation
- colour graphics package and edit tool for presentation of plant mimic diagrams with dynamic display of parameters
- trend logging
- graphic display of logged data via bar charts, graphs, etc.
- full mathematics functions.

Provide graphics pages to represent the installation, control and monitoring of the mechanical services plant, which shall include 3D-type graphics representing the air conditioning and mechanical ventilation plant and live schematic DDC logic diagrams to represent the installation. The graphics shall identify alarm points and manual override points. The graphics shall be ‘drill down’ from a state map, campus plan, building plan/levels, air handling unit, etc. to the approval of Curtin University, prior to installation.

Graphics for air handling equipment shall identify the operating mode (occupied, unoccupied) of the plant and also identify the last time economy cycle, warm up, night purge or air quality control routines were last utilised.

BMS graphics shall include the final values from the commissioning reports on all equipment. This may include minimum and maximum air flow rates, supply air setpoints, return air flow rate setpoints, and water flow rates for CHW and HTGW coils.

Always provide a functional description and points schedule to Curtin University for approval prior to installation.

Always provide control valve selections to Curtin University for approval prior to installation. Control valves for chilled and heating hot water coils shall be equal percentage type and selected to provide sufficient authority over the coils. Actuators shall consider the maximum closing of pressure. Provide an access button on the BMS graphics to access the latest as constructed function description, point list and system topology.

Identify the location of all TO connections required to interface with the University’s Ethernet system prior to commencing works on site.

Always provide training to Curtin University staff to familiarise staff to the new mechanical services plant and its controls system.

Always provide 12 months free labour and warranty on all new equipment.

Tune the control system and modify control routines to provide efficient and effective operation of the mechanical services plant to the approval of Curtin University.

All works associated with the Campuses shall be completed to the approval of nominated mechanical services consultant and Curtin University.

3.9.2 RESPONSIBILITY TO MAINTAIN RECORDS

The responsibility to maintain BMS records shall be with the two incumbent BMS companies, as appropriate. The records that are required to be maintained and updated for new and existing buildings include but are not limited to:

- Master building functional description.
- Master building Input / Output schedules.
- Site and building topologies.
- Master spreadsheet of all points and their type and function.

For minor works within existing buildings the BMS company must supply abridged information that is clearly highlighted as amendments, for reviews and comments to the Contractor and Consultant.

3.9.3 CONTROL PANELS, BOARDS & SWITCHBOARDS

Switchboards, panels and the like for mechanical services power, control & BMS must not be located outside. All boards are to be located internally and in an appropriately secured location. Locating a switchboard or panel outdoors must be an absolute last resort. In the event a switchboard or panel is located outside all components associated with the board and inside them shall be ruggedised (Electrical, Controls & BMS).

3.9.4 CONTROL SYSTEM DESIGN

The consultant shall, in consultation with Curtin and a BMS vendor, determine an appropriate BMS hardware topology design that addresses:

- the critical nature of the systems being controlled or monitored
- redundancy requirements addressing power failure, controller failure and IT or communications failure
- prevention of systems cascade failure issues relating to multiple mechanical system points residing on the same controller(s)
- segregation of building floors or large floor plate spaces
- spare space provisions.

Topology designs shall not be left to the BMS contractor to determine during construction, as it is too late and potentially costly to address the above issues at that point of the project.

3.9.5 CONTROL DEVICES

3.9.5.1 General

Typically, air handling plant shall use the following control and monitoring points, which shall be presented on their associated graphics page:

- start/stop
- fault (via differential pressure switch)
- supply air temperature
- supply air temperature set point (depending on type of air conditioning plant)
- space temperature
- space temperature set point
- return air temperature
- outside air temperature (global)
- outside air humidity (global, if specified)
- Outside air flow rate via velocity sensors
- occupied/unoccupied mode and time left to run
- economy enable/disable
- date/time economy was last enabled
- night purge enable/disable mode
- optimum start/stop
- date/time night purge was last enabled
- warm-up mode enable/disable
- date/time warm-up was last enabled
- air quality control enable/disable
- date/time air quality control was last enabled
- date/time stamp to be printable for each page
- DX fault (via interface card)
- safety tray moisture alarm (comms and AV room CHW FCU and/or DX FCU)
- filter differential pressure (SP: 50–125 Pa depending on filter type).

3.9.5.2 Occupied/Unoccupied Switches

Occupied/unoccupied switches shall use a rocker- style toggle switch with spring return (not depression type) and shall incorporate a green neon indicator light that provides the occupant with an indication of air conditioning status and that the zone is active.

The occupied/unoccupied switches shall be engraved to identify:

- 'Air Conditioning'
- VAV or fan coil unit served
- room number(s) that the switch serves.

3.9.5.3 Control Valves

Control valves for chilled water and heating water services to air conditioning units shall be Belimo Characterised Control Valves or approved equivalent to provide equal percentage flow to percentage open valve position. PICCV valves may be considered for new buildings. The valves shall be selected that the valve KV value is less than the calculated KV value. For optimum selection, valves shall be selected between 20-80% at maximum water flow and not below than 20% at minimum water flow

Where the design pressure drop of existing water coils is unknown, the control valves shall be sized to meet the following criteria:

The following criteria shall be used only in the absence of the data regarding and coils and the lack of information to provide a full hydraulic analysis of the system.

- for chilled water valves, to achieve a pressure drop at full design flow between 10 kPa and 30 kPa
- for heating water valves, to achieve a pressure drop at full design flow between 25 kPa and 60 kPa
- for chilled water and heating water valves, the valves to typically be one size smaller in diameter than the pipework line size.
- Valve authority shall be between 0.5 and 1 and not by any means less than 0.25

3.9.5.4 Balancing Valves

Balancing valves shall be selected to account for the balance pressure and shall be selected according to the manufacturer's recommended range. Most manufacturers recommend sizing the balancing valves at 6 kPa when fully open. Balancing valves shall be TA (IM Hydronic) valves. Balancing valves on very low flow heating water coils, like those on VAV boxes, may need to be one or two pipe sizes smaller to facilitate water balancing that is more closely aligned with the design values.

3.9.6 CONTROL LOGIC

The objective of control strategy outlined in this document is to set a minimum standard with consistency in programming for typical type HVAC systems in use across Curtin campuses. There may be instances where there is a need to move away from these control standards. Examples of such instances could be related to specific requirements of laboratories, process control cooling systems or where specific temperature/relative humidity control is required. In such circumstances, the control logic needs to be developed in association with the project mechanical engineering consultant and Curtin's Infrastructure Manager Mechanical Services.

3.9.6.1 Time Schedules

Time schedules shall be provided for each item of air conditioning plant regardless of the item of equipment actually utilising the time schedule, unless the equipment was ever to be manual operation based.

Curtin University core hours of operation are from 8:00am to 5:30pm Monday to Friday, except public holidays and University holidays. The core hours shall be used in most instances unless the operation of the mechanical services plant warrants an alternative time schedule to suit (e.g. Library.)

The time schedules shall be user friendly and allow full access to users to vary public holidays and University holidays and non-working days. Stage the scheduled start times to avoid all the plant being enabled at the same time. The activation of the occupied/unoccupied switches shall override the associated time schedule.

The comms room duty/stand-by arrangement uses the following peak/off-peak hours of the University for change-over operation:

- Peak 8.00am – 10.00pm weekdays
- Off-Peak 10.00pm – 8.00am weekdays and 24 hrs weekends

During peak hours, the duty unit shall be the CHW FCU.

During off-peak hours the duty unit shall be the DX system.

Where there is a duty unit only, the equipment shall run 24/7.

The duty unit shall swap at either the designated time or on mismatch alarms (as indicated above) after time delay.

3.9.6.2 Occupied/Unoccupied Mode

When enabled via the time schedule, the air conditioning plant shall operate in the unoccupied mode until the occupied/unoccupied switch for that air conditioning plant is activated, upon which the air conditioning plant shall operate in the occupied mode.

For a single zone air conditioning unit, if the occupied/unoccupied switch was activated during core hours, then the air conditioning plant shall operate in the occupied mode for a period of four hours.

For a single zone air conditioning unit, if the occupied/unoccupied switch was activated outside core hours, then the air conditioning plant shall be enabled in the occupied mode for a period of two hours.

For a multi-zone air conditioning unit, if the occupied/unoccupied switch was activated during core hours, then that zone shall operate in the occupied mode for a period of four hours, while the remaining zones shall operate in the unoccupied mode.

For a multi-zone air conditioning unit, if the occupied/unoccupied switch was activated outside core hours, then the air conditioning unit would be enabled and that zone shall operate in the occupied mode for a period of two hours, while the remaining zones shall operate in the unoccupied mode.

For variable air volume (VAV)-type air conditioning, if the occupied/unoccupied switch was activated during core hours, then that VAV shall operate in the occupied mode for a period of four hours, while the remaining VAV boxes shall operate in the unoccupied mode.

For VAV-type air conditioning, if the occupied/unoccupied switch was activated outside core hours, then the air conditioning plant shall be enabled and that VAV box shall operate in the occupied mode for a period of two hours, while the remaining zones shall operate in the unoccupied mode.

If the occupied/unoccupied switch was activated outside core hours and the air conditioning unit was operating in warm-up mode or night purge mode, these modes shall be cancelled.

The afterhours switch control logic shall be set up where the toggle switch has to be depressed for a period of no longer than three seconds to enable occupied mode. A further 30 seconds shall elapse before the toggle switch can be re-depressed for a period of no longer than three seconds to enable unoccupied mode in core hours or to turn the AHU/FCU off in an out-of-hours condition.

3.9.6.3 Standby Mode

Standby mode shall be a nominated timeframe before the start of core hours and is used to enable either night purge or warm-up cycle control routines for the nominated air conditioning plant able to utilise these control routines.

Depending on the thermal mass of the building, the standby mode nominal time frame shall be set at one hour for both night purge or warm-up cycle control, however if the building had a high thermal mass, the time frame for warm-up cycle may need to be extended, which would warrant a separate standby mode time schedule for each control routine.

3.9.6.4 Space Temperature Set Point

For space temperature requirements for comms and AV rooms see the space temperature control section under Section 3.2.16.

The space temperature set point control shall utilise three parameters to determine set point, these being ambient temperature, heat/cool mode and occupied/unoccupied mode, as illustrated in the table below.

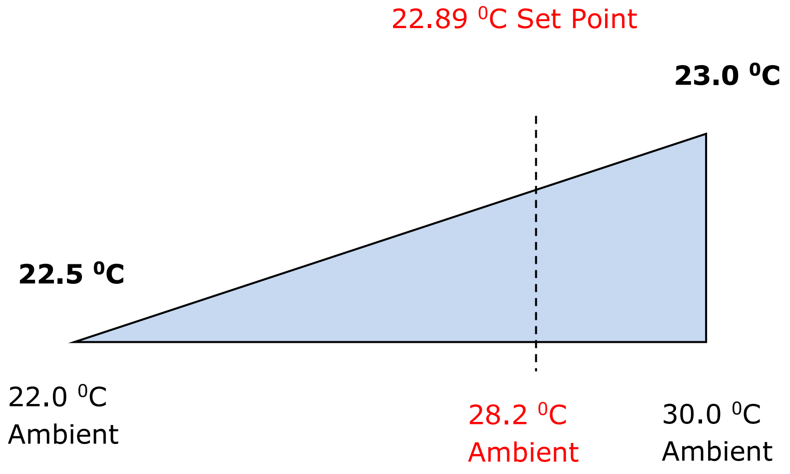
Mode	***Occupied***	***Unoccupied***
Cool Mode	22.5–23.0 °C	25.0 °C
Heat Mode	22.0 °C	20.0 °C

In the occupied mode, the control system shall control to achieve set point. In the unoccupied mode, no heating or cooling would be provided between the Unoccupied Cool Mode set point and the Unoccupied Heat Mode set point.

For example, if in the unoccupied mode, if the space temperature were less than 22.0 ^{0}C but greater than 20.0 ^{0}C then the space temperature control set point would be 20.0 ^{0}C, but no heating would be provided. If the space temperature increased above 23 ^{0}C but less than 25.0 ^{0}C then the space temperature control set point would be 25.0 ^{0}C, but no cooling would be provided. If the space temperature increased above 25.0 ^{0}C (or below 20.0 ^{0}C), then the control system would operate using PID control to provide cooling to maintain the cooling set point of 25.0 ^{0}C (or heating set point of 20.0 ^{0}C).

3.9.6.5 Space Temperature Cooling Set Point Rescheduling Control

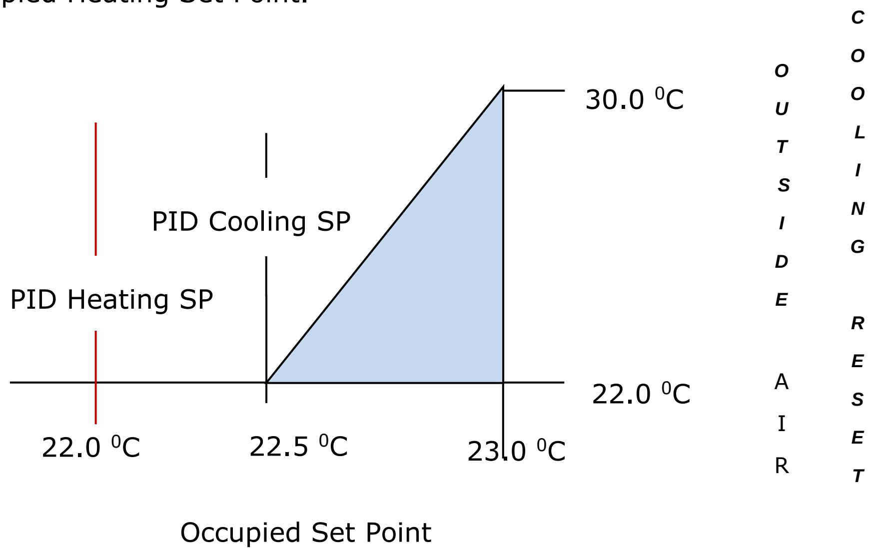
Space temperature set point shall be allowed to reschedule the occupied cooling mode set point such that the set point will vary on a sliding scale from 22.5 ^{0}C at an ambient temperature of 22.0 ^{0}C to a set point of 23.0 ^{0}C at 30.0 ^{0}C.



3.9.6.6 Space Temperature Control – Constant Volume Single Zone Chilled and Heating Water Systems

When operating in the Occupied Mode and the system is in Cool Mode (see 3.5.3.4), modulate the chilled water valve using Proportional Integral Derivative (PID) control to maintain the Occupied Cooling Set Point. Note that the PID loop will control to the specific set point as it re-schedules off outside air.

When operating in the Occupied Mode and the system is in Heat Mode (see 3.5.3.4), modulate the heating water valve using Proportional Integral Derivative (PID) control to maintain the Occupied Heating Set Point.

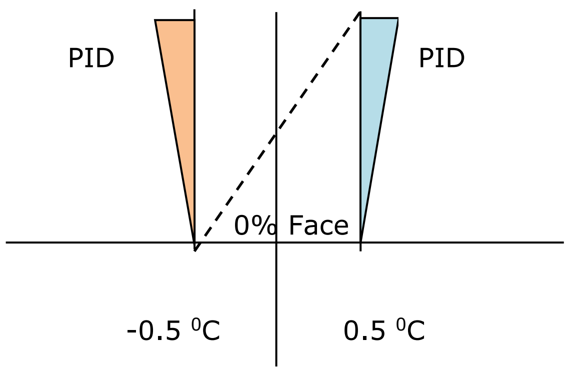


3.9.6.7 *Space Temperature Control – Constant Volume Multi Zone Face and Bypass Hot Deck/Cold Deck Chilled and Heating Water Systems*

When in the occupied mode, provide face/bypass damper control for each zone to modulate its face/bypass damper using PID to maintain the set point.

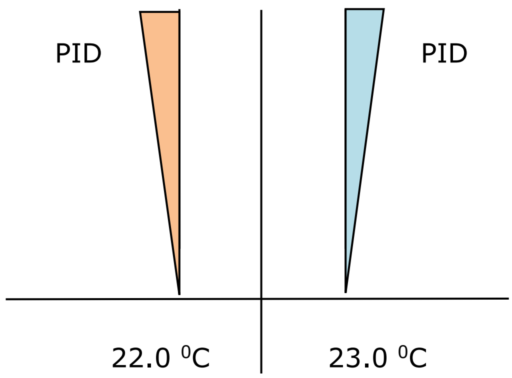
In <u>Cool Mode,</u> the chilled water valve for the air handling unit shall modulate based on the greatest positive deviation from set point of any zone. The chilled water valve shall modulate using PID control to maintain space temperature equal to SP + 0.5 ^{0}C.

In <u>Heat Mode</u> the heating water valve for the air handling unit shall modulate based on the greatest negative deviation from set point of any zone. The heating water valve shall modulate using PID control to maintain space temperature equal to SP - 0.5 ^{0}C.



3.9.6.8 *Space Temperature Control – Constant Volume Single Zone Single-stage DX Systems*

When in the occupied mode, provide a 0.5 ^{0}C dead band either side of set point and then use PID either side of the dead band for enabling heat or cooling. Disable at set point.



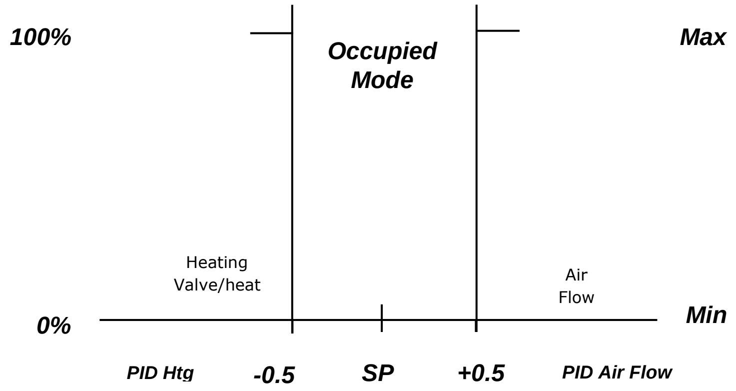
3.9.6.9 Space Temperature Control – Constant Volume Single Zone Two-stage DX Systems

When in the occupied mode, provide a 0.5 ^{0}C dead band either side of set point and PID control either side of the dead band for sequentially enabling the two stages of heat or cooling as indicated for the Single Stage DX System above.

3.9.6.10 Space Temperature Control – Variable Air Volume System

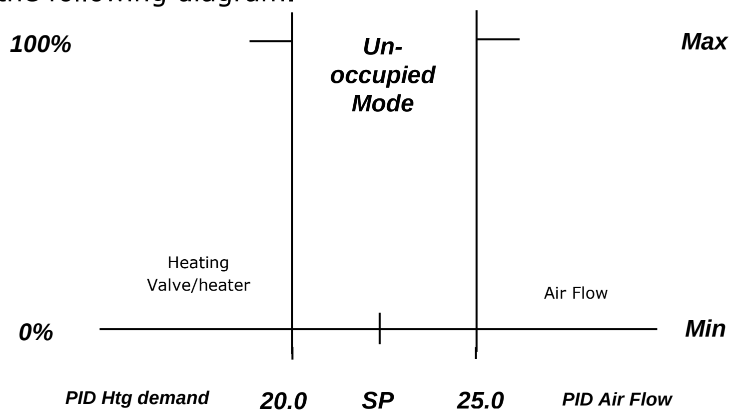
When in the occupied mode, each VAV box shall modulate the supply air flow rate from minimum design airflow to maximum design airflow to maintain space temperature set point using PID control as per the diagrams below.

VAV boxes with heating water coils shall modulate their heating water valve using PID control such that the valve modulates to maintain the space temperature set point as per the diagrams below. VAV boxes with electric heaters shall regulate the heaters using Pulse Width Modulation (PWD) to maintain space temperature set point as per the diagrams below. Air handling units containing electric heaters shall use an electric heater isolation contactor located in the MSSB that electrically isolates the power supply to the heaters when the air handling unit air flow status is off.



Occupied VAV Space Temperature Control

When in unoccupied mode the VAV box damper and heating valve/electric heater will modulate in sequence to maintain the required space temperature set point as indicated in the following diagram.

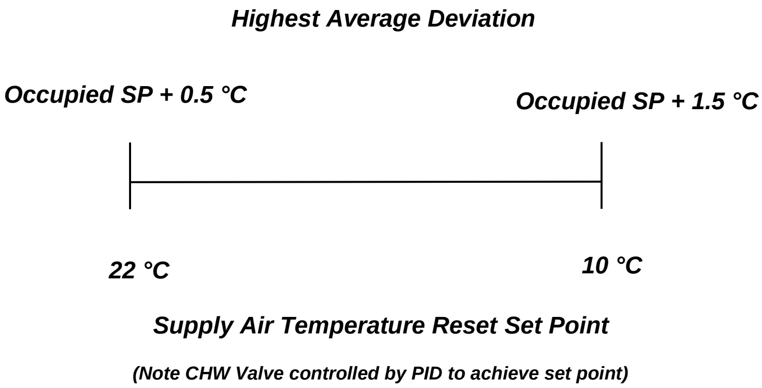


Unoccupied VAV Space Temperature Control

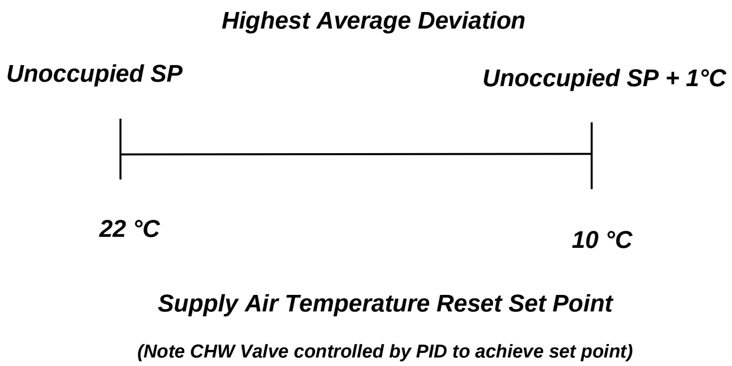
3.9.6.11 *Leaving Air Temperature Reset Control – VAV AHU's*

Temperature control is disabled if no fan status has been established or if the supply air temperature sensor is in fault.

Variable air volume air handling units operating in cooling mode shall use leaving air temperature reset control incorporating chilled water valve control via its own PID loop to achieve supply air set point. Supply air temperature reset is determined using the highest average deviation from set point across all VAV boxes operating in the occupied mode. (Highest average is the average of the sum of all the deviations from set point added to the highest deviation from set point, which is then averaged again. This limits the effect of any rogue VAV boxes. If no VAV boxes are in the occupied mode, then leaving air temperature reset control shall be based on the highest average deviation from set point across all VAV boxes operating in the unoccupied mode. Cooling mode leaving air temperature set point shall reset proportionally to a nominal 10.0 ^{0}C, subject to the coils design leaving dry bulb temperature as illustrated in the following diagrams.



Occupied VAV Leaving Air Temperature Reset



Unoccupied VAV Leaving Air Temperature Reset

3.9.6.12 Minimum Outside Air Damper Control

Where the air conditioning unit incorporates an economy cycle, the economy outside air damper shall be separately controlled from the economy return air damper and the economy relief air damper such that when the economy mode is disabled, the economy return air damper and the economy relief air damper close fully while the outside air damper shall close to the minimum outside air set point position. The minimum outside air set point position shall be determined by commissioning the minimum outside airflow rate as part of the project scope of works. When operating in economy cycle (or night purge), the outside air damper shall modulate from minimum outside air set point position to 100 per cent open as specified under Economy Cycle Control. When in warm-up mode, the outside air damper shall modulate to the fully closed position. The graphics shall display the outside air damper at its minimum outside air position as being at 0 per cent open.

3.9.6.13 Economy Cycle Control – CAV Single Zone Systems

Enable the economy cycle if the space temperature is above space temperature set point and the outside air temperature is less than return air temperature by 0.5 ^{0}C for 600 seconds (adjustable). If the control system can report the enthalpy, then economy cycle shall employ enthalpy comparison between OA and indoor air enthalpy and shall activate the economy cycle if enthalpy of the outdoor is less than the enthalpy of return air by (10 kJ/kg.) for a period of 600 seconds. Modulate the economy dampers from 0 per cent open at SP and the damper opens as determined by the PID loop when space temperature is greater than SP. Disable the economy cycle if any of the above parameters are not achieved.

