



THE UNIVERSITY OF
SYDNEY

Building Management and Control Systems Standard

Design, Engineering, Planning & Sustainability

University Infrastructure

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1 Purpose

The UI BMCS Standard sets out the University of Sydney's minimum requirements for the design, construction and maintenance of BMCS systems. It ensures new and refurbished systems are energy efficient, fit-for-purpose, made from durable good-quality materials, contain no or minimal environmentally harmful substances, and are cost efficient to operate and maintain.

Applicable requirements documented in Workplace Health and Safety legislation, Disability Discrimination legislation, State Environmental Planning legislation, Commonwealth and State legislation, National Construction Codes (NCC), the Building Code of Australia (BCA) and Australian and New Zealand Standards (AS/NZS) are the minimum and mandatory compliance requirements.

Where any ambiguity exists between this standard and the aforementioned mandatory requirements then:

- a. The highest performance requirements must apply
- b. Applicable requirements must follow this order of precedence:
 1. Workplace Health and Safety legislation.
 2. Safety in Design Legislation.
 3. Disability Discrimination legislation.
 4. State Environmental Planning and Assessment legislation.
 5. All other Commonwealth and State legislation.
 6. NCC, BCA and PCA.
 7. AS/NZS.
 8. This standard and other University of Sydney standards.

2 Scope

This standard describes minimum requirements for design, purchase, construction, and operation and maintenance of The BMCS, equipment and infrastructure for buildings and spaces owned, operated, maintained and/or managed by the University of Sydney. It applies to:

- a. New Building Construction.
- b. Refurbishment spaces within existing buildings
- c. Facilities maintenance services.

The standards apply to all planners, project managers, consultants, contractors, sub-contractors, tenants, managing agents and University staff involved in the design, construction and maintenance of existing, new and proposed University buildings and facilities.

The Standard provides:

- a. A reference document to enable consistency with the design and engineering objectives.
- b. Details of the minimum performance requirements for planning, architectural design and maintenance.
- c. Support of the University vision for the built environment and best practice.

The Standard addresses key objectives:

- a. Quality design which responds, enhances and complements the environment.
- b. Appreciation of the heritage context and cultural history of the campuses.
- c. Value for money in all aspects of the project.
- d. The design of low maintenance buildings and environments.
- e. Longevity of construction approach to design.
- f. Standardization of key flashing and ancillary details.

- g. Flexible design, to future proof building usage for expansion or adaption to new uses
- h. Safety in design.

All BMCS products and services provided or specified by designers, consultants, staff and contractors must conform to this standard.

Where specific applications are not explicitly covered, or ambiguity exists, the intent of the design standard must be satisfied. In such cases a return design brief must be provided for review and approval by the issuer of this standard or their appointed delegate who must have relevant technical competence in the subject matter. Additional more stringent requirements may apply on a project-specific basis dependent upon risk management and insurance requirements.

3 Glossary of Terms

AIRAH	Australian Institute of Refrigeration Air Conditioning and Heating
AS	Australian Standard
BACnet	Building Automation Control Networks
BCA/NCC	Building Code of Australia / National Construction Code
BMCS	Building Management Control System
CIBSE	Chartered Institution of Building Services Engineers
COS	Central Operations Services
DDC	Direct Digital Control
EP&AR	Environmental Planning & Assessment Regulation
FCU	Fan Coil Unit
FIP	Fire Indicator Panel
HLI	High Level Interface
HVAC	Heating Ventilation and Air Conditioning
I/O	Input/output
IP	Internet Protocol
MSDS	Material safety data sheets
NATA	National Association of Testing Authorities
NCC	National Construction Code
PC	Practical Completion
PICS	Protocol Implementation Conformance Statement

PID	Proportional-Integral-Derivative
PPR	Project Principal Requirements
PUG	Project User Group or Project Working Group
RAC	Room Air conditioner (window mounted)
UI	University Infrastructure
VAV	Variable Air Volume
VOC	Volatile organic compound
VRF	Variable Refrigerant Flow
VRV	Variable Refrigerant Volume

4 Roles and Responsibilities

This standard is issued by UI. It is approved and signed off by the Chief University Infrastructure Officer. UI is responsible for maintaining the standard and keeping it up to date.