The economy cycle shall operate as the first stage of cooling, with the chilled water valve operating as the second stage of cooling.

3.9.6.14 Economy Cycle Control – CAV Multi Zone Hot/Cold Deck Systems

Enable the economy cycle if any zone space temperature is above set point and the outside air temperature is less than the return air temperature by 0.5 ^{0}C for 600 seconds (adjustable). Modulate the economy dampers using the greatest positive deviation from set point of any zone from 0 per cent open at SP and the damper opens as determined by the PID loop when space temperature is greater than SP. Disable the economy cycle if any of the above parameters are not achieved

The economy cycle shall operate as the first stage of cooling, with the chilled water valve operating as the second stage of cooling.

3.9.6.15 Enthalpy Control

Where enthalpy control has been provided/specified, it shall be applied to the economy and night purge control routines.

If enthalpy (determined by dry bulb temperature and humidity sensor) is located in the return air and another enthalpy sensor has been provided for outside air, the <u>additional</u> parameter for enabling the economy and night purge shall be that the outside air enthalpy shall be less than the return air enthalpy for more than 600 seconds. If this parameter is not achieved, then the economy/night purge cycle shall be disabled.

If only an outside air enthalpy sensor is specified, then the additional parameter for enabling the economy and night purge shall be that the outside air enthalpy shall be less than 48 kJ/kg for more than 600 seconds. If this parameter is not achieved, then the economy/night purge cycle/air quality control routines shall be disabled.

3.9.6.16 CO_2 Air Quality Control & O_2 Depletion

If CO_2 monitoring for air quality control has been specified, then on air quality exceeding 500 (adjustable) part per million (ppm) and the air conditioning system is not in warm-up mode or night purge mode, the economy dampers shall open on a proportional scale between 800 ppm and 900 ppm (adjustable), until the chilled water or heating water valves are open 100 per cent whereupon the economy damper operating in air quality control shall modulate to maintain space temperature or leaving air temperature set point.

When designing the air conditioning plant intending to utilise air quality control, the consultant shall ensure that sufficient heating/cooling capacities are incorporated into the design and specification to allow for lower and higher 'air on coil' conditions due to increased proportions of outside air being introduced under this control routine.

If O_2 monitoring for air depletion alarming has been specified, then it shall include:

- Audible and visual alarms inside and outside the room being monitored.
- O_2 monitoring and alarm by BMS.
- Consider interface to notify Curtin Safer Community Team.

3.9.6.17 Duct Static Pressure Reset

Duct static pressure reset (DSPR) is an energy-saving strategy typically applied to variable air volume (VAV) air distribution systems controlled by direct digital control (DDC) or BMS. The objective for this strategy is to minimise the energy consumption of supply air (S/A) fans in air handling units (AHUs) and AC systems. The DSPR strategy uses variable speed drives (VSDs) to control S/A fans in AHUs to dynamically reset the duct static pressure set point when demand for S/A reduces at the VAV terminals during part-load conditions. This has the benefit of reducing AHU fan energy consumption.

The DSPR optimisation monitors the positions of volume control dampers of VAV boxes and adjusts the AHU fan speed (hence duct static pressure) to ensure that at least one VAV box (the most open VAV box) is kept nearly fully open (90–95 per cent) at any time. This strategy minimises duct static pressure by resetting its set point at regular time intervals, reducing the energy consumption of the associated AHUs (S/A fan). To prevent a faulty VAV box affecting the pressure optimisation, it is essential to obtain the DSPR feedback signal from a representative VAV box.

The controls logic for DSPR may be based either on a proportional integral derivative (PID) control loop or an incremental loop with feedback.

With constant air volume (CAV) systems (AHUs or AC units), DSPR can be achieved simply by varying the pressure in relation to the deviation of space temperature from the set point. Care should be taken with direct expansion (DX) systems, as they are sensitive to air flow reduction, resulting in possible freezing of coils if air flows are reduced excessively (due to reduced heat transfer between air and refrigerant in the cooling coils).

3.9.6.18 Optimum start and optimum shutdown

This strategy involves the optimisation of the HVAC system's start and stop times. Automated starting and stopping of HVAC equipment reduces system operating hours, maintenance costs, energy costs and greenhouse gas (GHG) emissions while maintaining occupant comfort levels.

An optimum start/stop (OSS) energy-saving control strategy/function uses the BMS or HVAC controller to determine:

- the shortest period of time required to bring each zone from current temperature when systems are off, to the set point temperature.
- how early heating and cooling can be shut off for each zone so that the indoor temperature remains within specified margins (albeit drifting).

3.9.6.19 Night Purge Cool-down Cycle (where economy cycle provided)

Enable night purge cycle if the average space temperature is greater than Cool Mode Occupied SP + 1.0 ^{0}C and the ambient temperature is less than Cool Mode Occupied SP – 2.0 ^{0}C and the time of day is less than one hour before core hour start time (Standby Mode).

When night purge is enabled, open the economy cycle dampers 100 per cent and run the supply air fan until the average space temperature achieves set point whereupon the air handling unit shall continue to operate and the economy dampers shall modulate as described for economy cycle control.

For VAV systems operating in night purge mode, the VAV boxes shall open to 100 per cent of design airflow until the associated space temperature achieves set point whereupon the VAV box shall modulate to maintain space temperature set point without the use of trim heating.

The night purge cycle shall be terminated at the commencement of core hours while the supply air fan shall continue to run and normal temperature control shall be enabled. The heating water and chilled water valves shall be held closed during night purge operation. If the occupied mode is enabled, then night purge cycle shall be terminated.

3.9.6.20 Warm-up Cycle

Enable the warm-up cycle if the average space temperature is less than Heat Mode Unoccupied SP – 2.0 ^{0}C and the time of day less than 1.5 hours before core hour start time (adjustable subject to the size of the heating water system and delay of enabling the heating water boiler) and ambient temperature is less than 16.0 ^{0}C (adjustable).

When warm-up is enabled, disable the economy cycle, fully close the minimum outside air damper, enable the supply air fan and open the heating water valve 100 per cent until Occupied mode space temperature set point is achieved or start of core hours, whereupon revert to normal operation. The chilled water valve shall be held closed during warm-up mode.

If the air conditioning system incorporates a motorised minimum outside air damper, then close the minimum outside air damper when the warm-up cycle is enabled.

If the variable volume air handling unit has a heating coil installed as part of the unit, then only this heating coil shall be used when operating in warm-up mode and the leaving air temperature set point shall be set at a nominal 32.0 ^{0}C, adjustable subject to building inertia and thermal mass. Where the variable volume system has heating coils at the VAV boxes, then these coils' heating water valves shall be used only where the AHU does not have a primary heating coil.

For VAV boxes operating in warm-up mode, the VAV boxes shall open to 100 per cent of design airflow and the heating water valves shall open to 100 per cent until the associated space temperature achieves set point whereupon the VAV box shall modulate its airflow and heating water valve normally to maintain space temperature set point minimizing the use of trim heating or cooling.

When operating in warm-up mode, the supply air temperature delivered into the space shall be between 28.0 ^{0}C and 32.0 ^{0}C. If the air handling unit base heating coil does not have sufficient heating capacity at 100 per cent design airflow, it may become necessary to control the VAV boxes towards a pre-set warm-up minimum airflow and/or possibly use any trim heating available (taking into account the impact on the site heating water system DP), however this is not preferred.

Disable the warm-up cycle when the time of day is greater than core hours start time less 15 minutes. Maintain supply air fan operation (and return air fan if applicable) with both the chilled water and heating water valves closed until the commencement of core hours. If prior to warm-up cycle commencing, the occupied mode is enabled, warm-up cycle shall not start. If during warm-up cycle, the occupied mode is enabled, then the warm-up cycle shall be terminated.

3.9.6.21 Cooling Call

A cooling call shall be generated if any chilled water valve is open more than a set percentage, typically 70 per cent, and shall be disabled when all chilled water valves are typically less than 20 per cent open, but these percentages may change depend on the type of air conditioning plant being controlled and system response.

3.9.6.22 Heating Call

A heating call shall be generated if any heating water valve is open more than a set percentage, typically 70 per cent, and shall be disabled when all heating water valves are typically less than 20 per cent open, but these percentages may change depend on the type of air conditioning plant being controlled and system response.

3.9.6.23 Duty/Standby Toilet Exhaust

The toilet exhaust shall be enabled via a time schedule or when the associated air conditioning unit is enabled. The toilet exhaust shall be disabled one hour after the associated air conditioning unit has been disabled.

In a mismatch alarm between the airflow differential pressure switch and the lead exhaust fan, the lead exhaust fan shall be disabled, an alarm fault generated and the lag exhaust fan shall be enabled.

The lead/lag of the duty standby exhaust fans shall change weekly on a Wednesday at 10.00 am unless there was a fault from the lag exhaust fan.

3.9.6.24 Multi Services Interfaces

The consultant must determine the BMS requirements for multiple building services or related services interfaces and monitoring requirements for:

- Hydraulic (Gas, Water, Waste, etc)
- Electrical including but not limited to:
    - Interfaces with DALI lighting controls.
    - Mechanical interfaces with DALI movement sensors.
- Fire - Wet systems
- Fire - Dry systems
- Lifts
- Other as determined necessary on a project by project basis.

Ensure that the respective Service Managers & Infrastructure Managers are included in stakeholder consultations.

Interfaces, alarms and monitoring to have their own dedicated graphics pages as needed, contained within the Building Page.

3.9.6.25 CHW & HW Building Pressure Differential Sensing

Any modification to, upgrade or replacement of a BMS shall include differential pressure (DP) devices at the entry/exist point of the chilled & heated water pipework within the building.

The DP devices are to be displayed on the graphics for the BMS that is installed.

The DP devices are to be integrated into the central energy plant programming for monitoring and control of the secondary chilled & heating water pumps. The integration is to ensure the following:

- DP can be added into or removed from having a controlling status via graphic button.

- Must consider the impact on the control of the secondary pumps for the variety of central energy plants staging and operation.
- The functional operation of the DP's are reviewed and agreed to by the Infrastructure Manager, Mechanical Services, prior to works commencing.

DP devices shall be to the following specification;

- 5 Port Manifold, Pressure Transmitters to be used for differential pressure applications.
- Pressure transmitters to be suitable for minimum 4 bar scaling or to suit higher pressures as needed.
- Pressure transmitters to be provided with 316 Stainless Steel manifolds.
- Transmitters shall provide 4-20mA output.
- Supplied with new power supplies mounted in the controls boards.
- Supplied with all the necessary cabling.
- Pressure lines to be provided with isolating ball valves at the CHW and arranged in an 'H' pattern that is additional to the manifold.
- Pressure gauge pipework connections into the chilled and heating water pipework shall only be positioned in the middle of the pipe where the pipe is horizontal (connections shall not be made on the top or bottom of the CHW & HW mains).
- Transmitters to be located in a suitable position for access to the screen.
- Label transmitters indicating CHW or HW.
- Remove and reinstate pipework insulation as necessary.
- Sensors / Gauges shall be of Rosemont model 3051 series, Yokagowa model EJA series, or approved equivalent.

3.9.6.26 Alarms, Alarm Priorities and Search, Sort & Filter

ALARMS

Provide mismatch alarms and critical alarms and transmit the alarm to the front end PCs of the Curtin Bentley Campus Operations and Maintenance Office and any other nominated PC, via the University's WAN.

Provide automatic dial out for the nominated critical alarms and transmit the alarm in text format to the mobile telephones, pagers and email as nominated by the Curtin Bentley Campus Operations and Maintenance Office.

ALARM PRIORITIES

The following alarm priorities shall be incorporated into new Buildings, Refurbishments and BMS installations. Existing buildings BMS systems shall only be updated to suit the relevant minor works being undertaken.

Priority 1 (Group 1) – Remote monitoring devices only – not to be used by the BMS.

Priority 2 (Group 2) – BMS text alarm with the following critical mechanical services.

- Any central chilled or heating water plant, including pumps, cooling towers etc.
- Thermal energy, Energy, Water and Waste meter fault of any kind.
- Chilled and Heating water feed and expansion tank systems.
- PC2 or PC3 facilities:
  - HVAC system failure, e.g., Mismatch alarm,
  - Air Compressors & Vacuum systems.
  - Lab reverse osmosis system(s).
  - Steam boiler.
- Critical buildings, facilities, and rooms temperature alarm including but not limited to:
  - Data centres.
  - Communications Rooms.
  - Audio visual rooms.
  - Critical buildings RH% alarm.
  - Cool rooms and Freezers.
  - Defined controlled environments.
- Critical Buildings Fire alarm (PC2 & PC3 buildings).
- Electrical Generator alarm.

Priority 3 onwards to be BMS Groups of alarms including but not limited to the following:

- Group 3 - Non-Critical Temperature alarms.
- Group 4 - Non-Critical RH% alarms.
- Group 5 - PC2 &PC3 room pressure alarms.
- Group 6 - General AC & EF mismatch alarms (Non PC2 & PC3).
- Group 7 - Rooms CO_2 & O_2 level alarms. (Critical area(s) go to RMD).

- Group 8 - Filter high DP alarms.
- Group 9 - Non-Critical Mechanical system failure, i.e., Compressors/Vacuum system(s) alarms.
- Group 10 - Data centres, Communications Rooms, Audio visual rooms hardware alarms.
- Group 11 - Non Critical Fire Alarms.
- Group 12 - Lift Alarms.
- Group 13 - Test alarms (Commissioning, DLP period alarms).
- Group 14 - Test alarms (Commissioning, DLP period alarms, for multiple buildings).
- Group 15 – Software alarms.
- Group 16 – Communications alarms.
- Group 17 – Spare.
- Group 18 – Spare.
- Group 19 – Spare.
- Group 20 – Spare.

ALARM SEARCH, SORT & FILTER FUNCTIONS

BMS software must have:

- A search function that dynamically generates a list of specific alarms that target the relevant search based on the user's criteria and the text that's most relevant to that contained in the alarm's descriptions.
- The search functionality must include dynamic sorting / filtering of delineated alarm data / headings.

The designer and/or BMS provider shall conduct stakeholder consultation to determine requirements.

3.9.7 BMS GRAPHICS

Graphics are a fundamental criterion for the use and application of the controls systems at Curtin University. This section of the design guidelines outlines the approach and standards that apply to the design and creation of BMS graphics. Any deviation from these guidelines requires the specific approval by Curtin's Manager Infrastructure Manager Mechanical Services.

The desired outcome of these guidelines is to provide a uniform method of addressing and formatting graphics pages to provide a system 'drill down' approach to navigating around the graphics. This will assist maintenance staff to interrogate the control system using the main graphics page, rather than using cumbersome index trees and the like.

Graphics will be 3D-type graphics pages that use ‘hot spots’ (hyperlinks) to navigate between pages to allow forward and reverse movement from one graphics page to another. Where index trees exist, they will be turned off by default so that they are not visible. The use of proprietary forward/back arrows on the graphics pages shall not form part of the system for accessing the various graphics pages. Graphics will include Campus Summary Pages, Building Home Pages and Building Summary Pages for each building, as specified further in this document. Where some graphics pages have been set up specifically for faculties, these will need to reflect the specific needs of the faculty without them being able to view/access the remainder of the campus.

The entry point to the BMS when logging on shall be at a map of Western Australia that is in sufficient detail to identify the Bentley (including Technology Park), Murray Street, Shenton Park and Kalgoorlie campuses and any other remote locations as specified. From the map of Western Australia, a click on the hot spot associated with a campus location will take the user to a campus map of that particular campus. The buildings on that map shall be identified by their building number. Those buildings that have the relevant BMS contained within shall have the building number bolded (highlighted and contain a hot spot) while those buildings without a BMS will not be bolded (highlighted). The campus maps shall be in sufficient detail to identify the building layout. The ‘building’ hot spot shall take the user to a Building Home Page. Each building shall use a photograph of that building as the background wallpaper, with the photo being submitted to Curtin’s Mechanical Engineering Services Department for approval prior to its use.

Uploading of the new graphics pages (and programs) onto the BMS server shall be conducted out of normal hours to minimise disruption of the operation and control of the various mechanical services systems and general user access.

3.9.8 DATA MANAGEMENT AND LOGGING STANDARDS

It is imperative that data management within Curtin University's building management systems is managed in a formalised structured manner with the objective of minimising the volume of data traffic over the various BMS virtual networks. This is vitally important in ensuring the smooth operation of the BMS with response times maintained and, above all else, no loss of data. To assist BMS providers in achieving these objectives the following table constitutes Curtin University's data logging standard and has been established in consultation with Curtin's BMS suppliers.

These standards are to be applied to all works undertaken on University facilities unless otherwise specified. Ad-hoc trends required for troubleshooting can deviate from these standards however they shall be removed from the system on resolution of issues.

System	Point Description	Frequency	Trend Type	Duration Held
	Non Critical Plant Points			
A/Cs/FCUs	Zone Air Temperature	15 Mins	Database	12 Months
	Supply Air Temperature	15 Mins	Database	3 Months
	Return Air Temperature	30 Mins	Controller	5 Days
	Outside Air Velocity	30 Mins	Controller	5 Days
	Supply Air Static Pressure	30 Mins	Controller	5 Days
	Carbon Dioxide ppm	30 Mins	Database	12 Months
	Set Points (General)	30 Mins	Database	3 Months
	Chilled Water Valve	30 Mins	Controller	5 Days
	Heating Water Valve	30 Mins	Controller	5 Days
	Economy Output	30 Mins	Controller	5 Days
	VSD Speed	30 Mins	Controller	5 Days
	Non Critical Plant Points			
VAVs	Zone Air Temperature	15 Mins	Database	3 Months
	Set Points (General)	15 Mins	Database	3 Months
	Critical/Research Area Plant Points			
A/Cs/FCUs	Zone Air Temperature	15 Mins	Database	12 Months
	Supply Air Temperature	15 Mins	Database	12 Months

System	Point Description	Frequency	Trend Type	Duration Held
	Return Air Temperature	15 Mins	Database	12 Months
	Outside Air Velocity	15 Mins	Database	12 Months
	Supply Air Static Pressure	15 Mins	Database	12 Months
	Carbon Dioxide ppm	15 Mins	Database	12 Months
	Set Points	15 Mins	Database	12 Months
	Chilled Water Valve	15 Mins	Database	12 Months
	Heating Water Valve	15 Mins	Database	12 Months
	Economy Output	15 Mins	Database	12 Months
	VSD Speed	15 Mins	Database	12 Months
	Critical/Research Area Plant Points			
VAVs	Zone Air Temperature	15 Mins	Database	12 Months
	Set Points (General)	15 Mins	Database	12 Months
Common	Ambient Temperature	30 Mins	Database	1 Year
	Ambient Humidity	30 Mins	Database	1 Year
Metering	Electrical Metering	5 Mins	Database	1 Year
	Gas Metering	5 Mins	Database	1 Year
	Water Metering	5 Mins	Database	1 Year
	Thermal Metering	5 Mins	Database	1 Year
Main Plant	Chiller Entering Temp	15 Mins	Database	12 Months
	Chiller Leaving Temp	15 Mins	Database	12 Months
	Chiller Differential Pressure	15 Mins	Database	12 Months
	Main CHW Flows	15 Mins	Database	12 Months
	Boiler Entering Temp	15 Mins	Database	12 Months
	Boiler Leaving Temp	15 Mins	Database	12 Months
	Boiler Differential Pressure	15 Mins	Database	12 Months
	Main HtgW Flows	15 Mins	Database	12 Months

System	Point Description	Frequency	Trend Type	Duration Held
	Thermal Tank Entering Temp	15 Mins	Database	12 Months
	Thermal Tank Leaving Temp	15 Mins	Database	12 Months
	Thermal Tank Flow	15 Mins	Database	12 Months
	Domestic HtgW Leaving Temp	15 Mins	Database	12 Months
	All of these types of points below are captured in the events database.			
AHU/FCUs	Fan Enable	Change Of State	Event Database	12 Months
	Fan Status	Change Of State	Event Database	12 Months
	Occupied/Unoccupied Mode	Change Of State	Event Database	12 Months
	Warm-up Mode	Change Of State	Event Database	12 Months
	Night Purge Mode	Change Of State	Event Database	12 Months
	Cooling Call	Change Of State	Event Database	12 Months
	Heating Call	Change Of State	Event Database	12 Months
	Ventilation Mode	Change Of State	Event Database	12 Months

The following outlines the graphical profiles and arrangements required of the graphics pages compiled for all Curtin University Campuses. The graphics pages shall be compiled in a drill-down arrangement from State map, Campus plan, building etc. down to devices such as fan coil units and variable air volume boxes. Navigation through the graphics pages shall be via the graphics pages themselves, by cursor clicking on an item within the graphics page, known as a 'hot spot,' to move forward or backward, rather than using the index tree. The Index Tree, should it be currently displayed, shall be disabled.

Graphics Level	Description	Requirement
1.0	Campus Location Map	Map of Western Australia titled Curtin University – Western Australian Campuses. The map will identify the location of each of the Curtin Campuses (Bentley, Murray Street Perth, Shenton Park and Kalgoorlie) and other locations as specified.
		This level in the Log On page and also display the name of the control system that is being logged on to, either Johnson or StruxureWare, using a User ID and a Password for access that is unique to the user.
		Each campus location would be a 'hot spot' to move forward to a Campus Site Plan (Graphics Level 2). Where a site plan was not warranted (e.g. Murray St), then the hot spot would jump to the Building Index Home Page.
		Each campus location would flash red if there was an active high level alarm, regardless of being logged on or not.
2.0	Campus Site Plan	Applicable for Bentley and Kalgoorlie campuses. The site plan shall identify all Curtin University buildings regardless of if they are on the Johnson or StruxureWare control system, but highlight the building or building numbers applicable to the control system in use. The highlighted building numbers shall be a hot spot to provide direct access to that building's home page. Each building shall flash red if there is an active high level alarm.
		The Campus Site Plan will also identify: • Campus ambient temperature/humidity/enthalpy (identified on all graphics pages for that campus) • Campus cooling call (enabled/disabled) (for each cooling plant as applicable for each

Graphics Level	Description	Requirement
		campus) • Campus heating call (enabled/disabled) (for each heating plant as applicable for each campus) • List in table format at the bottom of the Site Plan any unacknowledged high level alarms
		Each Campus Site Plan would also have hot spots to forward to: • Campus Building Cooling Summary • Campus Building Heating Summary • High Level Alarms • Low Level Alarms • Lighting Control
		Each Campus Site Plan will also have a hot spot to move backwards to: • Campus Location Map
3.0	Campus Cooling Calls	List all buildings and their cooling calls. List all the applicable buildings regardless of if they generate a cooling call. For Bentley Campus, this page would also identify if the cooling call has been relayed from the Schneider Electric StruxureWare control system to the Central Chilled Water Plant Johnson Metasys control system and also identify if the cooling call has been generated by the Johnson Metasys control system: • Hot spot to move forward to each building's Building Index Home Page • Hot spot to move back to Campus Site Plan • Hot spot to move sideways to Building Summary Page
3.1	Campus Heating Calls	List all buildings and their heating calls. List all the applicable buildings regardless of if they generate a heating call. For Bentley Campus, this page would also identify if the heating call has

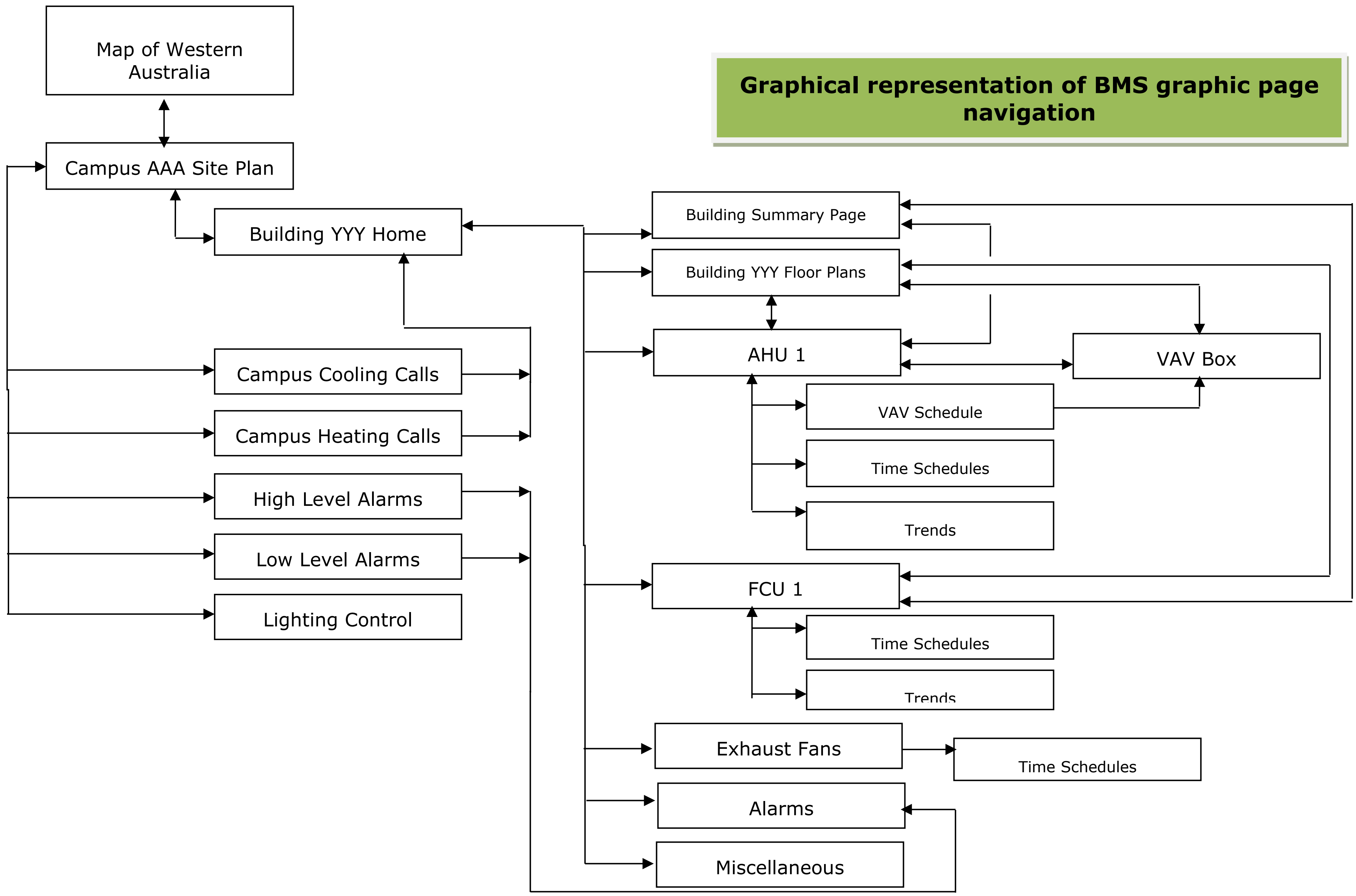
Graphics Level	Description	Requirement
		been relayed from the Schneider Electric StruxureWare control system to the Central Heating Water Plant Johnson Metasys control system and also identify if the heating call has been generated by the Johnson Metasys control system: • Hot spot to move forward to each building's Building Index Home Page • Hot spot to move back to Campus Site Plan • Hot spot to move sideways to Building Summary Page
3.2	High-level Alarms	Lists a description of all unacknowledged and acknowledged high-level alarms , time/date when the alarm was generated and when/who acknowledged the specific alarm: • Hot spot to move to move back to Campus Site Plan
3.3	Low-level Alarms	Lists a description of all unacknowledged and acknowledged low-level alarms , time/date when the alarm was generated and when/who acknowledged the specific alarm: • Hot spot to move back to Campus Site Plan
3.4	Lighting Control	Where is controlled by the BMS, list lighting schedules for the Campus's external lighting control, as applicable: • Hot spot to move back to Campus Site Plan
4.0	Building Home Page	Background wallpaper to be a photo of the actual building.
		Displays a list of all floor plans, items of equipment, miscellaneous information and time schedules associated within each building (e.g. A/C units, FCUs, VAV box schedule, alarms), each with a hot spot to move forward.
		Shall also indicate a hot spot to Building Summary Page, which shall list in table format: • Building Cooling calls and Building Heating calls

Graphics Level	Description	Requirement
		• AHU/FCU cooling and heating calls • AHU/FCU chilled and heating water control valve positions • AHU/FCU space temperatures • Building alarms • Building chilled and heating water temperatures, water flow rates, calculated thermal consumption • List all points that have been manually overridden or disabled.
		Each Building Index shall have a hot spot tag 'Campus Site Plan' to move backwards.
4.1	Building Floor Plans	Floor plan of each level identifying: • Room layouts and room numbers • North point • Space temperature and space temperature set point for each sensor • The associated FCU, AHU, VAV box or zone number shall also be identified (colour-coded) • Ambient temperature/humidity/enthalpy (for all graphics pages for the associated campus)
		Each space temperature shall have a hot spot to jump directly forward to the associated end device e.g. VAV Box.
		The floor plan shall be colour coded to identify the zone of the VAV, FCU or AHU and a legend or list provided to identify each area.
		Each floor plan shall have a hot spot tag 'Building Home Page' to move backwards.

Graphics Level	Description	Requirement
4.2	Building Equipment (AHU/FCU)	Each AHU/FCU graphics page shall have a hot spot to move forward to the associated VAV box schedule, time schedule and trends.
		Each AHU/FCU graphics page shall have a hot spot to move back to the associated floor plan and back to the Building Home Page.
4.3	Building Equipment (VAV Box Schedule)	Each VAV Box Schedule graphics page shall identify the area they serve and shall have a hot spot to move forward to the associated VAV box.
		Each VAV Box Schedule graphics page shall identify the area they serve and shall have a hot spot to move back to the associated AHU/FCU, back to the associated floor plan and back to the Building Home Page.
4.4	VAV Box	Shall identify the area it serves and shall have hot spots to move backwards to VAV Box Schedule, AHU and Building Floor Plan.
4.5	Building Equipment (Exhaust Fans)	Shall list all exhaust fans with equipment name tags and identify the area they each serve.
		Hot spot to access the time schedules for each exhaust fan as applicable. If not operating on a time schedule, identify means of operation in text on the graphics page (e.g. "Manual operation", "Operates with AC 2", etc.).
		Hot spot back to Building Home Page.
4.6	Building Equipment (Miscellaneous)	This graphics page shall list an index or item of equipment each with a hot spot to move forward and may include equipment such as : • Exhaust Fans • CHW/HTGW secondary pumps

Graphics Level	Description	Requirement
		• CHW/HTGW thermal consumption data (flow, temperatures, thermal consumption, thermal consumption rate) • Building Cooling Calls • Building Heating Calls
		Hot spot back to Building Home Page.
4.7	Alarms	Shall lead to an active list of the most recent acknowledged and unacknowledged alarms register for the building.
		Hot spot back to Building Home Page.
4.8	Time Schedules	Hot spot access forward to a list of all time schedules for each item of equipment.
		Hot spot back to Building Index
4.9	Miscellaneous	List or display each of the miscellaneous items (exhaust fans, chilled water and heating water flow, temperatures and thermal consumption, etc.
		Hot spot back to Building Index.

Graphical representation of BMS graphic page navigation



In terms of provision of BMS graphics for Curtin University, the following shall be adhered to.

1. Graphic pages shall comply with the following points to standardise graphics types and styles across campuses:
   a) shall be 3D
   b) shall navigate by way of 'hot spots' (hyperlinks)
   c) shall be of standard layout for similar types of equipment (FCUs, VAVs, etc.) to allow ease of navigation and 'look and feel' of the system
   d) shall use light coloured backgrounds to reduce consumption of printer ink
   e) shall use the full screen size of the VDU
   f) shall be legible with minimum 10pt font and constant theme font throughout
   g) shall incorporate side and bottom scroll bars only if the graphics page is larger than the screen and only in cases where it is absolutely unavoidable to fit onto the full screen of the VDU
   h) shall be configured to be printed on A4 landscape in colour, where connected to a printer and display the time/date of the graphics page when printed.
2. All graphics pages except the Map of WA shall display:
   a) ambient temperature, humidity and enthalpy for the relevant campus location
   b) A time/date stamp that is displayed on the graphics page when printed
   c) identify any point that has been manually overridden.
3. All Building Home Page graphics pages shall:
   a) have a picture of the respective building as background wallpaper
   b) have a hot spot index of all main items of plant.
4. All AHU and FCU graphics pages shall identify:
   a) chilled water and heating water supply temperature into the building
   b) if their time schedule has been enabled or disabled
   c) if after hours of occupied/unoccupied operation has been activated, the duration and the <u>elapsed</u> time
   d) AHU/FCU fault status
   e) date and time of last economy, warm-up or night purge operation as applicable
   f) the mode of operation the unit is currently utilising (economy, warm-up or night purge operation) as applicable
   g) if the unit has generated a cooling call or heating call

h) for a VAV type AHU, identify

    I. the cooling demand and the heating demand

    II. leaving air temperature upper and lower limits (adjustable)

    III. leaving air temperature set point

i) for an FCU, identify the active space temperature set point

j) provide text to identify that 0 per cent represents closed and 100 per cent open (e.g. economy dampers fully open at 100 per cent).

5. All VAV box graphics summary pages and VAV graphics pages to identify:
    a) VAV space temperature set point (adjustable)
    b) VAV maximum/minimum design airflow set points
    c) VAV box airflow set point
    d) VAV box airflow
    e) calculated cooling or heating demand
    f) occupied/unoccupied mode, time period and lapsed time
    g) AHU supply air temperature.
6. For the Building's thermal consumption identify:
    a) DP reading for the CHW and HTGW setpoints
    b) Heating water and chilled water EWTs and LWTs
    c) Heating water and chilled water flow rates
    d) Calculated heating water and chilled water thermal consumption.

High-level alarms are those alarms that use automatic dial out to a pager and email the maintenance office on fault activation. Low-level alarms are non-critical alarms such as mismatch alarms for non-critical equipment or systems. The list of high-level alarms shall be reviewed by Curtin University from time to time.

3.9.9 PROCUREMENT OF IP ADDRESSES FOR NETWORK DEVICES

The issuing of IP addresses for any BMS device should be a very simple and quick process if proper protocol is followed. The following information is required. If all information is not supplied, IP addresses will not be issued so it is important all information is provided.

Required information:

This information is to be provided by the Project Manager directly to the PF&D Technology and Systems team within Operations and Maintenance in the Properties, Facilities and Development area of Curtin University via the email address of propertiessystemsupport@curtin.edu.au.

The application process for an IP address and associated interface by the PF&D Technology and Systems team with DTS is as follows:

1. The Project Manager provides the required IP address information to the PF&D Technology and Systems team
2. The PF&D Technology and Systems team allocates an IP address for the requested device
3. The PF&D Technology and Systems team raises a Service Request through the ticketing system for patching of the TO
4. The ticketing system issues a Service Request number (SR #nnnnnn)
5. DTS Networks actions the Service Request and completes it in the ticketing system which notifies a member of the PF&D Technology and Systems team
6. The PF&D Technology and Systems team notifies the Project Manager and provides the IP Address and any other relevant information.

In managing the use of IP addresses for BMS devices, ensure the following:

7. IP address: Ensure IP addresses are not swapped between like devices.
8. IP Gateway address: Configure devices exactly as given. An incorrect number will prevent the device from working.
9. Subnet Mask: Configure devices exactly as given. An incorrect number will prevent the device from working.
10. Note that DTS Networks will not patch a TO Outlet until test results for that circuit have been received. This, however, does not prevent the issuing of IP addresses.

4 APPENDIXES

4.1 APPENDIX 1 – ADDITIONAL DATA SHEETS

ADDITIONAL EQUIPMENT DATA COLLECTION SHEETS – TEMPLATES

1) Chilled and Heating Water Connected Load
2) Pits and Valves
3) Pipework and Fittings
4) Chillers
5) Cooling Towers
6) Water Heaters (Gas)
7) Water Heaters (Heat Pump)
8) Pumps
9) VAV Boxes
10) DX Units
11) Fans, AHU's, FCU's, Coils, EDH's, Heat Recovery and Heat Exchangers
12) Chilled Water Flow & Thermal Energy Meters
13) Heating Water Flow & Thermal Energy Meters
14) Electric Meters
15) Gas Meters
16) Water Meters
17) Chilled Water Supply and Return Temperature Sensors
18) Heating Water Flow and Return Temperature Sensors
19) Chilled Water Supply Pressure and Pressure Difference Transmitters
20) Heating Water Flow Pressure and Pressure Difference Transmitters

The following screen shots are examples of the template information, may alter from time to time. Refer to the excel spreadsheet template *Standard Mechanical Engineering Data Capture_ Bentley Campus* on the University's website to download the current version.

4.1.1 CHILLED AND HEATING WATER CONNECTED LOAD

Curtin University

Project Number:

Contractor:

Submitted By:

Date:

CHILLED AND HEATING WATER CONNECTED LOAD

Building	Room	Location	A/C UNIT			CHW COIL					CHW VALVE		HTGW COIL					HTGW VALVE	
			CMMS CODE	OLD CODE if Deleted or Retired	SERVED BY	Design kW	Install kW	DESIGN l/s	SET L/S	PIPE SIZE	SIZE mm	kv	Design kW	Install kW	DESIGN l/s	SET L/S	PIPE SIZE	SIZE mm	kv
100	126	L1 WEST	100-AHU-01-0001			175.00	180.00	5.971	0.500	25	25		85.00	86.00	2.030	2.100	100	80	10
100	117	RM. 117, PL. RM. 1	100-FCU-01-0001			55.40	54.00	1.600	1.590	40	40	13.5	25.00	24.00	0.597	0.590	50	40	6
100		RM. 117, PL. RM. 1	100-FCU-01-0002			36.30	38.10	1.000	1.010	32	32	6	15.00	17.00	0.358	0.360	40	32	6
100	125	RM. 125, MDF RM.	100-FCU-01-0016			5.00	5.00	0.171	1.010	20	15	3	N/A	N/A					
100		RM 109	100-VAV-01-0001		100-FCU-01-0001	N/A	N/A						1.50	1.60	0.025	0.030	20	15	3
100	122	RM 109	100-VAV-01-0002			N/A	N/A						4.50	4.60	0.065	0.070	20	15	3
100	109	RM 109	100-VAV-01-0003			N/A	N/A						3.00	3.00	0.045	0.050	20	15	3
100	109	RM 109	100-VAV-01-0004			N/A	N/A						3.00	3.00	0.048	0.050	20	15	3
100	108	RM 108	100-VAV-01-0005			N/A	N/A						1.50	1.60	0.028	0.030	20	15	3
100	102	RM 102	100-VAV-01-0006			N/A	N/A						1.00	1.60	0.019	0.020	20	15	3

* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED AND HEATING EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.

4.1.2 PITS AND VALVES

Curtin University

CU Project Number:
Company:
Submitted By:
Date:

PITS General				Location		PITS Data											Lids				Pit & Lids	Comments
Legacy ID on SLDs	EquipmentID	Status	Service	Long'	Lat'	Install Date	Manufacturer	Construction Type	Trafficable Load Rating	Material of Pit Base	RL of top of pit	Pit depth (AHD)	Pit depth (mm)	Pit width or dia	Pit Length (mm)	In-Built Access Ladder	Lid Type	Lid Cover	Lid Size (mm)	Number of Lids	Standard Life Span	Comments
		In Service	Chilled Water					Brick		Earth						Y	Cast Iron	Brick				
		Not in use	Heated Water					Concrete		Blue Metal						N	Chequer Plate	Garden				
		Redundant	Pit					Pre-cast Concrete		Concrete							Concrete	Buried				
								Other		Paving							Plastic	None				
										Other							Steel					
																	Other					
	N5E-MSP-00-0001	In Service	Pit			20/05/2023	Pits R Us	Pre-cast Concrete	10000		20.600		2500	2500	2500	Y	Cast Iron	Brick	800x800	4		

* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED AND HEATING EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.

Curtin University

CU Project Number:
Company:
Submitted By:
Date:

Valves General					Location		Valves Data										Life Span	Comments
Legacy ID on SLDs	EquipmentID	Parent Pit ID	Status	Service	Long'	Lat'	Install Date	Manufacturer	SubType	Operation	Size	Material	Handle Type	Connections	Invert Level	Depth of Valve	Standard Life Span	Comments
			In Service	Chilled Water					Butterfly	Automatic		Cast Iron	Hand Wheel Gear Drive	Flanged				
			Not in use	Heated Water					Ball	Manual		Copper	Hand Wheel Std	Lug				
			Redundant	Pit					Gate			Plastic	Lever type W/ Lock	Wafer				
									Globe			Steel	Lever type W/O Lock	Other				
									Other			Stainless Steel	None, Pole					
												Other	Other					
	N5E-CWV-00-0001	N5E-MSP-00-0001	In Service	Chilled Water			20/05/2023	Valves R Us	Butterfly	Manual	200	Stainless Steel	Hand Wheel Gear Drive	Flanged				
	N5E-CWV-00-0002	N5E-MSP-00-0001	In Service	Chilled Water			20/05/2023	Valves R Us	Butterfly	Manual	200	Stainless Steel	Hand Wheel Gear Drive	Flanged				
	N5E-HWV-00-0001	N5E-MSP-00-0001	In Service	Heated Water			20/05/2023	Valves R Us	Butterfly	Manual	100	Stainless Steel	Hand Wheel Gear Drive	Flanged				
	N5E-HWV-00-0002	N5E-MSP-00-0001	In Service	Heated Water			20/05/2023	Valves R Us	Butterfly	Manual	100	Stainless Steel	Hand Wheel Gear Drive	Flanged				

* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED AND HEATING PITS INSTALLED DURING YOUR PROJECT PER THE DATA HEADINGS ABOVE. PLEASE ALSO IDENTIFY ANY PITS THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY PITS THAT HAS BEEN MADE REDUNDANT/DELETED.

4.1.3 PIPEWORK AND FITTINGS

Curtin University

CU Project Number:
Company:
Submitted By:
Date:

Pipework Mains General					Location		Pipe Data										
Legacy ID on SLDs	EquipmentID	Status	Service	Flow Direction	Long'	Lat'	Install Date	Manufacturer	Material	Class or Rating	Nominal Diameter	Internal Diameter	Wall thickness	External diameter	Length (m)	Exterior Protection or Lining	JointType
		In Service	Chilled Water						Acrylonitrile-Butadiene-Styrene (ABS)							HDPE	Brazed
		Not in use	Heated Water						Asbestos Cement (AC)							Concrete Slab	Compression
		Redundant							Copper Type B							None	Flanged
									Cast Iron							Other	Grooved
									Glass Reinforced Plastic (GRP)								Rubber Ring
									Polyethylene (PE)								Soldered
									PVC								Solvent Cement (Socket)
									Reinforced Concrete								Threaded
									Steel								Weld (Fusion)
									Stainless Steel								Welded (Butt)
									Vitrified Clay								Welded (Socket)
									Other								
	N5E-CWP-00-0001	In Service	Chilled Water	Flow			20/05/2023	Pipes R Us	Polyethylene (PE)	PE100 DN200 SDR7	200	195	25	245	30	Pre Ins HDPE	Weld (Fusion)
	N5E-CWP-00-0002	In Service	Chilled Water	Return			20/05/2023	Pipes R Us	Polyethylene (PE)	PE100 DN200 SDR7	200	195	25	245	30	Pre Ins HDPE	Weld (Fusion)
	N5E-HWP-00-0001	In Service	Heated Water	Flow			20/05/2023	Pipes R Us	Polyethylene (PE)	SS Sch 40	100	98	15	128	30	Pre Ins HDPE	Welded (Butt)
	N5E-HWP-00-0002	In Service	Heated Water	Return			20/05/2023	Pipes R Us	Polyethylene (PE)	SS Sch 40	100	98	15	128	30	Pre Ins HDPE	Welded (Butt)

*** PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED AND HEATING PITS INSTALLED DURING YOUR PROJECT PER THE DATA HEADINGS ABOVE. PLEASE ALSO IDENTIFY ANY PITS THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY PITS THAT HAS BEEN MADE REDUNDANT/DELETED.**

Curtin University

CU Project Number:	
Company:	
Submitted By:	
Date:	

Pipe Data					**Fittings**																			**Reference**	**Comments**
Insulation Type	Insulation Thickness	Overall pipe O.D.	Invert Level 1	Invert Level 2	30°	Radius	45°	Radius	90°	Radius	Iso Valve	Tee	Radius	Branch size (mm)	Trans (mm)	Trans Type	Trans Length	Trans Angle	Spare	Spare	Spare	Spare	Drawing #	Comments
Glasswool																								
Fibreglass																								
Polystyrene (Closed Cell)																								
Polystyrene (Open Cell)																								
Polyurethane (Closed Cell)																								
Polyurethane (Open Cell)																								
Rockwool																								
None																								
Polystyrene (Closed Cell)	50	345			2	Long	2	Long	2	Long	2	1	Abrupt	100	200 to 100	Concentric	400	30						
Polystyrene (Closed Cell)	50	345			2	Long	2	Long	2	Long	2	1	Abrupt	100	200 to 100	Concentric	400	30						
Other	50	228			2	Long	2	Long	2	Long	2	1	Swept	100	100 to 80	Eccentric	350	45						
Other	50	228			2	Long	2	Long	2	Long	2	1	Swept	100	100 to 80	Eccentric	350	45						

*** PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED AND HEATING PITS INSTALLED DURING YOUR PROJECT PER THE DATA HEADINGS ABOVE. PLEASE ALSO IDENTIFY ANY PITS THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY PITS THAT HAS BEEN MADE REDUNDANT/DELETED.**

4.1.4 CHILLERS

Project Number:		Curtin University
Contractor:		
Submitted By:		
Date:		

GENERAL			INSTALLATION LOCATION				ACQUISITION DETAILS		EQUIPMENT DETAILS					ADDITIONAL INFORMATION				
Equipment CMMS ID	Type	Replaces Equipment	Campus	Building No.	Level	Room No.	Date	Value	Vendor	Manu-facturer	Model	Serial No.	Expected Life (Yr)	Associated Pump ID	MSSB ID	Input kW Elect	FLA	Phase
117-CHL-01-0005		N/A	Bentley	117	1	101	13/06/2018	$7,150.00	Contractor	York	FDYQN250 LBV1	DFDY-7610496	25	117-CHP-01-0008				

* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED AND HEATING EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER

Project Number:		Curtin University
Contractor:		
Submitted By:		
Date:		

CHILLERS

Evaporator							Condenser							Motor			Direct Drive	Refrigeration			
Capacity (kW)	Water Ent Temp (°C)	Water Leav Temp (°C)	Water Flow - Design (L/s)	Water Flow - Set (L/s)	DP at Set Flow (kPa)	Pipe Size (mm)	Capacity (kW)	Water Ent Temp (°C)	Water Leav Temp (°C)	Water Flow - Design (L/s)	Water Flow - Set (L/s)	DP at Set Flow (kPa)	Pipe Size (mm)	Amps (FLA)	Volts	kW	Type	Comp Type	Gas Type	Gas weight (kg)	HP/ LP Settings (kPa)

R THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.