5 Construction Requirements

Due to the complex nature of the University's Infrastructure, the requirements for construction of new buildings, and the refurbishment of existing buildings differ and must be assessed on a case by case basis. Careful consideration must be taken in relation to connection and disconnection of existing services, and the reuse of existing equipment. This section outlines the construction requirements for both new and existing buildings.

5.1 New Buildings

The BMCS provided in University buildings must be designed and installed in accordance with the minimum legislative requirements incorporating all Statutory Regulations, Australian Standards, Local Council, Work Health & Safety (WHS) and WorkCover requirements.

Each building must be equipped with a complete BMCS, all designed and installed in accordance with the requirements of the project PPR, NCC and Australian Standards. Additional measures may also be required to meet specific building hazards and/or the requirements of University Insurers.

The consultant/contractor will consult with UI, and Project User Groups, to discuss any additional mechanical services that must be included in the design, in order to suit the proposed occupancy, associated hazards, proposed equipment and environmental conditions.

5.2 Refurbishments

All existing BMCS systems in a building must be extended/replaced as necessary into the given project. The design for projects within existing buildings must be assessed on a case by case basis and developed in conjunction with this standard. Existing systems must be kept the same system type in a building, mixed systems in a building will not be accepted.

All project associated redundant equipment, fixings and wiring, including inaccessible ceiling spaces, must be removed as part of the project works. Make good exposed surfaces before commencing the installation of new services. This includes the removal of redundant underground services unless otherwise approved by the project superintendent.

5.3 Reuse of existing equipment

Where existing equipment is utilised as part of a project it is the responsibility of the contractor to confirm its performance\condition and provide a written report to the University. The contractor must ensure that there is sufficient capacity in the existing equipment.

6 Technical Requirements

6.1 Introduction

The BMCS system of a University building must include surrounding structures and annex buildings. In some cases, components of the BMCS system will be installed or must be installed in other buildings. In these cases, the word building in this document is to be interpreted as inclusive of these structures, annexes and components.

6.2 Design and Documentation

6.2.1 General

This section outlines the extent of the services to be provided by the contractor during the process of Design and Construction.

The contractor shall be fully responsible for the complete design of the BMCS installations, including the selection, sizes, quantity of equipment, shall provide calculations, drawings and other documentation as necessary to demonstrate conformance with the design parameters, industry practice, UI requirements, codes, regulations and standards. This includes all calculations required to confirm that existing infrastructure is sufficient to supply the proposed systems and equipment installed under the project.

The contractor shall allow to fully co-ordinate the documentation with the Architect, Structural Engineer and all other services consultants / contractors.

6.2.2 Calculations

As part of the contractor's design, it is expected as a minimum that the following design calculations are produced for review by UI for approval prior to finalising design:

- a. Cable sizing

- b. Controller capacities (processor capacity and memory)
- c. Actuator and Valves sizing
- d. Ensure system has sufficient point Licencing for project (contractor to provide licencing as required for each project)

6.2.3 Equipment Selection and Sizing

In selecting equipment, the University expects consultants and contractors to select products of proven and reliable quality, with reputable support and after sales service.

Products which are of closed systems and proprietary in nature, thus locking the University into exclusive dependence of one manufacturer must be avoided and only used if there are no other options.

The provision of 20% spare capacity for future use must be provided when designing and sizing all new BMCS installations. Where existing infrastructure is being used, provision must be made to ensure sufficient capacity remains for future works in the building.

6.2.4 Drawings and Documentation

The contractor must provide design, construction and as-built drawings, which may be either design drawings produced by the contractor or shop drawings produced by equipment manufacturers.

The BMCS contractor is responsible for producing all design and as-built documentation, including, but not limited to:

- a. Concept design documentation (as required);
- b. Detailed design documentation, including:
 - i. Alarm matrix
 - ii. Layout drawings
 - iii. Details
 - iv. System architecture
 - v. Building specific reports and alarms
 - vi. Building specific virtual meters and dashboards
 - vii. Schematics
 - viii. Dashboards
 - ix. Design certification
 - x. Equipment details
 - xi. Testing / commissioning procedures
- c. Workshop drawings, including:
 - xii. Drawings for the purpose of system installation
- d. As Built drawings, including:
 - xiii. Detailed drawings demonstrating the as installed system
- e. Operations and maintenance manuals.
- f. Training manuals

All design documentation must be approved by UI prior to any works progressing onsite. Workshop, As-Built drawings and operation and maintenance manuals must be submitted to for review prior to final sign off.

6.2.5 Workshop Submittals

Technical submittals must be provided with the full technical, spatial and network requirements of each proposed item. The technical submissions must include, where applicable, but not be limited to:

- a. Certified workshop drawings of each system and control panel complete
- b. Electrical requirements including, operational voltage, recommended protection devices, wiring diagrams, connection and terminals details. Also detail of how cables are terminated to the equipment and earthing requirements must be provided.
- c. Manufacturer's recommendations for installation including power quality and thermal requirements.
- d. Confirmation of product lifespan assuming maintained to manufacturers recommendations.
- e. Where equipment model numbers / references are stated these are indicative only and the Contractor MUST ensure the selected equipment fully complies with the entire services standard
- f. Workshop Submittals

6.3 BACnet Protocol

6.3.1 Standard Compliance

Systems must comply with the BACnet standards ISO 16484. Systems not complying with these guidelines and standards are not accepted by the University.

6.3.2 BTL Listing

All product hardware and software types proposed must have obtained BACnet Testing Laboratories (BTL) listing and must display the BTL logo as shown in **Figure 1**.



Figure 1 : BTL Logo

6.3.2.1 BACnet Controllers

Building Controllers (BCs) must conform to the following device profile requirements as specified in ISO16484-6.

- a. BACnet Building Controller (B-BC)
- b. Advanced Application Controllers (AACs).
- c. Application Specific Controllers (ASCs).
- d. Smart Actuators (SAs).

6.3.3 BACnet Documentation

All products offered must provide a reference of BTL listing.

6.4 System Configuration

The BMCS must represent all inputs and outputs including configuration properties as appropriate BACnet Objects.

The BMCS must support the Status attribute of the BACnet Object.

6.5 Control Systems

The following systems are deemed to comply with this standard: Below in Table 1

Other alternative equivalent equipment may be provided subject to approval via the variation procedure listed in Section 13 of this standard

The University will not accept middle ware applications or systems such as plant room control systems. The consultant/contractor must design and specify the control system to ensure the efficient and optimal operation of all components.

Manufacturer	System
Automated Logic	WebCTRL BACnet version only
Delta Controls	Enteliweb
Reliable Controls	MACH System

Table 1 : University BMCS systems

6.6 Servers

The University operates virtual servers for its BMCS, the server operating system and server hardware are maintained by the University.

- a. Local servers are not accepted by the University.
- b. Network Routers are not accepted by the University.

6.6.1 Tag Naming Convention

The point name descriptions must comply with the University convention standard to provide a consistent, standardized methodology for describing the meaning of points and their data associated with equipment systems, energy metering systems, other smart devices including mobile assets. The convention may not provide the naming description for all plant and equipment on a particular project. In these cases, the BMCS contractor will fill in any gaps with proposed descriptions for the review and approval of the stakeholders prior to implementation.

6.6.2 BACnet Priority Array

Control logic within the DDC controllers will be programmed to adhere to the BACnet priority array in Table 2.

Priority Level	Application
1	Manual-Life Safety
2	Automatic-Life Safety
3	Available
4	Available
5	Critical Equipment Control
6	Minimum On/Off
7	Available
8	Manual Operator

9	Available
10	Available
11	Available
12	Available
13	Available
14	Available
15	Available
16	Available

Table 2 : BACnet Priority Array

Priority levels 3 and 4 must be made available for use by an enterprise platform either as part of the project, or for any future project which may require a high priority access.

6.6.3 Trend Logs

Trend logs must be engineered and reside within the DDC controllers and comply with the BACnet trend object standard. The trend log will initially be set to poll every 15 Minutes, or upon a change of value (COV). Trend data will be archived to the BMCS server. Modbus points from energy meters will be Trend logged by the Energy Management Software across the network.

Where specific PPR space conditions are required such as labs and controlled environment spaces, they must poll at project specific intervals that are determined during contractor design workshops with the University.

Controllers must be capable of holding its trend logs for a minimum time of 7 days.

All trends shall be initiated at the field level and initially setup for a 3-year trend period in the server.