4.1.5 COOLING TOWERS

Curtin University

Project Number:
Contractor:
Submitted By:
Date:

COOLING TOWERS

GENERAL		INSTALLATION LOCATION				ACQUISITION DETAILS		EQUIPMENT DETAILS					ADDITIONAL INFORMATION					Equipment Data							Motor(s)					Direct Drive	Belt Driven			
Equipment CMMS ID	Replaces Equipment	Campus	Building No.	Level	Room No.	Date	Value	Vendor	Manufacturer	Model	Serial No.	Expected Life (Yr)	Associated Pump ID	MSSB ID	Input kW Elect	FLA	Phase	Capacity (kW)	Water Entering Temp (°C)	Water Leaving Temp (°C)	Water Flow - Design (L/s)	Water Flow - Set (L/s)	Differential Pressure at Set Flow (kPa)	Pipe Size (mm)	Amps (FLA)	Volts	kW	No Off	Airflow Per fan	Type	Belt Size	Number of Belts	Motor Pulley Size (mm)	Drive Pulley Size (mm)
117-CWT-01-0005	N/A	Bentley	117	2	201	13/06/2018	$7,150.00	Contractor	Evapco	FDYQN250LBV1	DFDY-7610496	15	117-CWP-01-0005																					

*** PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED AND HEATING EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.**

4.1.6 WATER HEATERS (GAS)

Curtin University

Project Number:
Contractor:
Submitted By:
Date:

WATER HEATERS (GAS)

GENERAL		INSTALLATION LOCATION				ACQUISITION DETAILS		EQUIPMENT DETAILS					ADDITIONAL INFORMATION					Equipment Data						
Equipment CMMS ID	Replaces Equipment	Campus	Building No.	Level	Room No.	Date	Value	Vendor	Manufacturer	Model	Serial No.	Expected Life (Yr)	Associated Pump ID	MSSB ID	Input kW Elect	FLA	Phase	Capacity (kW)	Water Ent Temp (°C)	Water Leav Temp (°C)	Water Flow - Design (L/s)	Water Flow - Set (L/s)	DP at Set Flow (kPa)	Pipe Size (mm)
117-BLR-01-0003	N/A	Bentley	117	1	101	13/06/2018	$7,150.00	Contractor	Aira	xyz	DFDY-7610496	15	117-HWP-01-0005					3000	50	60	71.5		25	100

Curtin University

Project Number:
Contractor:
Submitted By:
Date:

Pressure Ratings			Fuel & Efficiency					Burner					Settings					
Comb Back Press-ure (kPa)	Max Working Press-ure (kPa)	Max Test Pressure (kPa)	Fuel Type	Input (MJ/Hr)	Input (kW)	High Fire Efficiency	Low Fire Efficiency	Make	Model	Serial No.	Type	Modul-ating Ratio	Purge Time (Sec)	Hi Temp Cutout (°C)	Hi/Lo Fire Gas Press-ure (kPa)	Gas Press-ure - Static (kPa)	High Fire Rate (MJ/Hr)	Low Fire Rate (MJ/Hr)
			Natural Gas															

* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED AND HEATING EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.

4.1.7 WATER HEATERS (HEAT PUMP)

Project Number:			Curtin University
Contractor:			
Submitted By:			
Date:			

WATER HEATERS HEAT PUMP																								
GENERAL		INSTALLATION LOCATION				ACQUISITION DETAILS		EQUIPMENT DETAILS					ADDITIONAL INFORMATION					Equipment Data						
Equipment CMMS ID	Replaces Equipment	Campus	Building No.	Level	Room No.	Date	Value	Vendor	Manufacturer	Model	Serial No.	Expected Life (Yr)	Assoc-iated Pump ID	MSSB ID	Input kW Elect	FLA	Phase	Capacity (kW)	Water Ent Temp (°C)	Water Leav Temp (°C)	Water Flow - Design (L/s)	Water Flow - Set (L/s)	DP at Set Flow (kPa)	Pipe Size (mm)
117-???-01-0001	N/A	Bentley	117	1	101	13/06/2018	$7,150.00	Contractor	Aira	xyz	DFDY-7610496	15	117-HWP-01-0005					3000	50	60	71.5		25	100
* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED AND HEATING EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.																								

4.1.8 PUMPS

Project Number:			Curtin University
Contractor:			
Submitted By:			
Date:			

PUMPS																										
GENERAL			INSTALLATION LOCATION				ACQUISITION DETAILS		EQUIPMENT DETAILS					ADDITIONAL INFORMATION					Duty		Impellor	Motor				Direct Drive
Equipment CMMS ID	Type	Replaces Equipment	Campus	Building No.	Level	Room No.	Date	Value	Vendor	Manu-facturer	Model	Serial No.	Expected Life (Yr)	Serves Equipment ID	MSSB ID	Input kW Elect	FLA	Phase	Water flow (L/s)	Head (kPa)	mm	Amps	Volts	kW	RPM	Type
117-HWP-01-0005	Primary	N/A	Bentley	117	1	101	13/06/2018	$7,150.00	Contractor	Goulds	FDYQN250LB V1	DFDY-7610496	20	117-BLR-01-0003												
117-CHP-01-0009	Primary		Bentley	117	1	101								117-CHL-01-0005												
117-HWP-01-0005	Secondary		Bentley	117	1	101								Network												
117-CWP-01-0005	Primary		Bentley	117	1	101								117-CWT-01-0005												
404-CHP-01-0002	Tertiary		Bentley	404	1	101								N/A												
404-HWP-01-0002	Tertiary		Bentley	404	1	101								N/A												
* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED AND HEATING EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.																										

4.1.9 VAV BOXES

Project Number:	
Contractor:	
Submitted By:	
Date:	

Curtin University

VARIABLE AIR VOLUME BOXES

GENERAL			INSTALLATION LOCATION				ACQUISITION DETAILS		EQUIPMENT DETAILS					ADDITIONAL INFORMATION					AIRFLOW		
Equipment CMMS ID	Type	Replaces Equipment	Campus	Building No.	Level	Room No.	Date	Value	Vendor	Manu-facturer	Model	Serial No.	Expected Life (Yr)	Serves Rms	MSSB ID	Input kW Elect	FLA	Phase	Min (L/s)	Max (L/s)	Fan (L/s)
111-VAV-01-0001			Bentley	111	1	110	13/06/2018	$7,150.00	Contract or	Celmec	FDYQ N250L BV1	DFDY-761049 6	20						100	500	200

* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED AND HEATING EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.

Project Number:	
Contractor:	
Submitted By:	
Date:	

Curtin University

HW Coil Data												HW Valve	
Capacity (kW)	Air on Coil (DB/WB)	Air off Coil (DB/WB)	No. of Rows	Water Ent Temp (°C)	Water Leav Temp (°C)	Water Flow - Design (L/s)	Water Flow - Set (L/s)	Dimen-sions	Face Velocity	Air DP (kPa)	Pipe Size (mm)	Size (mm)	kV

4.1.10 DX UNITS

Curtin University

Project Number:	
Contractor:	
Submitted By:	
Date:	

DX UNITS

GENERAL			INSTALLATION LOCATION				ACQUISITION DETAILS		EQUIPMENT DETAILS					ADDITIONAL INFORMATION				
Equipment CMMS ID	Type	Replaces Equipment	Campus	Building No.	Level	Room No.	Date	Value	Vendor	Manu-facturer	Model	Serial No.	Expected Life (Yr)	Serves Rms	MSSB ID	Input kW Elect	FLA	Phase
111-SPL-01-0004			Bentley	111	1	110	13/06/2018	$7,150.00	Contractor	Daikan	FDYQN250LBV1	DFDY-7610496	15					
111-PKU-01-0001			Bentley	111	1	110	13/06/2018	$7,150.00	Contractor	Daikan	FDYQN250LBV1	DFDY-7610496	15					
404-CRA-01-0001			Bentley	404	1	110												

Curtin University

Project Number:	
Contractor:	
Submitted By:	
Date:	

Duty		Indoor Fan Motor			Outdoor Unit			Refrigeration			Equipment Cooling Data				Equipment Heating Data		
Airflow (L/s)	Pressure (Pa)	Amps	Volts	kW	Amps	Volts	kW	Compressor Type	Gas Type	Gas weight (kg)	Total Kilowatts	Sensible Kilowatts	Air on Coil (DB/WB)	Air off Coil (DB/WB)	Total Kilowatts	Air on Coil (DB/WB)	Air off Coil (DB/WB)

* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED AND HEATING EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.

4.1.11 FANS, AHU'S, FCU'S, COILS, EDH'S, HEAT RECOVERY, HX'S

Project Number:
Contractor:
Submitted By:
Date:

Curtin University

FAN's, AHU's, FCU's, COIL's, EDH's, H

GENERAL			INSTALLATION LOCATION				ACQUISITION DETAILS		EQUIPMENT DETAILS					ADDITIONAL INFORMATION					Duty		Motor			Direct Drive	Equipment Cooling Data			
Equipment CMMS ID	Type	Replaces Equipment	Campus	Building No.	Level	Room No.	Date	Value	Vendor	Manu-facturer	Model	Serial No.	Expected Life (Yr)	Serves Rms / Systems	MSSB ID	Input kW Elect	FLA	Phase	Airflow (L/s)	Pressure (Pa)	Amps	Volts	kW	Type	Total Kilowatts	Sensible Kilowatts	Air on Coil (DB/WB)	Air off Coil (DB/WB)
404-AHU-01-0001			Bentley	404	1	110	13/06/2018	$7,150.00	Contractor	Daikan	abc	efg	5															
404-FCU-01-0001			Bentley	404	1	110	13/06/2018	$7,150.00	Contractor	Daikan	abc	efg	5															
404-GEA-01-0001			Bentley	404	1	110	13/06/2018	$7,150.00	Contractor	Daikan	abc	efg	5															
404-OAF-01-0001			Bentley	404	1	110	13/06/2018	$7,150.00	Contractor	Daikan	abc	efg	5															
404-RAF-01-0001			Bentley	404	1	110	13/06/2018	$7,150.00	Contractor	Daikan	abc	efg	5															
404-SAF-01-0001			Bentley	404	1	110	13/06/2018	$7,150.00	Contractor	Daikan	abc	efg	5															
404-TEF-01-0001			Bentley	404	1	110	13/06/2018	$7,150.00	Contractor	Daikan	abc	efg	5															
404-EDH-01-0001			Bentley	404	1	110	13/06/2018	$7,150.00	Contractor	Daikan	abc	efg	5															
404-HWC-01-0001			Bentley	404	1	110	13/06/2018	$7,150.00	Contractor	Daikan	abc	efg	5															

* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED AND HEATING EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABC

Project Number:
Contractor:
Submitted By:
Date:

Curtin University

IEAT RECOVERY, HEAT EXCHANGERS

CHW Coil Data										CHW Valve		Equipment Heating Data			HW Coil Data										HW Valve	
No. of Rows	Water Ent Temp (°C)	Water Leav Temp (°C)	Water Flow - Design (L/s)	Water Flow - Set (L/s)	Water DP (kPa)	Dimen-sions	Face Velocity	Air DP (kPa)	Pipe Size (mm)	Size (mm)	kV	Total Kilowatts	Air on Coil (DB/WB)	Air off Coil (DB/WB)	No. of Rows	Water Ent Temp (°C)	Water Leav Temp (°C)	Water Flow - Design (L/s)	Water Flow - Set (L/s)	Water DP (kPa)	Dimen-sions	Face Velocity	Air DP (kPa)	Pipe Size (mm)	Size (mm)	kV

OVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.

4.1.12 CHILLED WATER FLOW & THERMAL ENERGY METERS

Curtin University

Project Number:
Contractor:
Submitted By:
Date:

Chilled Water Flow Meters

				Energy Calculator			Transmitter Details			Sensor Details				Matched Pair Temp Sensors			Data Connection Details								BMS Connection		
Building Number	Building Name	Location (Room)	CMMS ID Number	Make	Model	Serial No	Make	Model	Serial No	Make	Model	Serial No	Size	Make	Model	No of Wires	Device Make	Device Model	MAC Add	TO No.	Colour	IP	Gateway	Sub Net Mask	Point address (IF APPLICABLE)	IP Address	BMS Type
100	CHANCELLORY	RISER 121A INSIDE RM.122	100-CWM-01-0001	SIEMENS	UC50-UO30	68950433	SIEMENS	MAG 5000	FDK083F5002	DANFOSS	MAG3100	219216T046	50mm	SIEMENS	Pt500	2	SWG	BacRouter	E0:B9:4D:F9:88:3E	B735W	Silver	10.31.2.225	10.31.2.1	255.255.254.0	Ai2 125		JOHNSON AND SCHNEIDER
* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED WATER FLOW EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.																											

4.1.13 HEATING WATER FLOW & THERMAL ENERGY METERS

Curtin University

Project Number:
Contractor:
Submitted By:
Date:

Heating Water Flow Meters

				Energy Calculator			Transmitter Details			Sensor Details				Matched Pair Temp Sensors			Data Connection Details								BMS Connection		
Building Number	Building Name	Location (Room)	Archibus Number	Make	Model	Serial No	Make	Model	Serial No	Make	Model	Serial No	Size	Make	Model	No of Wires	Device Make	Device Model	MAC Add	TO No.	Colour	IP	Gateway	Sub Net Mask	Point address (IF APPLICABLE)	IP Address	BMS Type
100	CHANCELLORY	RISER 121A INSIDE RM.121	100-HWM-01-0001	SIEMENS	UC50-M030	69212878	DANFOSS	MAG 2500	083F4083	DANFOSS	MAG3100	219216T046	50mm	SIEMENS	Pt500	2	SWG	BacRouter	E0:B9:4D:F9:88:3E	B735W	Silver	10.31.2.225	10.31.2.1	255.255.254.0	Ai2 125		JOHNSON AND SCHNEIDER
* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL HEATING WATER FLOW EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.																											

4.1.14 ELECTRIC METERS

Project Number:	
Contractor:	
Submitted By:	
Date:	

Curtin University

Electric Meters												
Master	***Master HV Supply - Feeder 1***					*0214000039R07*						
Electric Meters												
						Meter details					**BMS Connection**	
Building Number	**Building Name**	**Location (Serving)**	**Room**	**Switchboard**		**ID**	**Make**	**Model**	**Serial**	**Ratio/ Multiplier**	**Point address**	**BMS Type**
102	*HAYMAN HALL*	*102-SWB-01-0002*	***E121***	***102-SWB-01-0002***		*ION 6200*	*POWER MANAGEMENT*	*ION 6200*	*HA070700621-03*			*TAC VISTA*

*** PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL ELECTRIC METERS INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.**

4.1.15 GAS METERS

Project Number:	
Contractor:	
Submitted By:	
Date:	

GAS METERS -MASTER							Meter details						BMS Connection	
							ID	Make	Model	Serial	Range	Output/Pulse	Point address	BMS Type
Master	*Brand Drive - Gas Meter*	*East of B300*	*In enclosure*				*M450DR029*	*Instromet*	*IRM-3-DUO G650*	*B>V_NL 20403723*	*450m3/hr*		*07512601PI*	*TAC INET*
The above line is an example														
GAS METERS - Sub - Bentley														
				Equipment Details			**Meter details**						**BMS Connection**	
Building Number	**Building Name**	**Location**	**Room**	**Type**	**Rating (kW)**	**Input (MJ/hr)**	**ID**	**Make**	**Model**	**Serial**	**Range**	**Output/Pulse**	**Point address**	**BMS Type**
104	*Cafeteria*	*Main Cafe*	*D101 Undercroft*	*Cooking*		*997*	*87S6366265*	*American Meter Co*	*AL-800*				*02211501PI*	*TAC INET*

* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL GAS METERS INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.

4.1.16 WATER METERS

Curtin University

Project Number:	
Contractor:	
Submitted By:	
Date:	

WATER METERS (Water Corporation) - Bentley			**Meter Details**						**BMS Connnection**	
			ID	**Make**	**Model**	**Serial**	**Size**	**Output/Pulse**	**Point address**	**BMS Type**
Curtin	*McKay Street Master (Water)*	*Corner McKay St*	*NK00018*	*ELSTER*			*150mm*			*Not connected to BMS*
Water Meters			**Meter Details**						**BMS Connnection**	
Building Number	**Building Name**	**Location (Room)**	**ID**	**Make**	**Model**	**Serial**	**Size**	**Output/Pulse**	**Point address**	**BMS Type**
WATER METERS - AC Subs										
402	*Curtin Business School 1*	*Rooftop Heating Water Makeup Tank*	*WST170705*	*ARAD*		*170705*	*50mm*		*02200203PI*	*TAC INET*
The above line is an example										
WATER METERS - Buildings										
155	*South Plant*	*N/W - Cooling Tower Area*	*WST-2-07-15650*	*ARAD*		*HB-2 180507*	*0-15M3/h*		*Not connected to*	*JOHNSON*
*** PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL WATER METERS INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.**										

4.1.17 CHW FLOW & RETURN TEMPERATURE SENSORS

Project Number:	
Contractor:	
Submitted By:	
Date:	

Curtin University

Chilled Water Supply & Return Temp. Sensors

			CH/W SUPPLY TEMP. SENSORS					CH/W RETURN TEMP. SENSORS					
Building Number	Building Name	Location (Room)	Make	Model	Range	ID	BMS Point address	Make	Model	Range	ID	BMS Point address	BMS Type
100	*CHANCELLORY*	*RISER 121A INSIDE RM. 122*	*Johnson*	*FT-T105*	*0-100*		*Ai2 124*	*Johnson*	*FT-T105*	*0-100*		*Ai2 127*	*Johnson*
418	*SODBE*	*BASEMENT CARPARK*	*Schneider*	*FT-T105*	*0-100*		*Ai2 124*	*Schneider*	*FT-T105*	*0-100*		*Ai2 127*	*Schneider*
* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED WATER FLOW AND RETURN INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLE ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.													

4.1.18 HTGW FLOW & RETURN TEMPERATURE SENSORS

Project Number:	
Contractor:	
Submitted By:	
Date:	

Curtin University

Heating Water Flow & Return Temp. Sensors

			HTG/W SUPPLY TEMP. SENSORS					HTG/W RETURN TEMP. SENSORS					
Building Number	**Building Name**	**Location (Room)**	**Make**	**Model**	**Range**	**ID**	**BMS Point address**	**Make**	**Model**	**Range**	**ID**	**BMS Point address**	**BMS Type**
100	*CHANCELLORY*	*RISER 121A INSIDE RM. 122*	*Johnson*	*FT-T105*	*0-100*		*Ai2 124*	*Johnson*	*FT-T105*	*0-100*		*Ai2 127*	*Johnson*
418	*SODBE*	*BASEMENT CARPARK*	*Schneider*	*FT-T105*	*0-100*		*Ai2 124*	*Schneider*	*FT-T105*	*0-100*		*Ai2 127*	*Schneider*
* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL HEATING WATER FLOW & RETURN EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.													

4.1.19 CHW PRESSURE & PRESSURE DIFFERENCE TRANSMITTERS

Project Number:	
Contractor:	
Submitted By:	
Date:	

Curtin University

Chilled Water Supply Pressure & Press Diff. Transmitters

			CH/W SUPPLY PRESSURE. TRANSMITTERS					CH/W PRESSURE DIFF. TRANSMITTERS					
Building Number	**Building Name**	**Location (Room)**	**Make**	**Model**	**Range**	**ID**	**Point address**	**Make**	**Model**	**Range**	**ID**	**Point address**	**BMS Type**
154	*NORTH PLANT*	*PL.RM. M100*	*Yokagowa*	*SPP110*	*1600*		*U3AI*	*Yokagowa*	*SPP110*	*1600*		*U4AI*	*Johnson*
418	*SODBE*	*Basement Carpark*	*Yokagowa*	*SPP110*	*1600*		*U3AI*	*Yokagowa*	*SPP110*	*1600*		*U4AI*	*Schneider*
* PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL CHILLED WATER PRESSURE & DIFFERENTIAL EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.													

4.1.20 HTGW PRESSURE & PRESSURE DIFFERENCE TRANSMITTERS

Project Number:
Contractor:
Submitted By:
Date:

Heating Water Flow Press. & Press. Diff. Transmitters

			HTG/W SUPPLY PRESS. TRANSMITTERS					HTG/W PRESS. DIFF. TRANSMITTERS					
Building Number	**Building Name**	**Location (Room)**	**Make**	**Model**	**Range**	**ID**	**Point address**	**Make**	**Model**	**Range**	**ID**	**Point address**	**BMS Type**
154	*NORTH PLANT*	*PL.RM. M100*	*Yokagowa*	*SPP110*	*1600*		*U3AI*	*Yokagowa*	*SPP110*	*1600*		*U4AI*	*Johnson*
418	*SODBE*	*Basement Carpark*	*Yokagowa*	*SPP110*	*1600*		*U3AI*	*Yokagowa*	*SPP110*	*1600*		*U4AI*	*Schneider*
108	*SQUASH COURTS*	*PL. RM.*	*JOHNSON*	*P499-VCS-401C*	*0-10V*		*3-IN1-IC3*	*JOHNSON*	*P499-VCS-401C*	*0-10V*	*CH/WR.P.*	*4-IN2-IC4*	*JOHNSON*
*** PLEASE COMPLETE SPREADSHEET WITH ANY ADDITIONAL HEATING WATER PRESSURE & DIFFERENTIAL EQUIPMENT INSTALLED DURING YOUR PROJECT AS PER THE EXAMPLES ABOVE. PLEASE ALSO IDENTIFY ANY EQUIPMENT THAT HAS BEEN UPGRADED/REPLACED AND SEPERATELY EQUIPMENT THAT HAS BEEN MADE REDUNDANT/DELETED.**													

4.2 APPENDIX 2 – OCCUPANT BROCHURES

OCCUPANT INFORMATION BROCHURES

1. Air Conditioning Push Button Control Information Brochure

Curtin University

Operation of the Air Conditioning System

Buildings at Curtin University are air conditioned to allow a set point of approximately 22.5 °C to be achieved all year around. The systems are automatic and set to operate typically between the business hours of 8.00 am and 5.30 pm Monday to Friday.

Those areas that have local A/C push buttons will allow air conditioning to operate in a slightly relaxed mode of temperature control when the local push button is not activated, i.e. slightly above set point in summer and slightly below set point in winter. If occupants feel that they are a little uncomfortable and would like tighter temperature control, the local A/C push button can be activated by depressing the button until the indicator light illuminates. During business hours the push buttons will provide a four hour control time.

If air conditioning is required outside of these hours the push button can be depressed until the indicator light illuminates. This will turn on the air conditioning and automatically allow it to operate at approximately 22.5 °C for a duration of two hours.

The provision of controls that allow variations to the set points via the use of push button operation provides a good blend between providing comfort conditions when required and energy conservation.

Curtin University

Operation of the Air Conditioning System

Buildings at Curtin University are air conditioned to allow a set point of approximately 22.5 °C to be achieved all year around. The systems are automatic and set to operate typically between the business hours of 8.00 am and 5.30 pm Monday to Friday.

Those areas that have local A/C push buttons will allow air conditioning to operate in a slightly relaxed mode of temperature control when the local push button is not activated, i.e. slightly above set point in summer and slightly below set point in winter. If occupants feel that they are a little uncomfortable and would like tighter temperature control, the local A/C push button can be activated by depressing the button until the indicator light illuminates. During business hours the push buttons will provide a four hour control time.

If air conditioning is required outside of these hours the push button can be depressed until the indicator light illuminates. This will turn on the air conditioning and automatically allow it to operate at approximately 22.5 °C for a duration of two hours.

The provision of controls that allow variations to the set points via the use of push button operation provides a good blend between providing comfort conditions when required and energy conservation.

Curtin University

Operation of the Air Conditioning System

Buildings at Curtin University are air conditioned to allow a set point of approximately 22.5 °C to be achieved all year around. The systems are automatic and set to operate typically between the business hours of 8.00 am and 5.30 pm Monday to Friday.

Those areas that have local A/C push buttons will allow air conditioning to operate in a slightly relaxed mode of temperature control when the local push button is not activated, i.e. slightly above set point in summer and slightly below set point in winter. If occupants feel that they are a little uncomfortable and would like tighter temperature control, the local A/C push button can be activated by depressing the button until the indicator light illuminates. During business hours the push buttons will provide a four hour control time.

If air conditioning is required outside of these hours the push button can be depressed until the indicator light illuminates. This will turn on the air conditioning and automatically allow it to operate at approximately 22.5 °C for a duration of two hours.

The provision of controls that allow variations to the set points via the use of push button operation provides a good blend between providing comfort conditions when required and energy conservation.

4.3 APPENDIX 3 – OMM COVERS

OPERATIONS AND MAINTENANCE MANUALS

Front Cover and Spine Detail

1. Standard Operations and Maintenance Manual layout.
2. Specific Operations and Maintenance Manual layout for a site Chilled and Heating Water Pipework project

Standard Operation and Maintenance Manual front cover.

OPERATIONS

AND

MAINTENANCE MANUAL

FOR

MECHANICAL SERVICES

AT

CURTIN UNIVERSITY

(NAME OF CAMPUS)

BUILDING ###

(ROOM ### IF APPLICABLE)

(PROJECT NAME)

(PROJECT NUMBER)

Date: Day/Month/Year

Volume # of #

Consultant:

Architect (if applicable):

Project Manager (if applicable):

Contractor:

Operation and Maintenance Manual front cover and spine layout for site Chilled and Heating Water Pipework projects.

OPERATIONS

AND

MAINTENANCE MANUAL

FOR

MECHANICAL SERVICES

AT

CURTIN UNIVERSITY

(NAME OF CAMPUS)

CHILLED & HEATING WATER

PIPEWORK UPGRADES

(PROJECT NAME)

(PROJECT NUMBER)

Date: Day/Month/Year

Volume # of #

Consultant:

Project Manager (if applicable):

Contractor:

(Sample contents page to be used in all Chilled and Heating Water in ground pipework based projects only)

CONTENTS

Volume/s	Project Number	Project Title
1 – 3	UPJ000204	B402 to B407 CHW and HTGW installation
4 – 5	UPJ000353	B105 Fibro Pipe Replacement & HTGW Expansion Line
6 – 9	UPJ000432	B205/B206 CHW & HTGW Pipe Replacement

4.4 DEFINITIONS

Item	Description
A/C	air conditioning
AHU	air handling unit
AV	audio-visual
BMS	building management system
CAV	constant air volume
CCV	characterised control valve
CEP	central energy plant
CHW	chilled water
DTS	Digital Technology Solutions
DX	direct expansion
comms	communications
CRAC	computer room air conditioner
CT	Current Transformer
DB	dry bulb
DDC	direct digital control
DOL	direct online
DX	direct expansion
EC	Electronically Commutated
EWT	entering water temperature
FCU	fan coil unit
HLI	High Level Interface
HTGW	heating water
HVAC	heating, ventilation and air conditioning
Infrastructure Manager Mechanical Services	university representative charged with the responsibility for the university's mechanical fixed plant and equipment and associated infrastructure
LCCA	life cycle cost analysis
LWT	leaving water temperature
Mechanical Services Contractor	an external company engaged by the university to deliver construction and maintenance services for mechanical fixed plant and equipment and associated infrastructure

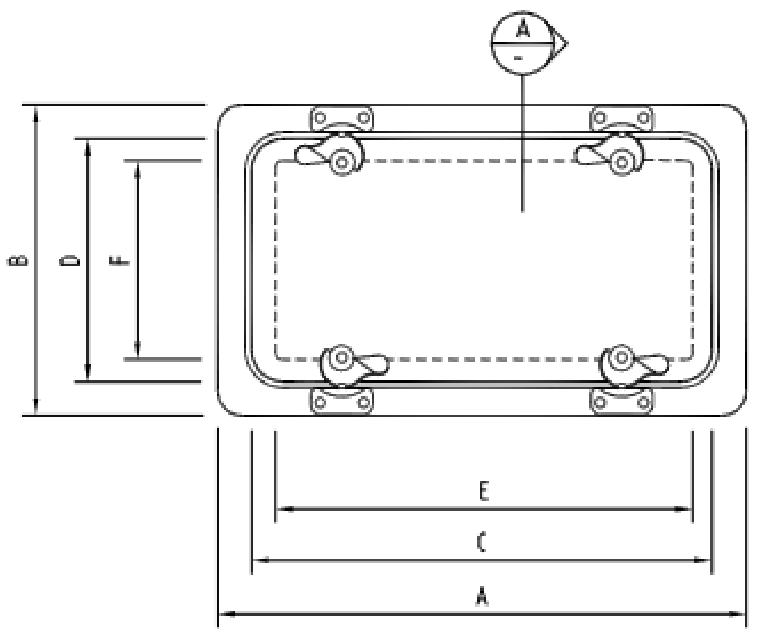
Item	Description
MSSB	mechanical services switch board
NCC	National Construction Code
NR	noise rating
OBD	opposable blade dampers
OPSO	over-pressure shut-off
PF&D	Properties, Facilities and Development
PI	proportional integral
PID	proportional integral derivative
POT	A variable potentiometer or rheostat
Practical Completion	Issued to a Contractor acknowledging completion of works to a stage where the works have been completed as per the contract documents and are "reasonably fit for occupation or their intended use".
Project Manager	The person managing the project on behalf of the University
PWD	pulse width modulation
RAC	room air conditioner
Responsible Officer	The University's representative on projects, nominated by the Portfolio Manager, as the person responsible for the project and may be CU Portfolio Manager, CU Project Manager, CU Project Officer, University Associate Lead Consultant
RH	relative humidity
RMD	Remote monitoring device
SP	set point
TO	Telecommunications Outlet
UPS	uninterruptible power supply
VAV	variable air volume
VDU	video display unit
VSD	variable speed drive
WB	wet bulb

4.5 STANDARD CONSTRUCTION DETAILS

Drawing Schedule

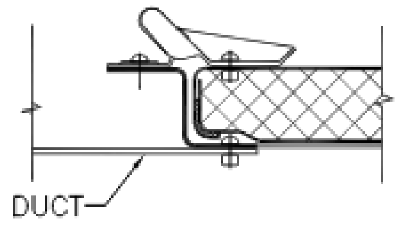
Dwg #	Title	Rev
M-D-01	2 HOUR FIRE SPRAYED DUCTWORK NOTES	A
M-D-02	2 HOUR FIRE SPRAYED DUCTWORK CONSTRUCTIONS DETAILS	A
M-D-03	ACCESS PANEL DETAIL	A
M-D-04	DUCT SUPPORT DETAILS CONNECTING TO PURLINS	A
M-D-05	DUCT CONSTRUCTION DUCT STEAM AND HEATING COIL INSTALLATION	A
M-D-06	TYPICAL ROOF DISCHARGE DUCT w/RAIN WATER DRAIN, WIRE MESH SCREEN AND FLASHING SHT 1 OF 2	A
M-D-07	TYPICAL ROOF DISCHARGE DUCT w/RAIN WATER DRAIN, WIRE MESH SCREEN AND FLASHING SHT 2 OF 2	A
M-D-08	TYPICAL ROOF MOUNTED EXHAUST FAN/FLUE DETAIL	A
M-D-09	DUCT CONSTRUCTION GENERAL NOTES - DUCTWORK	A
M-D-10	DUCT PENERATION THROUGH ACOUSTIC WALL DETAIL	A
M-D-11	TYPICAL PUMP INSTALLATION DETAIL	A
M-D-12	TYPICAL MITERED THROAT & RADIUS GOOSENECK COWL DETAIL	A
M-D-13	TYPICAL FUME EXTRACTION DETAIL	A
M-D-14	TYPICAL FUME CUPBOARD EXHAUST FAN	A
M-D-15	TYPICAL EXHAUST COWL DETAIL -UPWARD DISCHARGE	A
M-D-16	TYPICAL EXHAUST COWL DETAIL -DOWNWARD DISCHARGE	A
M-D-17	TYPICAL EVAPORATIVE COOLING UNIT	A
M-D-18	TYPICAL CONDENSING UNIT WALL STACKED MOUNTING DETAIL	A
M-D-19	TYPICAL CONDENSING UNIT WALL MOUNTING DETAIL	A
M-D-20	TYPICAL CONDENSING UNIT MOUNTING DETAIL	A
M-D-21	TYPICAL CONDENSING UNIT MOUNTING IN PLANTROOM	A
M-D-22	TYPICAL AXIAL FAN MOUNTING DETAIL c/w ACOUSTIC ENCLOSURE	A
M-D-23	TYPICAL CONCRETE PAD DETAIL	A
M-D-24	FAN COIL UNIT DETAIL	A
M-D-25	DUCT CONSTRUCTION KITCHEN EXHAUST DUCTWORK	A
M-D-26	DUCT SUPPORTS	A
M-D-27	DUCT CONSTRUCTION FIRE DAMPER INSTALLATION	A
M-D-28	CHEMICAL MANUAL DOSING POT	A
M-D-29	TYPICAL PUMP INSTALLATION DETAIL	A
M-D-30	SECURE VERTICAL DISCHARGE EXHAUST COWL	A
M-D-31	STANDARD PIPE BEDDING & BACKFILL IN TRENCHES DETAIL	A
M-D-32	SECURE DOWNFLOW EXHAUST COWL DETAIL	A
M-D-33	ROOF PLATFORM PIPE HANGER DETAIL	A

Dwg #	Title	Rev
M-D-34	ELECTRIC DUCT MOUNTED STEAM HUMIDIFIER DETAIL	A
M-D-35	DUCT MOUNTED STEAM HUMIDIFIER DETAIL	A
M-D-36	TYPICAL DUCT PENETRATION THROUGH ACOUSTIC WALL DETAIL	A
M-D-37	TYPICAL STACKED CONDENSING UNIT MOUNTING DETAIL	A
M-D-38	TRENCHING DETAIL	A
M-D-39	SAFETY DRIP TRAY DETAIL	A
M-D-40	SUB DUCT FABRICATION DETAIL	A
M-D-41	SUBDUCT INSTALLATION DETAILS	A
M-D-42	TRENCH DETAIL WITH FILL OVER	A
M-D-43	DUCT CONSTRUCTION KITCHEN EXHAUST RISER - GREASE TRAP DETAIL	A
M-D-44	DUCT CONSTRUCTION RISER DUCT AND PENETRATION IN SLAB	A
M-D-45	TYPICAL PIPE SUPPORT SYSTEMS	A
M-D-46	TYPICAL WATER COOLED CHILLER	A
M-D-47	IN-GROUND PIPEWORK & PIT DETAIL	A
M-D-100	TYPICAL CHILLED/HHW SCHEMATIC - CHILLED WATER SCHEMATIC	A
M-D-200	TYPICAL CONTROL; AND AIR SCHEMATIC - COMBINED CONTROL & AIR SCHEMATIC DETAILS	A

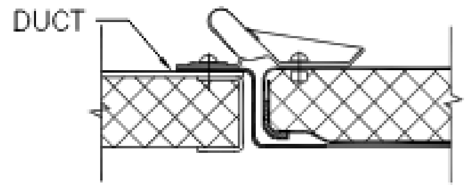


NOTES:

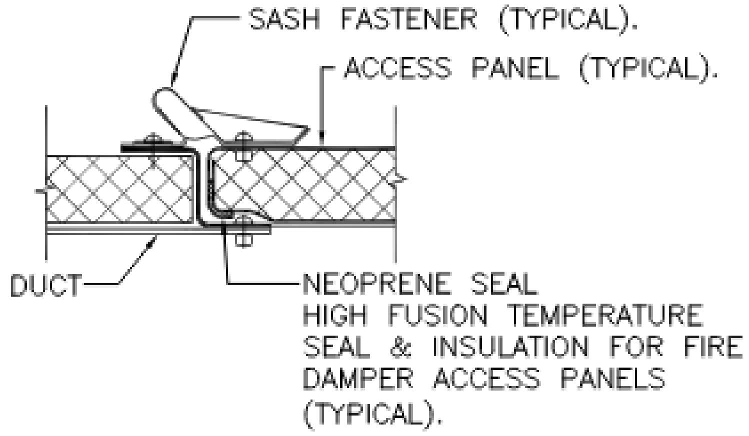
1. ENSURE ACCESS PANEL IS ACCESSIBLE.
2. PROVIDE ACCESS PANELS TO KITCHEN EXHAUST DUCTWORK AS SHOWN ON THE DRAWINGS.
3. INSULATION THICKNESS TO COMPLY WITH DUCT REQUIREMENTS IN ACCORDANCE WITH SECTION J OF BCA.



UN-INSULATED DUCTWORK



INTERNALLY INSULATED DUCTWORK



EXTERNALLY INSULATED DUCTWORK

ACCESS PANEL DETAILS

TYPE	NOMINAL SIZE	A x B	C x D	E x F
AP-0	650 x 500	700 x 550	650 x 502	607 x 458
AP-1	500 x 375	500 x 375	497 x 363	463 x 326
AP-2	375 x 250	375 x 250	369 x 238	330 x 196
AP-3	250 x 150	250 x 150	238 x 147	208 x 126

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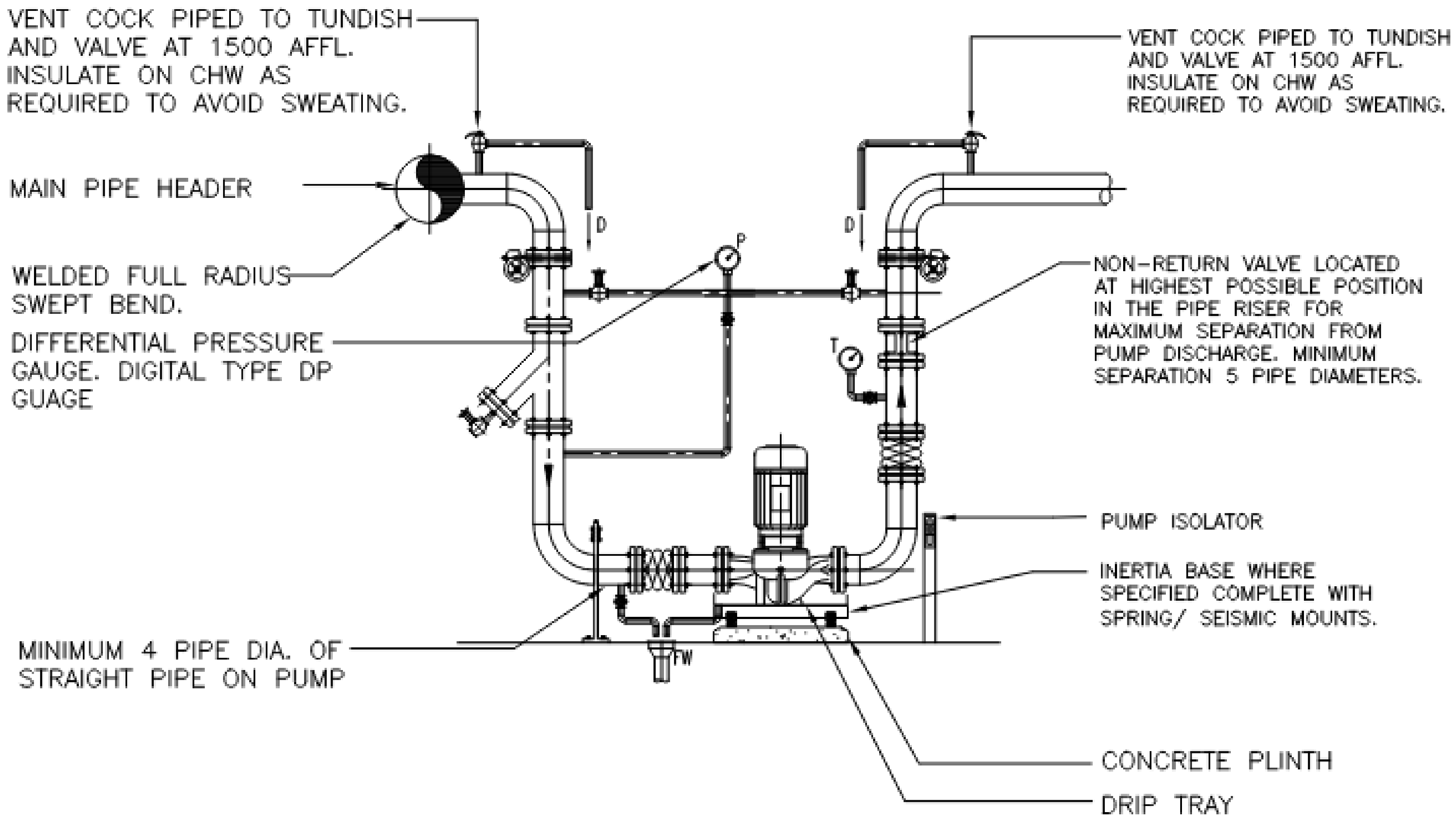
DETAIL

ACCESS PANEL DETAIL

CURTIN PROJ No	MASTER	SCALE: NTS	UNIT: mm
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4
DWG No	M-D-03	SHEET 01 OF 01	ISSUE A

1 2 3 4 5



TYPICAL INLINE PUMP INSTALLATION NOTES.

1. FOR PUMP ARRANGEMENT DETAILS REFER TO SPECIFICATION
2. PIPEWORK INSULATION AND SHEATHING NOT SHOWN FOR CLARITY.
3. EXTEND VALVE SPINDLES AS REQUIRED TO PROVIDE ADEQUATE CLEARANCE FROM PIPEWORK INSULATION.
4. PROVIDE SUFFICIENT CABLE LENGTH TO ALLOW FOR MAINTENANCE WITHOUT DISCONNECTION OF MOTOR CABLING & A MINIMUM OF ONE LOOP FOR VIBRATION ISOLATION.
5. ELECTRICAL INSULATION: IP66 MOTOR RATED ISOLATOR,IP66 FLEXIBLE CONDUITS & CONNECTORS.
6. PRESSURE GAUGE INSTALLATION: HARD DRAWN COPPER TUBING. PROVIDE ADEQUATE VIBRATION ISOLATION FOR GAUGE. GAUGE FACE TO BE ø150 MINIMUM.

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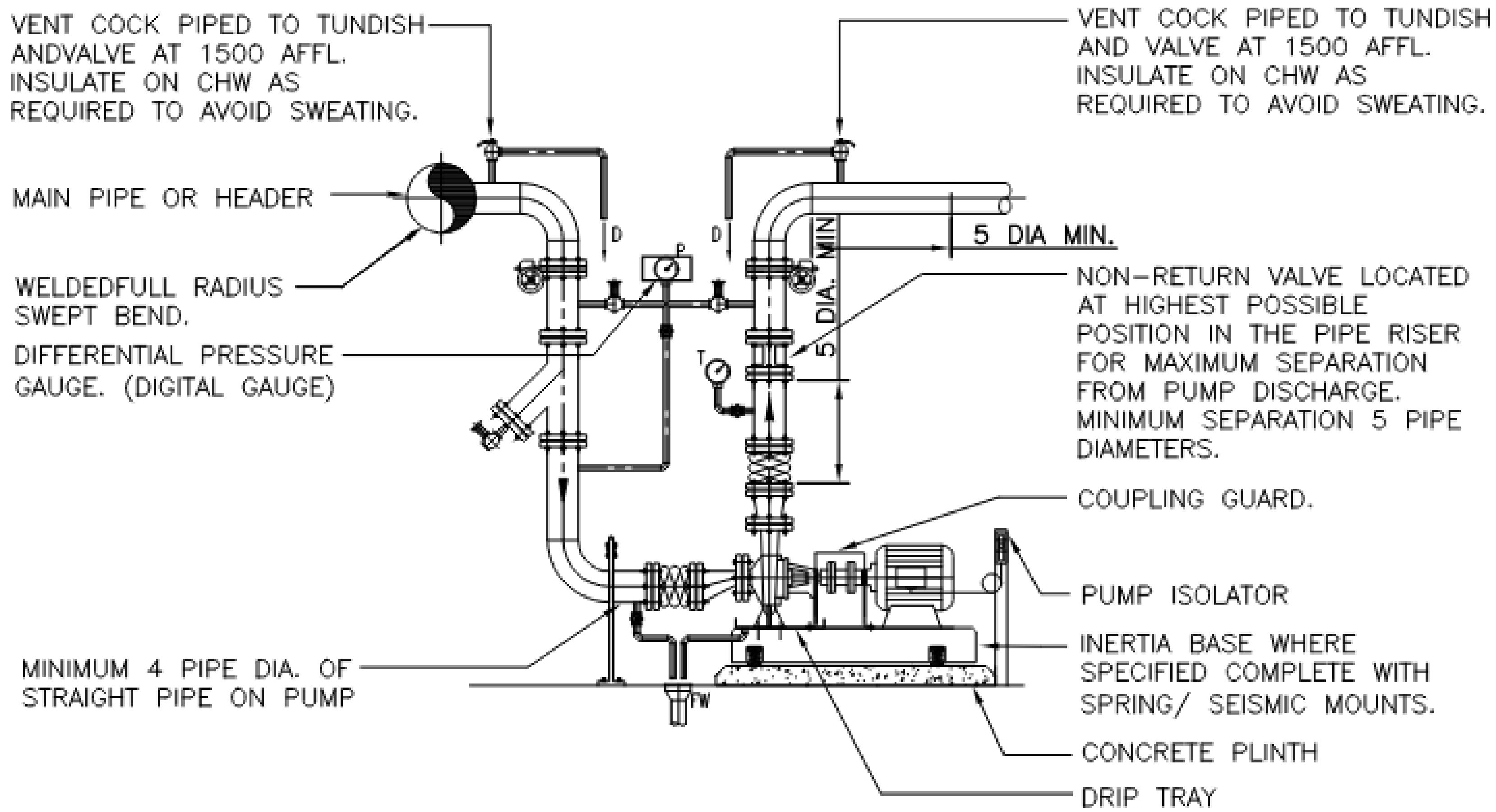
TYPICAL PUMP INSTALLATION DETAIL

CURTIN PROJ No	MASTER	SCALE: NTS		
		UNIT: mm		
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE A4		
DWG No	M–D–11	SHEET 01	OF 01	ISSUE A



TYPICAL PUMP INSTALLATION NOTES

1. FOR PUMP ARRANGEMENT DETAILS REFER TO SPECIFICATION
2. PIPEWORK INSULATION AND SHEATHING NOT SHOWN FOR CLARITY.
3. ACCESS TO VALVE HANDLES TO BE MAINTAINED.
4. EXTEND VALVE SPINDLES AS REQUIRED TO PROVIDE ADEQUATE CLEARANCE FROM PIPEWORK.
5. PROVIDE SUFFICIENT CABLE LENGTH TO ALLOW FOR MAINTENANCE WITHOUT DISCONNECTION OF MOTOR CABLING & A MINIMUM OF ONE LOOP FOR VIBRATION ISOLATION.
6. 5. ELECTRICAL INSULATION: IP66 MOTOR RATED ISOLATOR,IP66 FLEXIBLE CONDUITS & CONNECTORS.
7. PRESSURE GAUGE INSTALLATION: HARD DRAWN COPPER TUBING. PROVIDE ADEQUATE VIBRATION ISOLATION FOR GAUGE. GAUGE FACE TO BE ø150 MINIMUM.