6.7 Device Instances and Addresses

To ensure a seamless integration across all platforms and sites, the device instances and addresses of all the BMCS equipment shall comply with the University conventions. It is the responsibility of the BMCS contractor to co-ordinate\assign the BACnet numbering for other trades on each project.

6.7.1 BACnet Device Numbering Convention

The University's standard for BACnet Device numbering is alphanumeric using the building code as the starting number.

Example: Building code of A31 would equate to a starting number of 131.

Example: Building code H70 would equate to a starting number of 870.

Only one BBMD is allowed on any one IP subnet.

6.8 Quality Assurance

6.8.1 Products

All products used in this installation must be new, currently under manufacture and must be available as standard off-the-shelf products. Written approval from the University is required to install any new BMCS products that are not commercially available. Spare parts must be available for at least 10 years after completion of the contract in relation to BMCS installation.

6.8.2 System Performance

The system must have the following functionality:

- a. Graphic display-the system must display a graphic with 20 dynamic points/objects with all current data within 2.5 seconds.
- b. Graphic refresh – the system shall update a graphic with 20 dynamic points/objects with all current data within 2.5 seconds
- c. Object command - the maximum time between the command of a binary object by the operator and the reaction by the device must be less than 2 seconds. Analogue objects must start to adjust within 2 seconds
- d. Object scan – all changes of state and change of analogue values must be transmitted over the high-speed network such that any data used or displayed at a controller or workstation will have been current within the previous 2 seconds
- e. Alarm response time – the maximum time from when an object goes into alarm to when it is communicated at the workstation must not exceed 5 seconds
- f. Program execution frequency - custom and standard applications must be capable of running as often as once every 1(one) second. The contractor must be responsible for selecting execution times consistent with the mechanical process under control
- g. PID loops – programmable controllers must be able to execute DDC PID control loops at a frequency of at least once per second. The controller must scan and update the process value and output generated by this calculation at this same frequency.
- h. Multiple alarm annunciation - all workstations on the network must receive alarms within 5 seconds of each other
- i. Reporting accuracy; the system shall report all values with an end-to-end accuracy as per **Table 3** Reporting Accuracy or better.
- j. Stability of control - control loops shall maintain measured variable at set point within the tolerances listed in **Table 4** Control Stability and accuracy.

Measured Variable	Reported Accuracy
Space Temperature	±0.5°C
Ducted Air	±0.5°C
Outside Air	±0.5°C
Dewpoint	±1.0°C
Water Temperature	±0.2°C
Delta-T (ΔT)	±0.2°C
Relative Humidity	±1% RH
Water Flow	±2% of full scale
Airflow (terminal)	±5% of full scale
Airflow (measuring stations)	±2.5% of full scale
Air Pressure (ducts)	±0.5% of full scale reading
Air Pressure (space)	0.5% of full scale reading

Water Pressure	±2% of full scale
Carbon Monoxide (CO)	±3% of full scale
Carbon Dioxide (CO ₂)	±10 ppm

Table 3: Reporting Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±10 Pa	0 – 1000 Pa
Air Pressure	± 1 Pa	-30 to 25 Pa
Airflow	± 2% of full scale	
Temperature	± 0.25°C	
Humidity	± 2% RH	
Fluid Pressure	± 10 kPa	0 -1500 kPa
Fluid Pressure differential	± 10 kPa	0 – 1000 kPa

Table 4: Control Stability and Accuracy

6.8.3 Critical Environments

For critical environments such as animal houses, special laboratories, -80°C Freezer rooms, clean rooms, museums or the like, stable operation of systems is crucial. Thus system redundancy must be considered on a case by case basis for backup power to controls, fail safe control operation alarm configurations and redundant controller/sensor installations.

6.8.4 Submittals

The following submittals must be reviewed/approved by the University:

- a. A complete description of the System including hardware and software.
- b. All system components offered (model no., data sheets, etc.)
- c. A complete description of the operation of the control system, including sequences of operation.
- d. A complete system network architecture
- e. A point/object list for each system controller including inputs and outputs (I/O), point/object number, the controlled device associated with the I/O point/object, and the location of the I/O device.
- f. Selection of valves make and model, selected valve pressure drop at Design Flow, Valve Flow Coefficient (k_v)
- g. Description of all third part interfaces (i.e. lighting controls, fire, lifts, hydraulics, etc.)