NOTE:
THE ABOVE DETAIL IS FOR REFERENCE ONLY. OTHER STANDARD DETAILS MAY BE ACCEPTABLE SUBJECT TO CURTIN REVIEW

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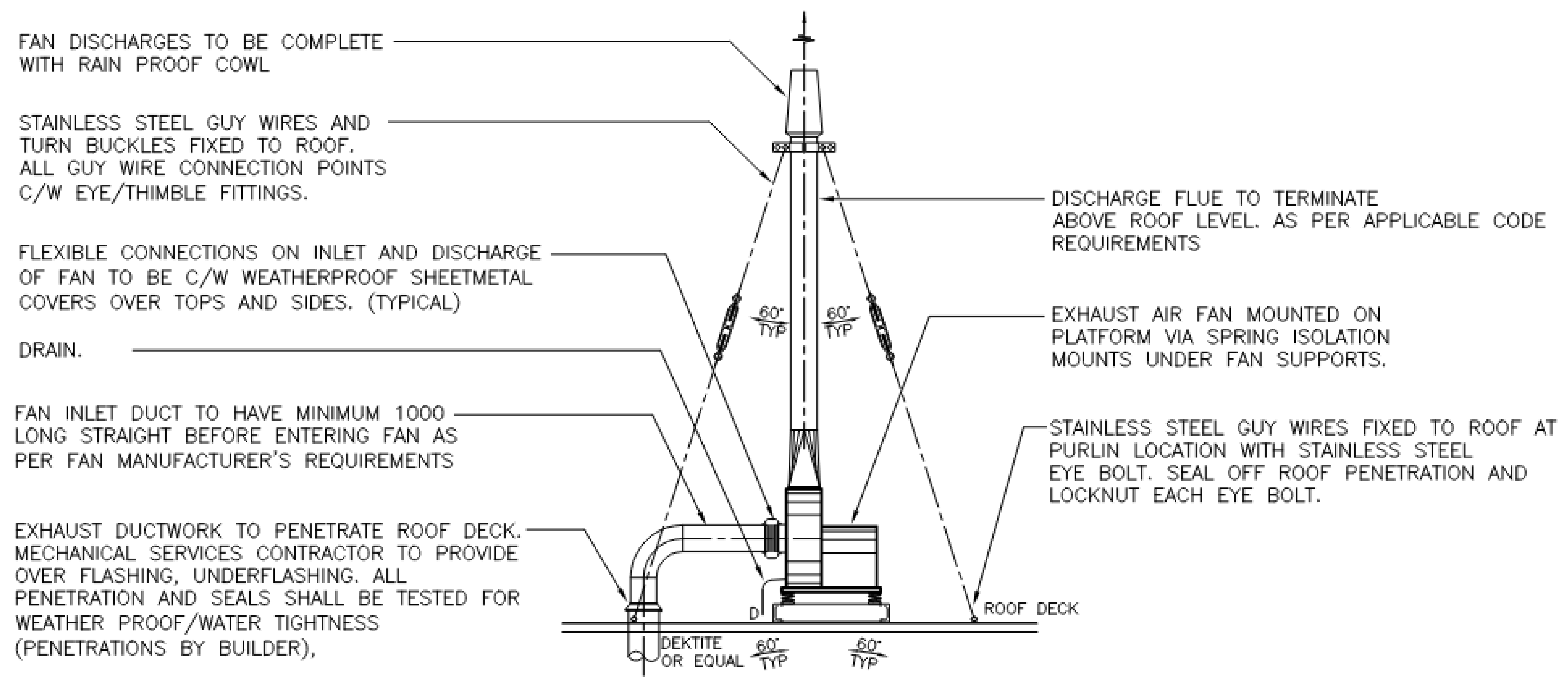
DETAIL
TYPICAL PUMP INSTALLATION DETAIL

CURTIN PROJ No	MASTER	SCALE: NTS UNIT: mm	
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4
DWG No	M–D–29	SHEET 01	OF 01
		ISSUE	A



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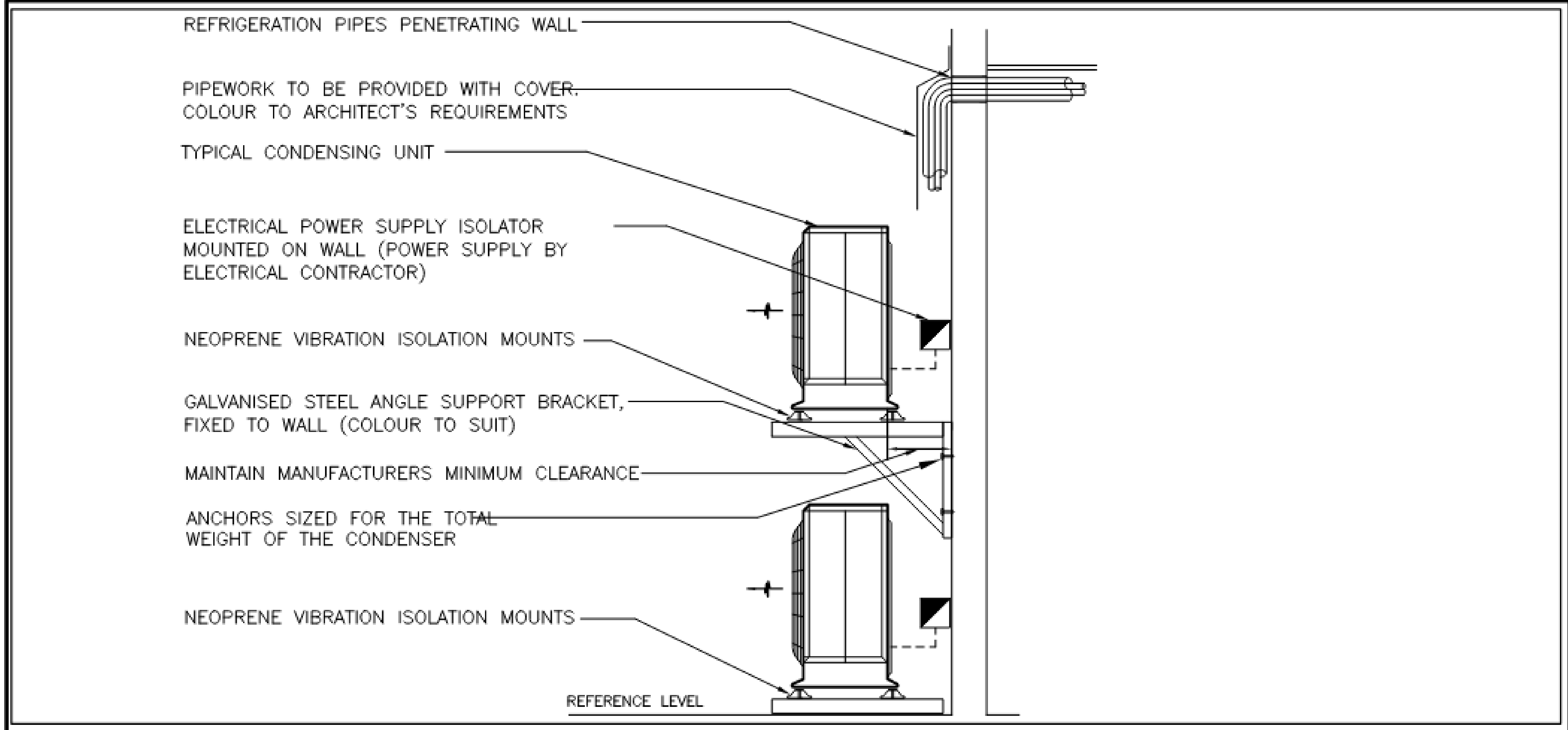
DETAIL

TYPICAL ROOF MOUNTED EXHAUST FAN/FLUE DETAIL

CURTIN PROJ No	MASTER	SCALE: NTS	UNIT: mm
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4
DWG No	M–D–08	SHEET 01 OF 01	ISSUE A



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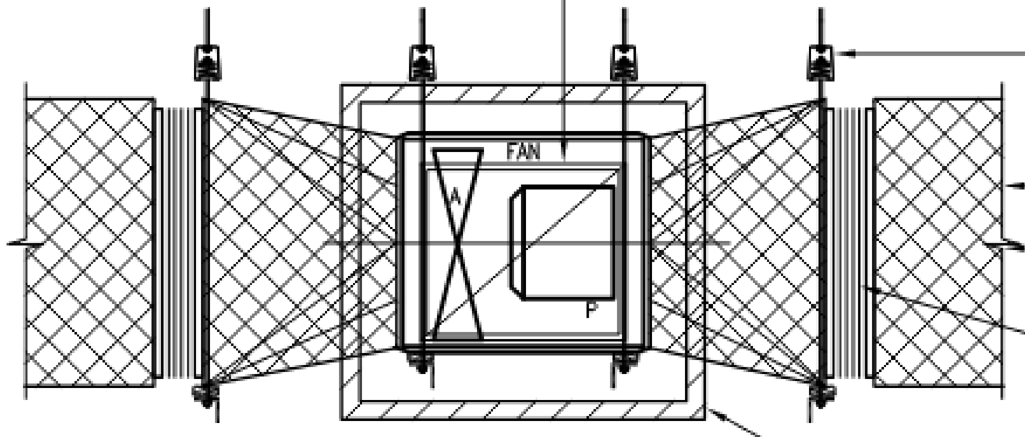
DETAIL

TYPICAL CONDENSING UNIT WALL STACKED MOUNTING DETAIL

CURTIN PROJ No	MASTER	SCALE: NTS	UNIT: mm
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4
DWG No	M-D-18	SHEET 01 OF 01	ISSUE A



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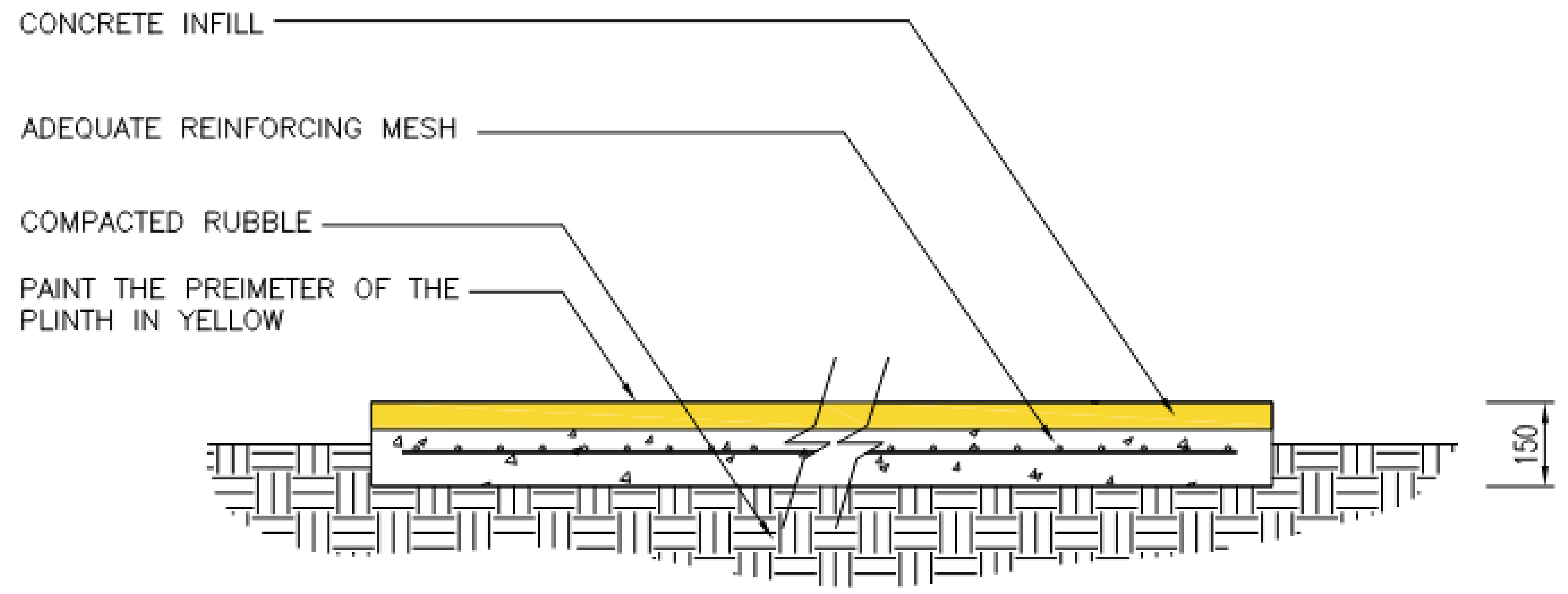
DETAIL

TYPICAL AXIAL FAN MOUNTING DETAIL c/w ACOUSTIC ENCLOSURE

CURTIN PROJ No	MASTER	SCALE: NTS	UNIT: mm
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4
DWG No	M–D–22	SHEET 01 OF 01	ISSUE A



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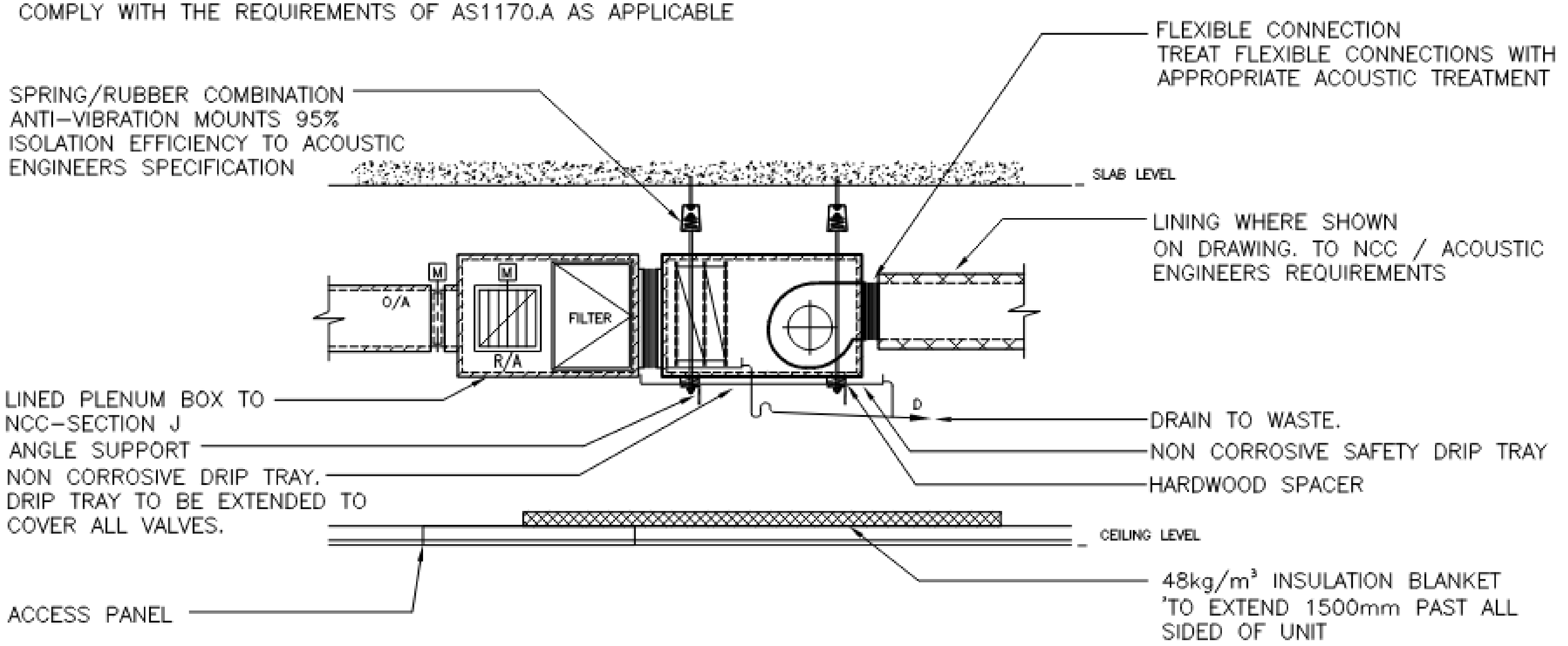
DETAIL

TYPICAL CONCRETE PAD DETAIL

CURTIN PROJ No	MASTER	SCALE: NTS	UNIT: mm
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4
DWG No	M–D–23	SHEET 01 OF 01	ISSUE A

NOTES:

1. ACOUSTIC REQUIREMENTS TO BE CONFIRMED WITH PROJECT ACOUSTIC ENGINEER
2. UNIT SUSPENSION FROM CONCRETE SLAB – COMPLY WITH AS5216 WHERE APPLICABLE
3. COMPLY WITH THE REQUIREMENTS OF AS1170.A AS APPLICABLE



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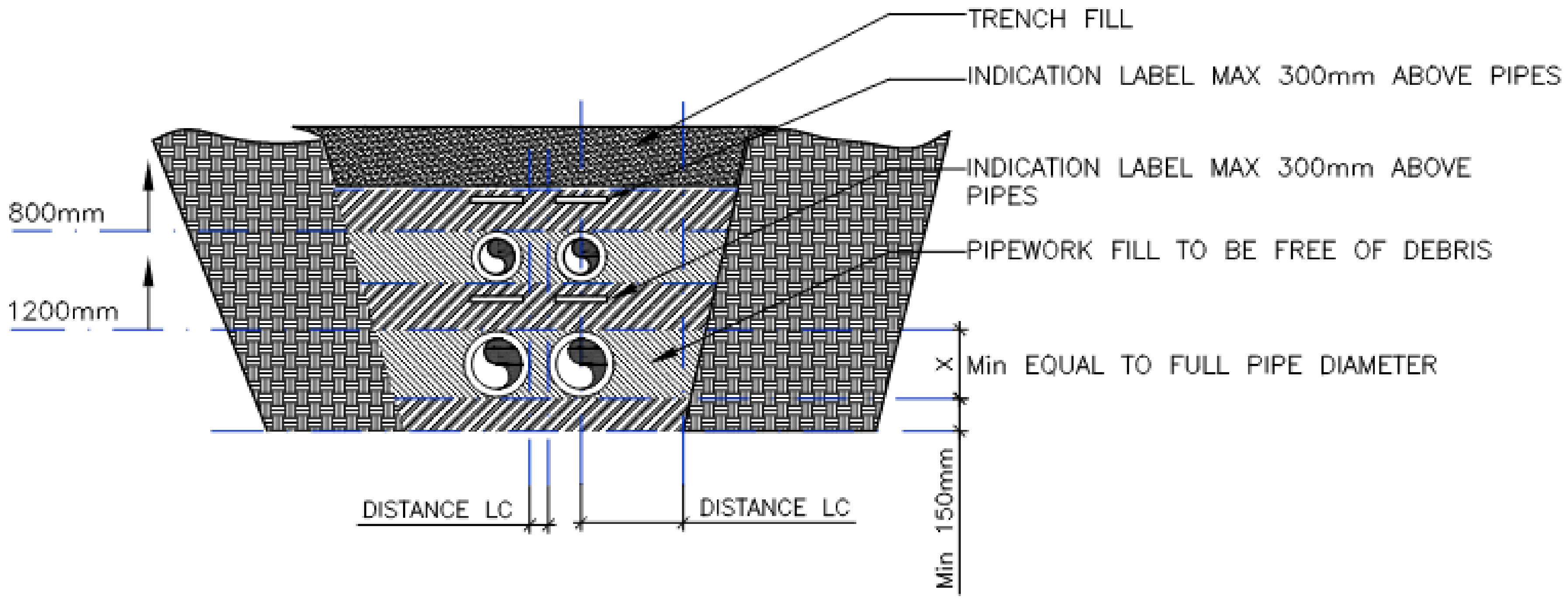
DETAIL

FAN COIL UNIT DETAIL

CURTIN PROJ No	MASTER	SCALE: NTS	UNIT: mm
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4
DWG No	M-D-24	SHEET 01 OF 01	ISSUE A

1 2 3 4 5



millimeters

De		Minimum values*		
		l_b	l_c†	l_o‡
≥ 75	≤150	75	100	100
>150	≤300	100	150	150
>300	≤450	100	200	150
>450	≤900	150	300	150
	≤1500	150	350	200
	≤4000	150	0.25De	300

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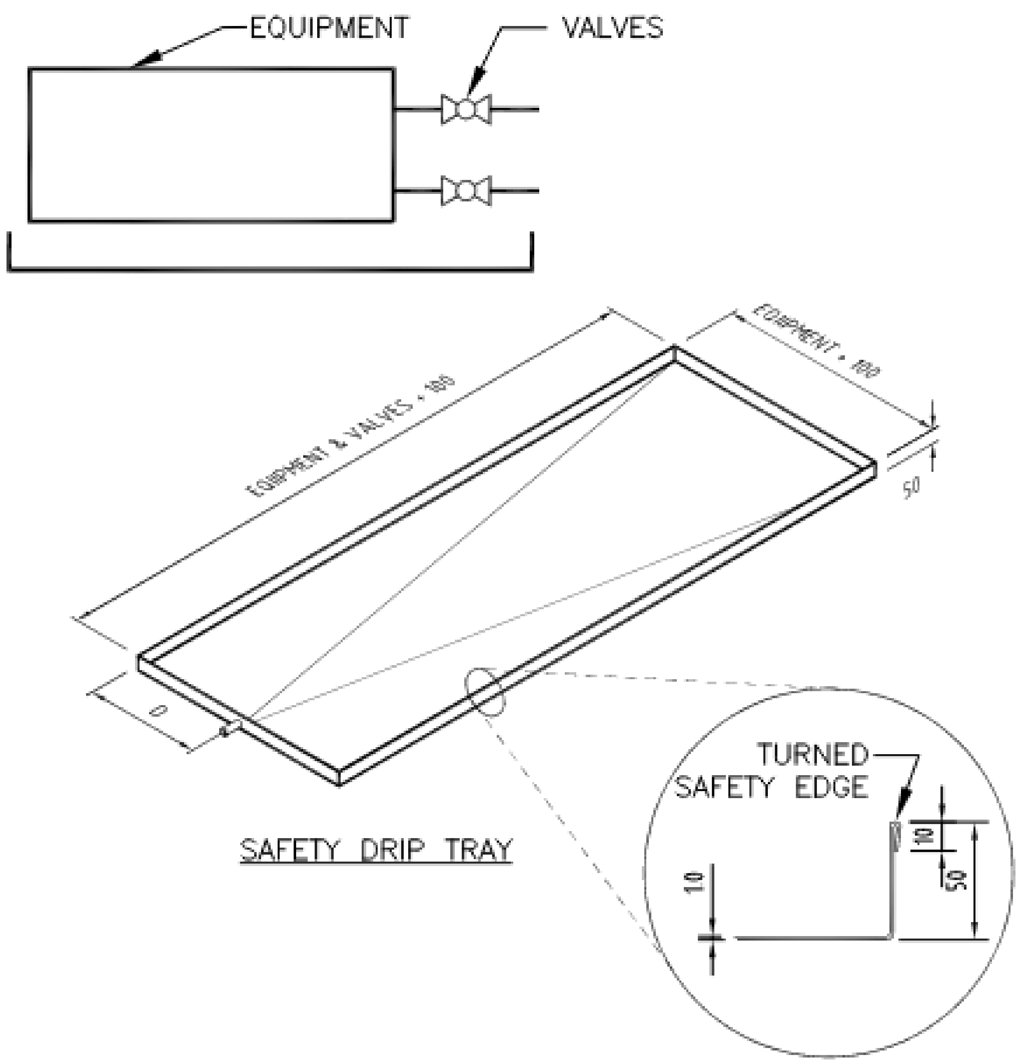
DETAIL
TRENCHING DETAIL

CURTIN PROJ No	MASTER	SCALE: NTS UNIT: mm		
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4	
DWG No	M–D–38	SHEET 01	OF 01	ISSUE A

1 | 2 | 3 | 4 | 5



SAFETY DRIP TRAY

NOTES:

1. 20ø x50 LONG COPPER STUB
2. ALL CORNER JOINTS TO BE LAPPED, FOLDED AND SILICON SEALED
3. TRAY TO BE MADE FROM 20 Ga. GALV. SHEETMETAL
4. TRAY TO HAVE GRADED FALL TO DRAIN STUB
5. ALL TRAYS TO HAVE SAFETY EDGE

PIPING MUST BE INSTALLED IN ACCORDANCE WITH LOCAL CODES.
DRAIN TRAYS SHOULD HAVE:

- PROVIDE TRAPS TO DRAIN TRAYS.
- DRAIN LINES AND TRAPS TO BE GRADED AWAY FROM DRAIN TRAY CONNECTION AND HAVE APPROPRIATE SIZING.
- INSULATE DRAIN PIPEWORK / LINES AND TRAPS
- FOR A DRAIN THROUGH UNIT ENSURE THAT THE TRAP DEPTH AND THE DISTANCE BETWEEN THE TRAP OUTLET AND THE DRAIN TRAY OUTLET CONNECTION SHOULD BE TWICE THE NEGATIVE STATIC PRESSURE (=H) IN MILLIMETRES OF WATER UNDER NORMAL UNIT OPERATION.

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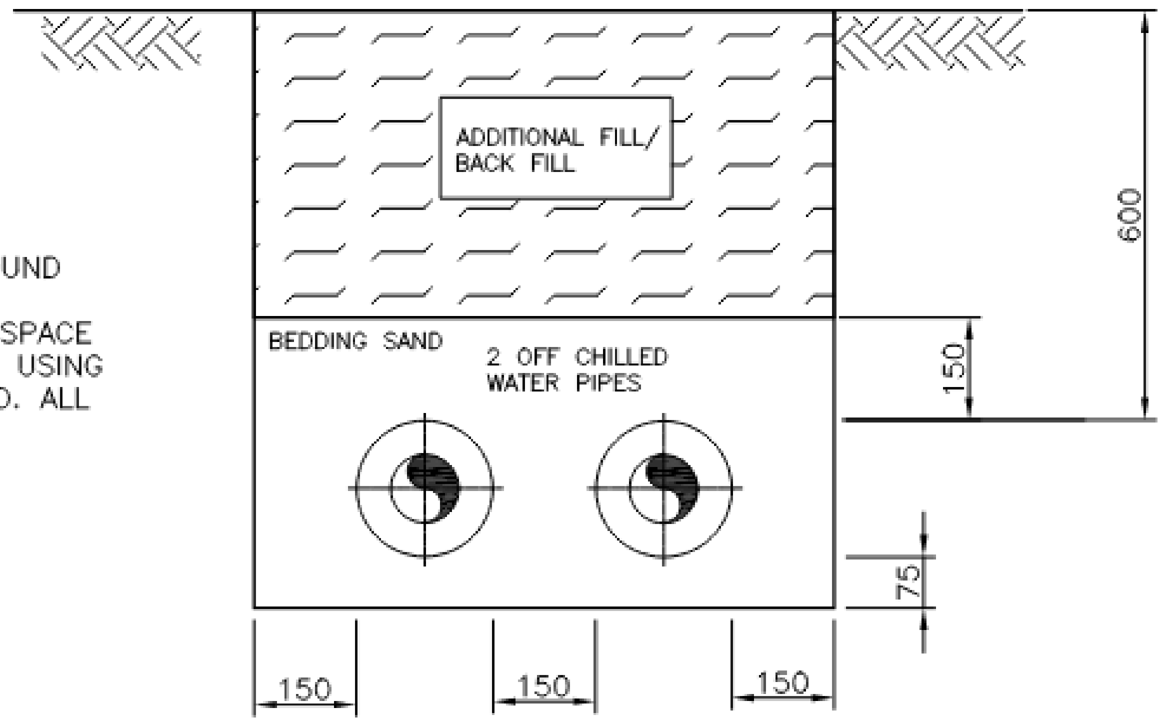
DETAIL

SAFETY DRIP TRAY DETAIL

CURTIN PROJ No	MASTER	SCALE: NTS	UNIT: mm		
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4		
DWG No	M–D–39	SHEET 01	OF 01	ISSUE A	

NOTE:
PROVIDE SLEEVES FOR PIPEWORK WHERE IT PENETRATES SLAB, FIRMLY GROUTED IN PLACE. CLEARANCE AROUND PIPEWORK AND UNIFORM CLEARANCE AROUND PIPEWORK AND PACK THIS SPACE WITH SEAL PACKING ON BOTH SIDES USING A NO-HARDING RESILIENT COMPOUND. ALL PIPES TO PENETRATE SLABSAT RIGHT ANGLES.



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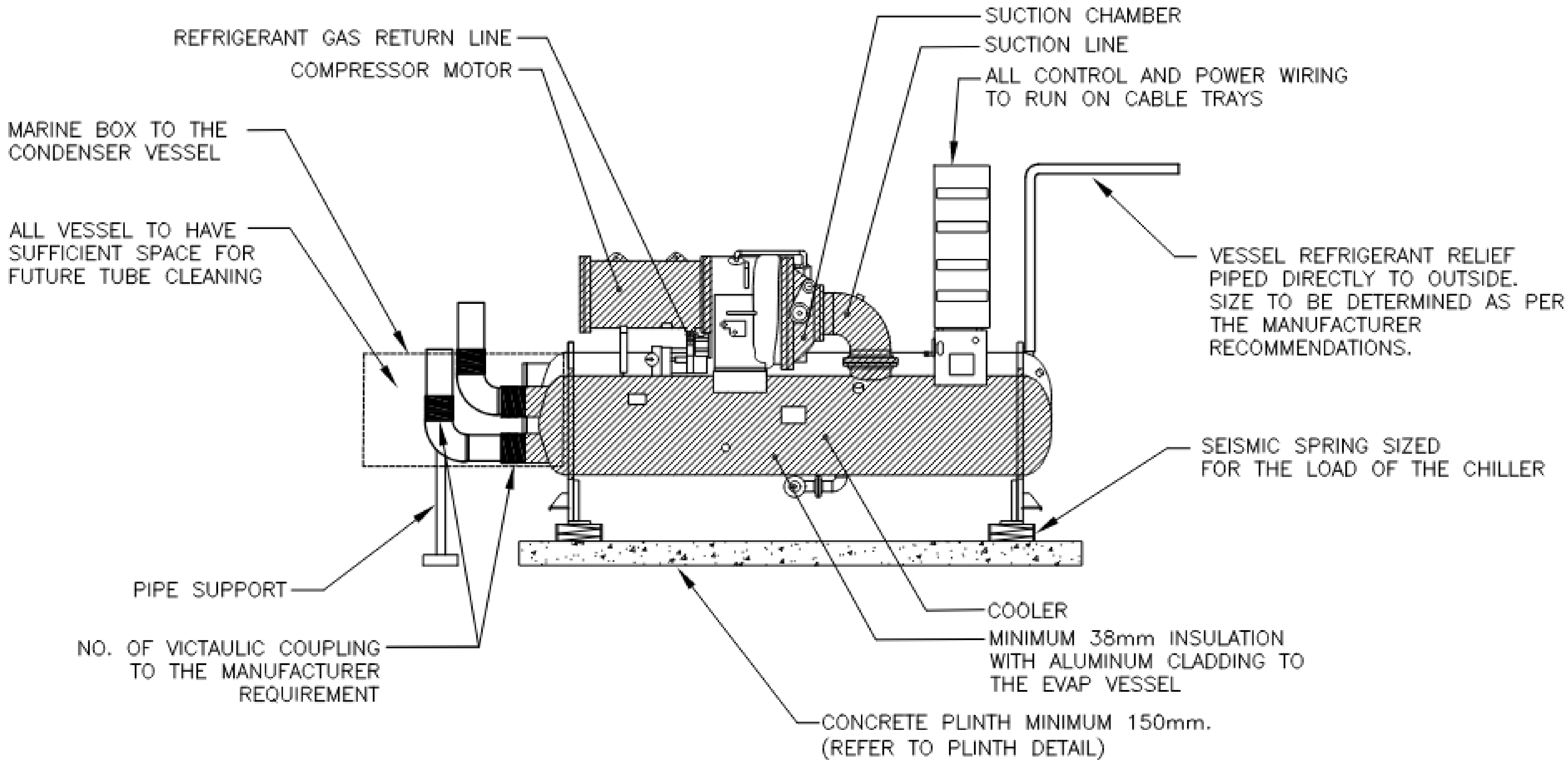
DETAIL
TRENCH DETAIL WITH FILL OVER

CURTIN PROJ No	MASTER	SCALE: NTS	UNIT: mm		
DWG STATUS	FOR INFORMATION ONLY		SHEET SIZE	A4	
DWG No	M–D–42	SHEET 01	OF 01	ISSUE A	



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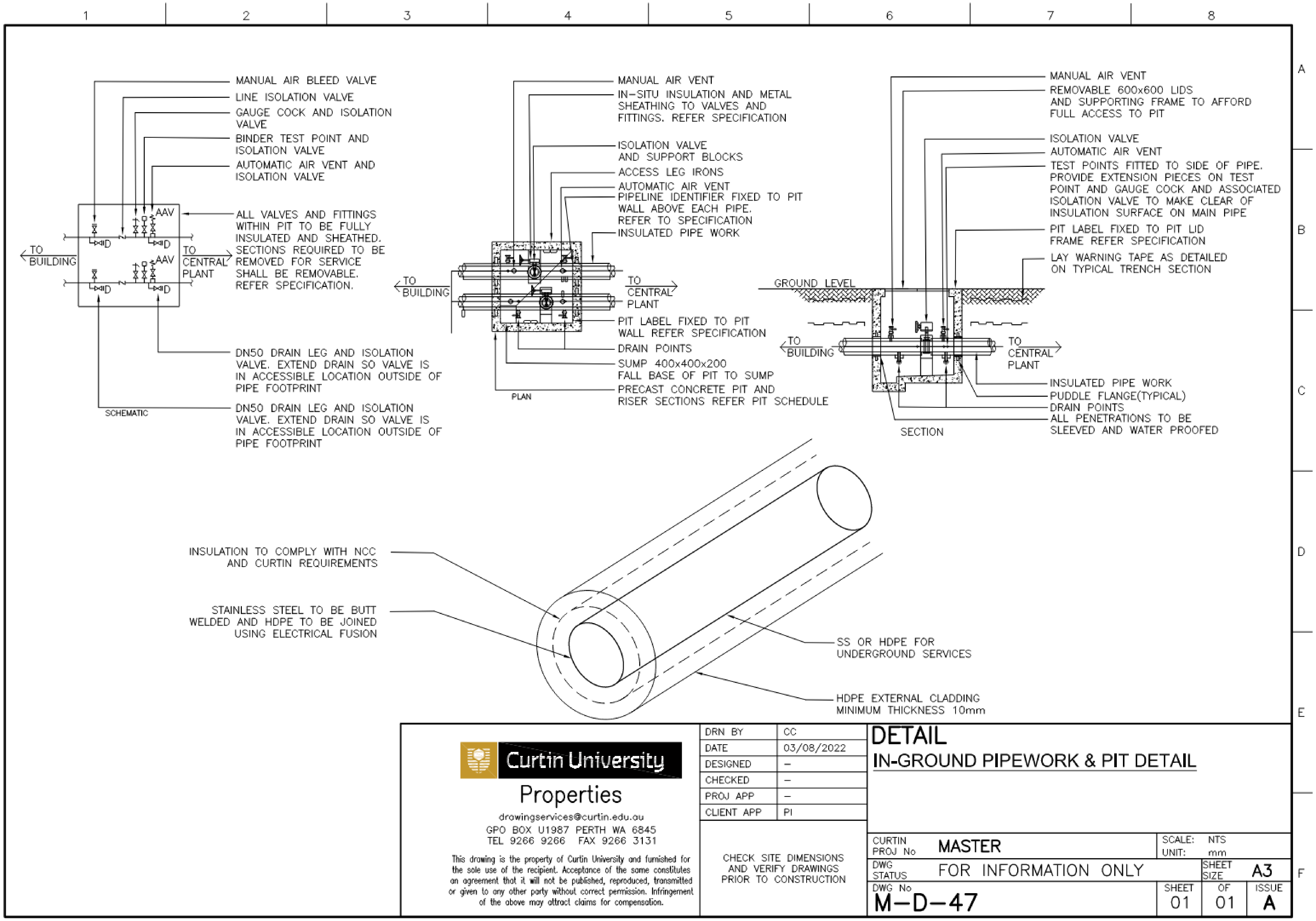
CHECK SITE DIMENSIONS AND VERIFY DRAWINGS PRIOR TO CONSTRUCTION

DETAIL

TYPICAL WATER COOLED CHILLER

CURTIN PROJ No	MASTER	SCALE:	NTS		
		UNIT:	mm		
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4		
DWG No	M–D–46	SHEET	01	OF 01	ISSUE A



MANUAL AIR BLEED VALVE
LINE ISOLATION VALVE
GAUGE COCK AND ISOLATION VALVE
BINDER TEST POINT AND ISOLATION VALVE
AUTOMATIC AIR VENT AND ISOLATION VALVE
AAV
ALL VALVES AND FITTINGS WITHIN PIT TO BE FULLY INSULATED AND SHEATHED. SECTIONS REQUIRED TO BE REMOVED FOR SERVICE SHALL BE REMOVABLE. REFER SPECIFICATION.
TO BUILDING
TO CENTRAL PLANT
D
DN50 DRAIN LEG AND ISOLATION VALVE. EXTEND DRAIN SO VALVE IS IN ACCESSIBLE LOCATION OUTSIDE OF PIPE FOOTPRINT
SCHEMATIC
DN50 DRAIN LEG AND ISOLATION VALVE. EXTEND DRAIN SO VALVE IS IN ACCESSIBLE LOCATION OUTSIDE OF PIPE FOOTPRINT
MANUAL AIR VENT
IN-SITU INSULATION AND METAL SHEATHING TO VALVES AND FITTINGS. REFER SPECIFICATION
ISOLATION VALVE AND SUPPORT BLOCKS
ACCESS LEG IRONS
AUTOMATIC AIR VENT
PIPELINE IDENTIFIER FIXED TO PIT WALL ABOVE EACH PIPE. REFER TO SPECIFICATION
INSULATED PIPE WORK
TO BUILDING
TO CENTRAL PLANT
PIT LABEL FIXED TO PIT WALL REFER SPECIFICATION
DRAIN POINTS
SUMP 400x400x200
FALL BASE OF PIT TO SUMP
PRECAST CONCRETE PIT AND RISER SECTIONS REFER PIT SCHEDULE
PLAN
MANUAL AIR VENT
REMOVABLE 600x600 LIDS AND SUPPORTING FRAME TO AFFORD FULL ACCESS TO PIT
ISOLATION VALVE
AUTOMATIC AIR VENT
TEST POINTS FITTED TO SIDE OF PIPE. PROVIDE EXTENSION PIECES ON TEST POINT AND GAUGE COCK AND ASSOCIATED ISOLATION VALVE TO MAKE CLEAR OF INSULATION SURFACE ON MAIN PIPE
PIT LABEL FIXED TO PIT LID FRAME REFER SPECIFICATION
LAY WARNING TAPE AS DETAILED ON TYPICAL TRENCH SECTION
GROUND LEVEL
TO BUILDING
TO CENTRAL PLANT
INSULATED PIPE WORK
PUDDLE FLANGE(TYPICAL)
DRAIN POINTS
ALL PENETRATIONS TO BE SLEEVED AND WATER PROOFED
SECTION
INSULATION TO COMPLY WITH NCC AND CURTIN REQUIREMENTS
STAINLESS STEEL TO BE BUTT WELDED AND HDPE TO BE JOINED USING ELECTRICAL FUSION
SS OR HDPE FOR UNDERGROUND SERVICES
HDPE EXTERNAL CLADDING MINIMUM THICKNESS 10mm
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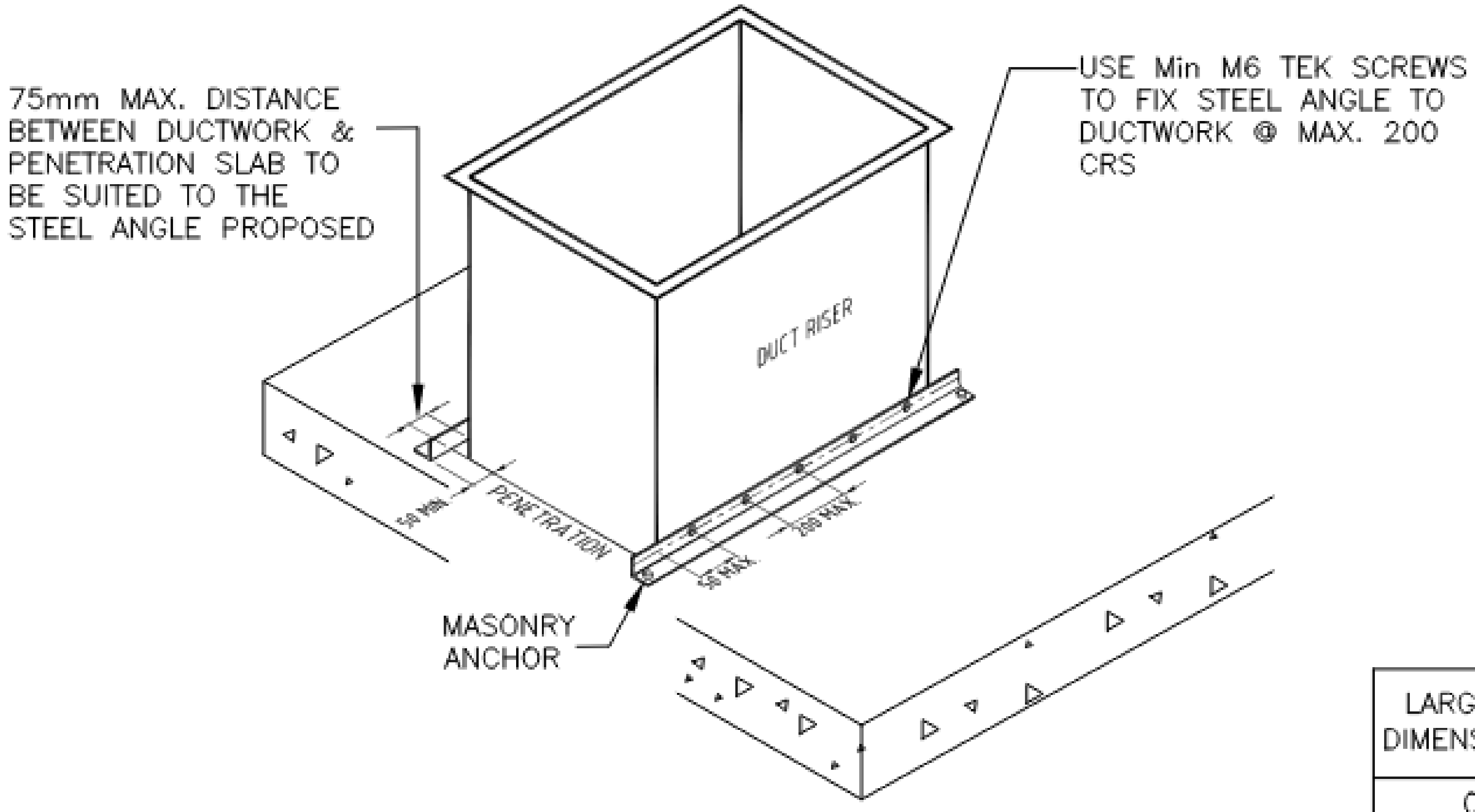
DETAIL
IN-GROUND PIPEWORK & PIT DETAIL
CURTIN PROJ No MASTER
SCALE: NTS
UNIT: mm
DWG STATUS FOR INFORMATION ONLY
SHEET SIZE A3
DWG No M-D-47
SHEET 01
OF 01
ISSUE A



NOTE:

1. ANGLE SHALL BE APPROPRIATELY SUITED TO THE DUCTWORK PROPOSED IN TERMS OF SIZE, MATERIAL & LOAD CARRYING CAPACITY
2. COMPLY WITH THE REQUIREMENTS OF STRUCTURAL ENGINEER & NCC WITH RESPECT TO ALL ANCHORS INSTALLED.

LARGEST DUCT DIMENSION (mm).	DURAGAL® STEEL ANGLE (mm).	MAXIMUM SPACING BETWEEN SUPPORTS (mm)
0-900	50x50x2.5	3600
OVER 901	50x50x5.0	3600

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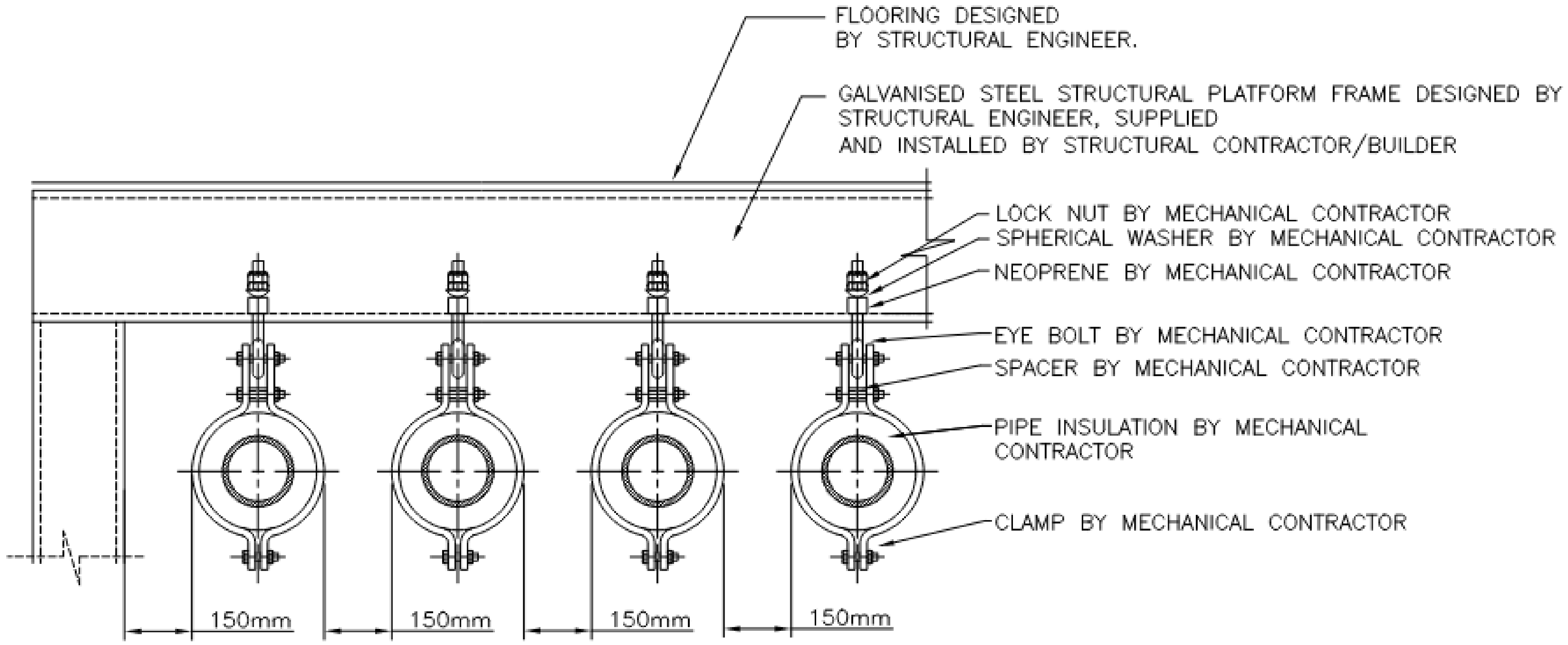
DETAIL

DUCT CONSTRUCTION

RISER DUCT AND PENETRATION IN SLAB

CURTIN PROJ No	MASTER	SCALE: NTS	UNIT: mm		
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4		
DWG No	M-D-44	SHEET 01	OF 01	ISSUE A	



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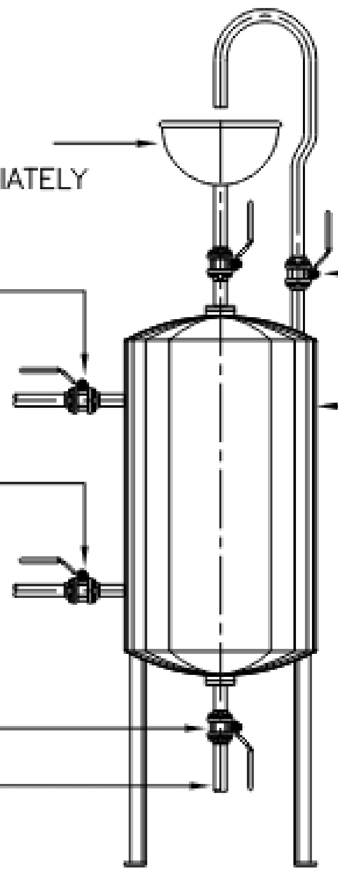
DETAIL

ROOF PLATFORM PIPE HANGER DETAIL

CURTIN PROJ No	MASTER	SCALE: NTS	UNIT: mm
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4
DWG No	M–D–33	SHEET 01 OF 01	ISSUE A



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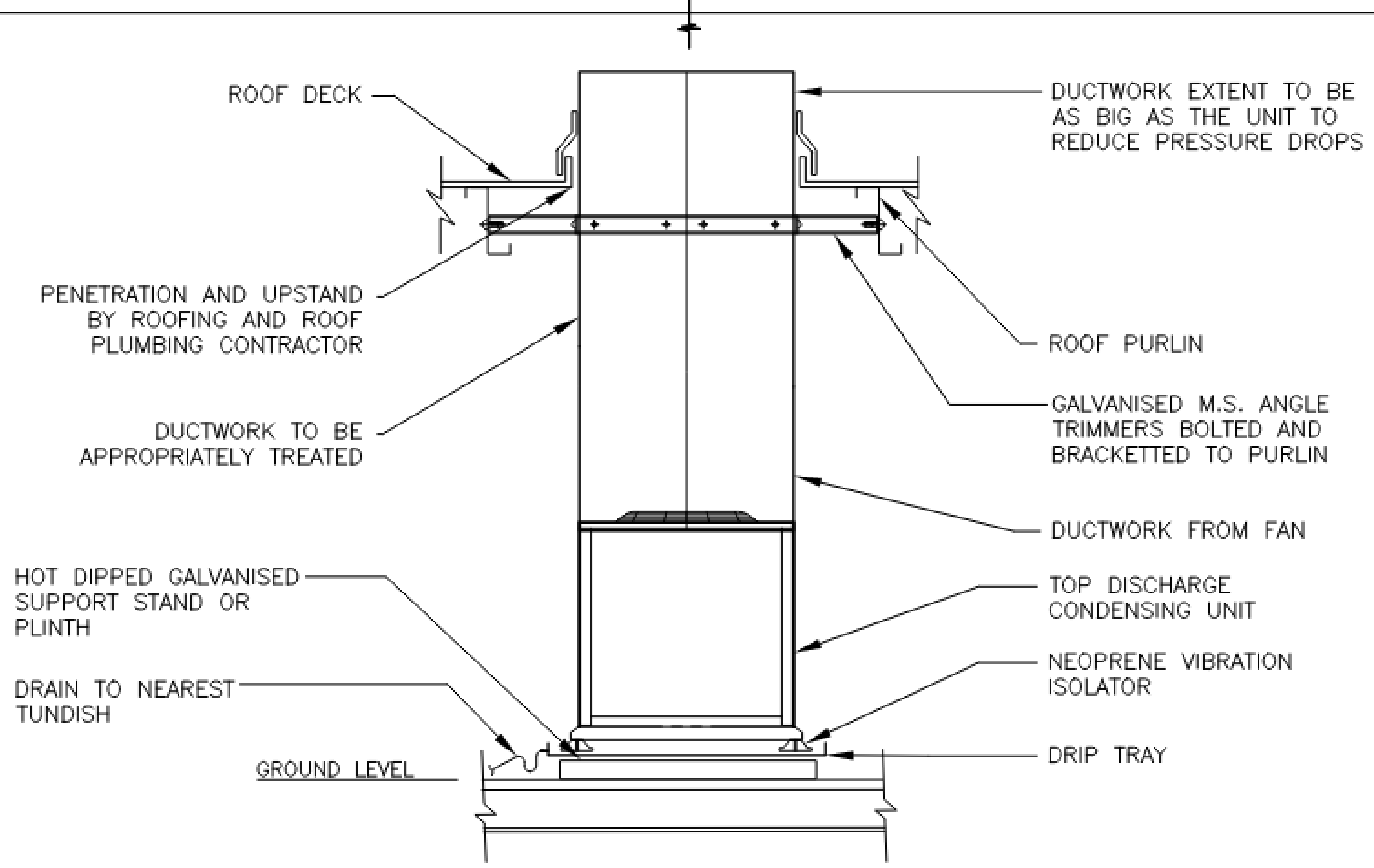
DETAIL

CHEMICAL MANUAL DOSING POT

CURTIN PROJ No	MASTER	SCALE: NTS UNIT: mm		
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4	
DWG No	M–D–28	SHEET 01	OF 01	ISSUE A



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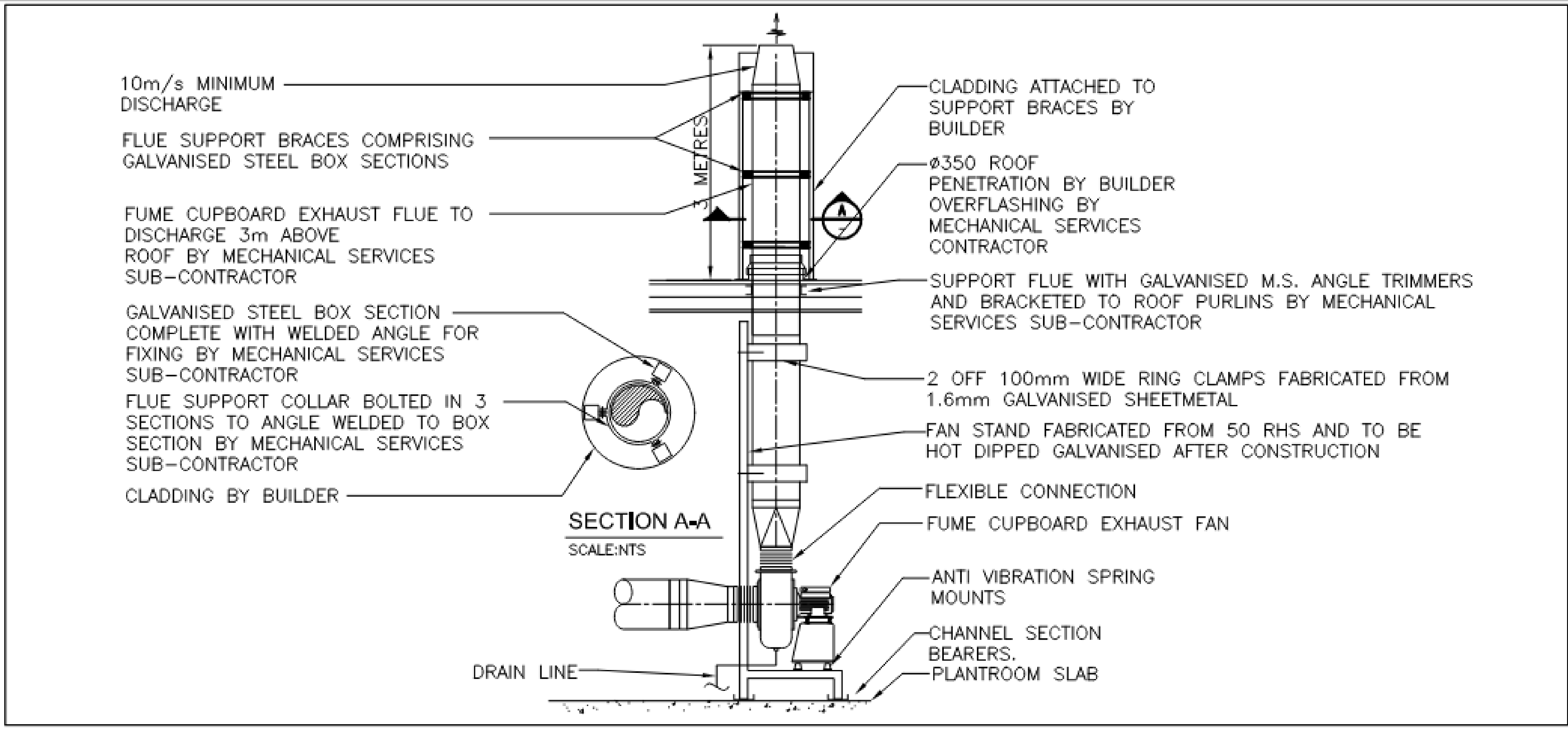
DETAIL

TYPICAL CONDENSING UNIT MOUNTING IN PLANTROOM

CURTIN PROJ No	MASTER	SCALE: NTS	UNIT: mm		
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4		
DWG No	M–D–21	SHEET 01	OF 01	ISSUE A	



DETAIL

TYPICAL FUME CUPBOARD EXHAUST FAN

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DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4
DWG No	M–D–14	SHEET 01 OF 01	ISSUE A

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GPO BOX U1987 PERTH WA 6845
TEL 9266 9266 FAX 9266 3131

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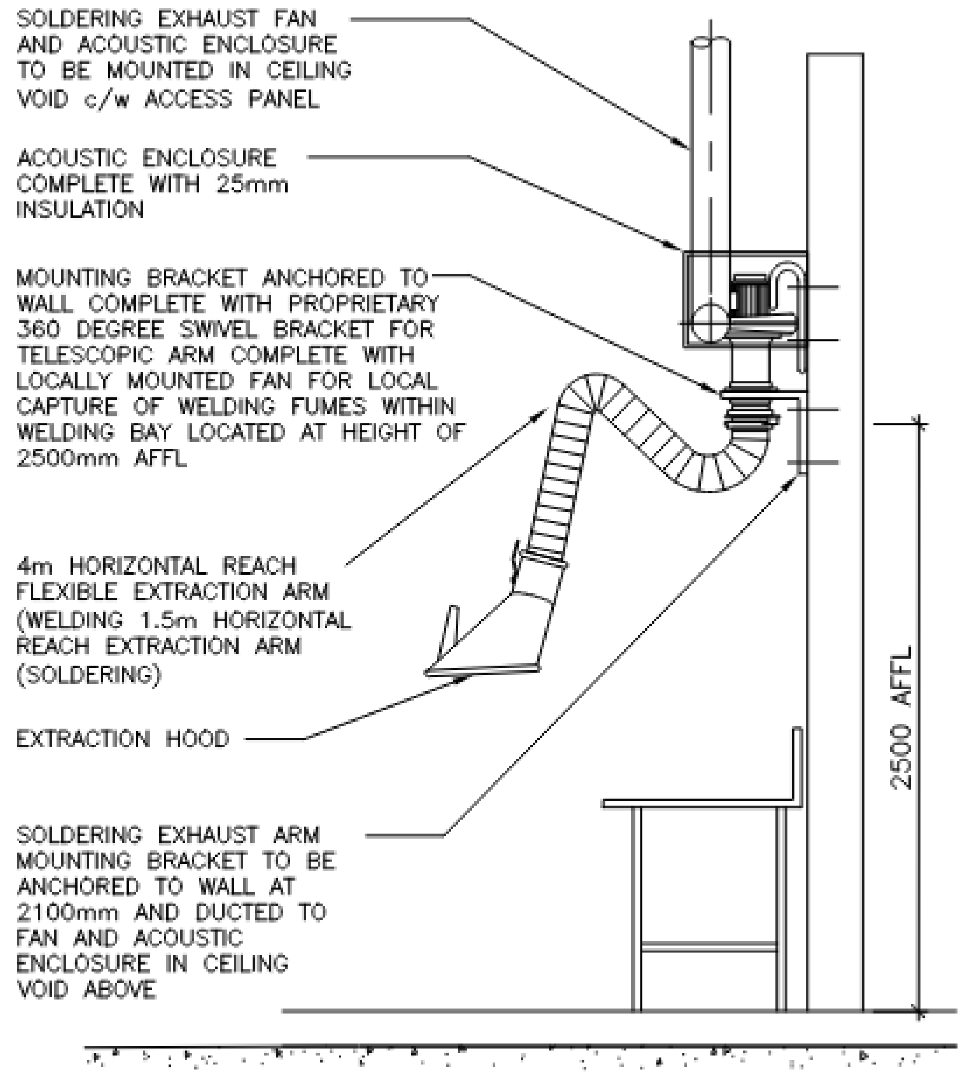

Curtin University

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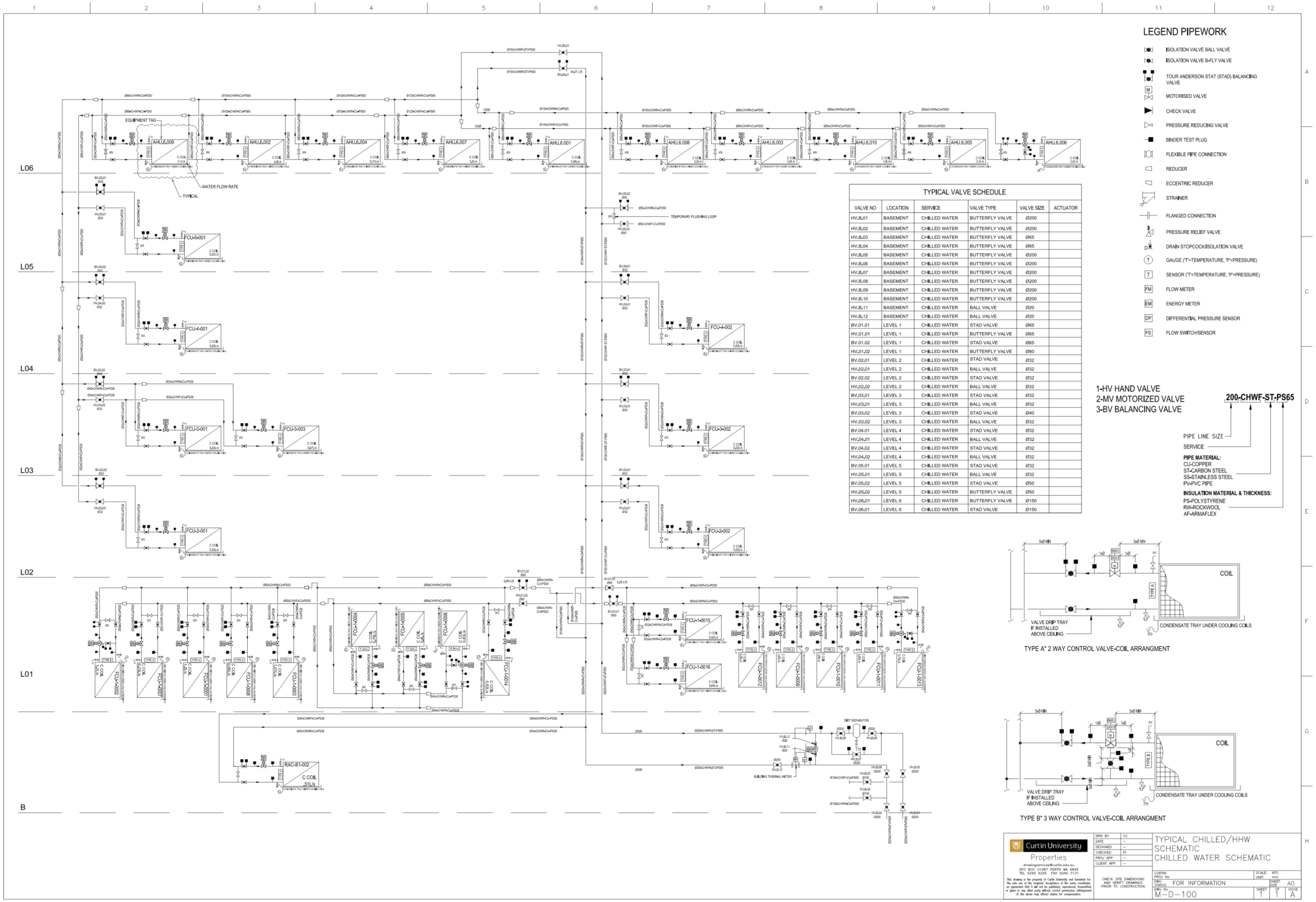
DRN BY	CC
DATE	03/08/2022
DESIGNED	–
CHECKED	–
PROJ APP	–
CLIENT APP	PI

CHECK SITE DIMENSIONS AND VERIFY DRAWINGS PRIOR TO CONSTRUCTION

DETAIL

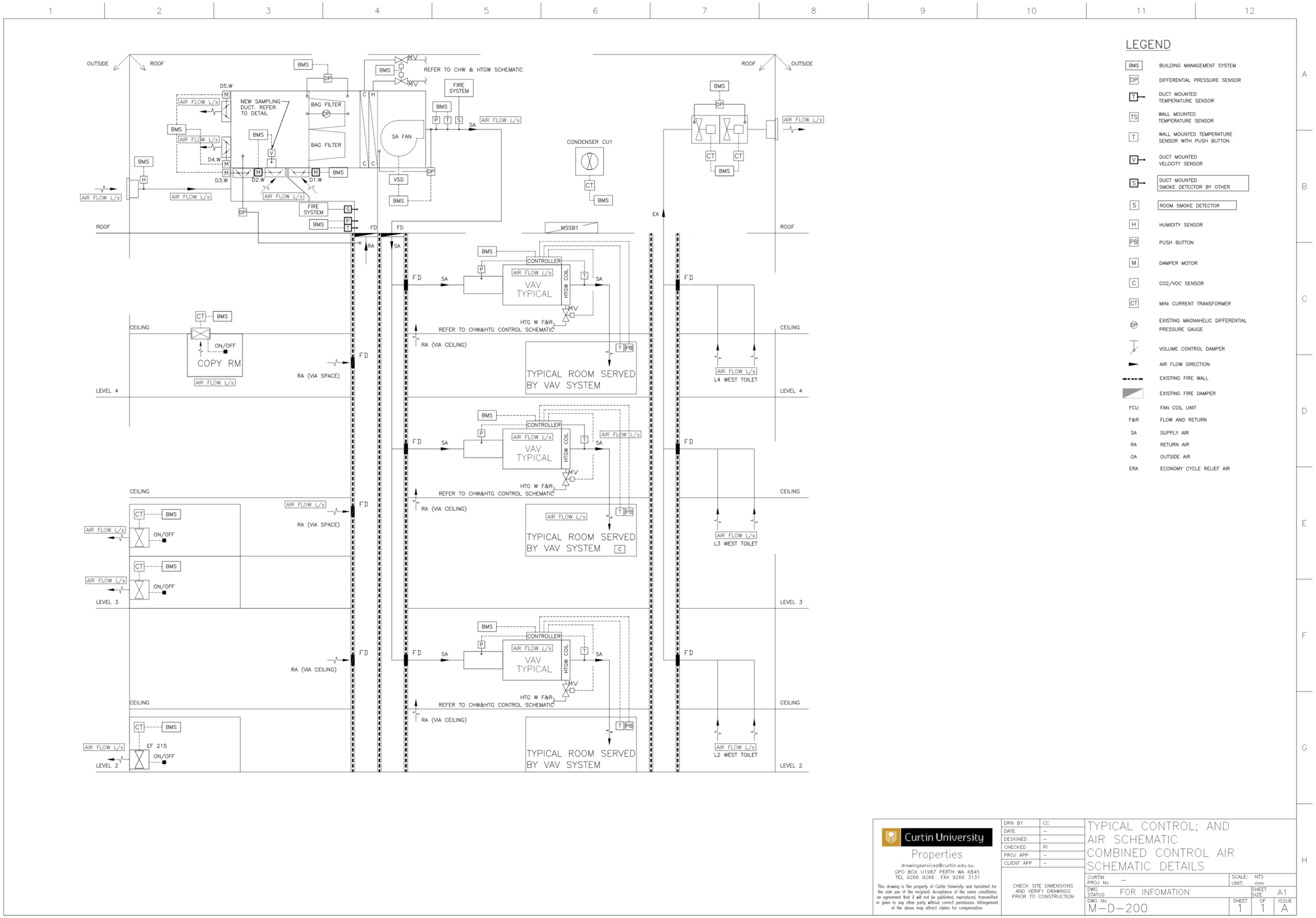
TYPICAL FUME EXTRACTION DETAIL

CURTIN PROJ No	MASTER	SCALE: NTS	UNIT: mm
DWG STATUS	FOR INFORMATION ONLY	SHEET SIZE	A4
DWG No	M–D–13	SHEET 01	OF 01
		ISSUE	A



TYPICAL VALVE SCHEDULE

VALVE NO	LOCATION	SERVICE	VALVE TYPE	VALVE SIZE	ACTUATOR
HV.B.01	BASEMENT	CHILLED WATER	BUTTERFLY VALVE	Ø200	
HV.B.02	BASEMENT	CHILLED WATER	BUTTERFLY VALVE	Ø200	
HV.B.03	BASEMENT	CHILLED WATER	BUTTERFLY VALVE	Ø65	
HV.B.04	BASEMENT	CHILLED WATER	BUTTERFLY VALVE	Ø65	
HV.B.05	BASEMENT	CHILLED WATER	BUTTERFLY VALVE	Ø200	
HV.B.06	BASEMENT	CHILLED WATER	BUTTERFLY VALVE	Ø200	
HV.B.07	BASEMENT	CHILLED WATER	BUTTERFLY VALVE	Ø200	
HV.B.08	BASEMENT	CHILLED WATER	BUTTERFLY VALVE	Ø200	
HV.B.09	BASEMENT	CHILLED WATER	BUTTERFLY VALVE	Ø200	
HV.B.10	BASEMENT	CHILLED WATER	BUTTERFLY VALVE	Ø200	
HV.B.11	BASEMENT	CHILLED WATER	BALL VALVE	Ø20	
HV.B.12	BASEMENT	CHILLED WATER	BALL VALVE	Ø20	
BV.01.01	LEVEL 1	CHILLED WATER	STAD VALVE	Ø65	
HV.01.01	LEVEL 1	CHILLED WATER	BUTTERFLY VALVE	Ø65	
BV.01.02	LEVEL 1	CHILLED WATER	STAD VALVE	Ø65	
HV.01.02	LEVEL 1	CHILLED WATER	BUTTERFLY VALVE	Ø80	
BV.02.01	LEVEL 2	CHILLED WATER	STAD VALVE	Ø32	
HV.02.01	LEVEL 2	CHILLED WATER	BALL VALVE	Ø32	
BV.02.02	LEVEL 2	CHILLED WATER	STAD VALVE	Ø32	
HV.02.02	LEVEL 2	CHILLED WATER	BALL VALVE	Ø32	
BV.03.01	LEVEL 3	CHILLED WATER	STAD VALVE	Ø32	
HV.03.01	LEVEL 3	CHILLED WATER	BALL VALVE	Ø32	
BV.03.02	LEVEL 3	CHILLED WATER	STAD VALVE	Ø40	
HV.03.02	LEVEL 3	CHILLED WATER	BALL VALVE	Ø32	
BV.04.01	LEVEL 4	CHILLED WATER	STAD VALVE	Ø32	
HV.04.01	LEVEL 4	CHILLED WATER	BALL VALVE	Ø32	
BV.04.02	LEVEL 4	CHILLED WATER	STAD VALVE	Ø32	
HV.04.02	LEVEL 4	CHILLED WATER	BALL VALVE	Ø32	
BV.05.01	LEVEL 5	CHILLED WATER	STAD VALVE	Ø32	
HV.05.01	LEVEL 5	CHILLED WATER	BALL VALVE	Ø32	
BV.05.02	LEVEL 5	CHILLED WATER	STAD VALVE	Ø50	
HV.05.02	LEVEL 5	CHILLED WATER	BUTTERFLY VALVE	Ø50	
HV.06.01	LEVEL 6	CHILLED WATER	BUTTERFLY VALVE	Ø150	
BV.06.01	LEVEL 6	CHILLED WATER	STAD VALVE	Ø150	


OUTSIDE
ROOF
BMS
DP
MV
REFER TO CHW & HTGW SCHEMATIC
FIRE SYSTEM
D5.W
NEW SAMPLING DUCT. REFER TO DETAIL
BAG FILTER
SA FAN
AIR FLOW L/s
D4.W
D3.W
D2.W
D1.W
VSD
CONDENSER CU1
MSSB1
EA
FD
RA
SA
CONTROLLER
VAV TYPICAL
HTGW COIL
HTG W F&R
REFER TO CHW&HTG CONTROL SCHEMATIC
RA (VIA CEILING)
RA (VIA SPACE)
CEILING
ON/OFF
COPY RM
TYPICAL ROOM SERVED BY VAV SYSTEM
L4 WEST TOILET
L3 WEST TOILET
L2 WEST TOILET
LEVEL 4
LEVEL 3
LEVEL 2
EF 215
LEGEND
BMS BUILDING MANAGEMENT SYSTEM
DP DIFFERENTIAL PRESSURE SENSOR
T DUCT MOUNTED TEMPERATURE SENSOR
TS WALL MOUNTED TEMPERATURE SENSOR
T WALL MOUNTED TEMPERATURE SENSOR WITH PUSH BUTTON
V DUCT MOUNTED VELOCITY SENSOR
S DUCT MOUNTED SMOKE DETECTOR BY OTHER
S ROOM SMOKE DETECTOR
H HUMIDITY SENSOR
PB PUSH BUTTON
M DAMPER MOTOR
C CO2/VOC SENSOR
CT MINI CURRENT TRANSFORMER
DP EXISTING MAGNAHELIC DIFFERENTIAL PRESSURE GAUGE
VOLUME CONTROL DAMPER
AIR FLOW DIRECTION
EXISTING FIRE WALL
EXISTING FIRE DAMPER
FCU FAN COIL UNIT
F&R FLOW AND RETURN
SA SUPPLY AIR
RA RETURN AIR
OA OUTSIDE AIR
ERA ECONOMY CYCLE RELIEF AIR
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DRN BY CC
DATE –
DESIGNED –
CHECKED PI
PROJ APP –
CLIENT APP –
CHECK SITE DIMENSIONS AND VERIFY DRAWINGS PRIOR TO CONSTRUCTION
TYPICAL CONTROL; AND AIR SCHEMATIC
COMBINED CONTROL AIR SCHEMATIC DETAILS
CURTIN PROJ No –
SCALE: NTS
UNIT: mm
DWG STATUS FOR INFOMATION
SHEET SIZE A1
DWG No M–D–200
SHEET 1 OF 1
ISSUE A