6.8.5 OWNERSHIP OF PROPRIETARY MATERIAL

All project-developed software and documentation must become the property of the University upon project handover. All Documentation, graphics and programming is to be saved on the University BMCS server. These include, but are not limited to:

- a. Project graphic images
- b. Drawings
- c. Databases
- d. Application programming code
- e. All documentation

6.8.6 Lighting Controls Integration with BMCS

Lighting control systems must be integrated into the BMCS via HLI with the following functionalities:

- a. Provide link to the building lighting control system
- b. Provide Interface to pick-up status of the space PIR, each space with HVAC that has an integrated PIR is to display the status of the PIR on the associated rooms HVAC units graphic.
- c. Lighting system must be able to create an output on BACnet for PIR status.

6.9 Network and Communication Requirements

6.9.1 General

The University network must not be used to transfer data from a controller to another controller such Chiller controller to a condenser water pump or cooling tower fan, where devices are passing data they must be on the same network chain or be directly wired.

This is to ensure that systems are controlled via the one control loop.

6.9.2 BACnet

The following are network specific requirements of the system:

- a. The BMCS system is to be interconnected to all other BMCS systems via the BACnet protocol over IP and across the university computer network.
- b. No BMCS subnet or controller is to operate that is not BACnet compliant, and all devices must be BACnet addressable.
- c. BACnet must pass data in a bi-directional manner across all routers, gateways on the University network.
- d. Un-managed switches are not to be used.
- e. Data port to be provided from communication room & BMCS cabinet by builder or ICT.
- f. Network port to be installed in board or next to cabinet.
- g. Data outlet shall be installed to allow one free port for network access to allow system servicing.
- h. Contractor is required to provide equipment MAC addresses and port details to Project manager to obtain IP addresses.
- i. Contractor is to provide BBMD (ONLY one BBMD per IP subnet) where required to integrate system on the network.

6.10 Function requirements of systems

6.10.1 Maintenance Supervision

The system must be designed and installed to be able to totalise run-times for all binary input objects, monitor equipment status and generate maintenance messages based upon use designated run-time, starts, and/or calendar date limits.

6.10.2 Sequencing

Sequence the connected output devices and prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, may be user-selectable.

6.10.3 PID Control

The BACnet loop object complete with self-tuning PID algorithm to calculate a time-varying analogue value that is used to position an output or stage a series of outputs. The set point and PID properties must be user-selectable from the operator interface.

6.11 Power Supplies

6.11.1 General

All transformers and power supplies for field devices to be located within designated control enclosures. Provide all power to cabinets, panels necessary for the complete and satisfactory operation of the entire BMCS.

UPS battery must be provided for controllers connected to animal houses, labs and critical control environments/processes. This requirement cascades through to the associated for the space such as FCUs, AHUs, VAVs, chilled/heating/condenser water system or supply/extraction air system.

6.11.2 Surge Diverters

Provide surge diverters connected to protect the sensing devices and all BMCS equipment/controls from damage or spurious operation caused by voltage surges in the power source

6.11.3 Ethernet filters

Provide EMI filters for Ethernet connections.

6.11.4 Dedicated Circuits

All power for controls equipment will be from dedicated circuits. Where a controller is dedicated to controlling a single piece of equipment power may be obtained directly from that equipment.

6.12 Graphic displays

6.12.1 General

The Contractor as part of the workshop phase is to provide sample graphics for review and comment by the University.

6.12.2 Front page

The front page shall consist of the following:

- a. List of building names and building codes controlled on the left side of the screen
- b. System time and date
- c. Map of selected campus with controlled buildings highlighted and linked
- d. Link to each campus map
- e. Temperature and Humidity of campus (to be specific to each campus)
- f. Link to alarms page
- g. Link to help page
- h. Link to user unique preferences/settings
- i. Link to main plant summary page
- j. Link to master list of all controller device schedule to be update with each controller installation and change (attachment 1)

6.12.3 Building main page

The building main page must consist of the following:

- a. Link to building levels
- b. Link to grouped equipment types such as all FCU's or chillers
- c. Global settings/overrides
- d. Fire trip monitoring
- e. Building schedules
- f. Building network status
- g. Summary pages providing a brief overview of all equipment statuses
- h. Link to thermo-graphic thermal maps which depict the temperature in the space
- i. Buildings operational description PDF document
- j. Mechanical Floor plans and Schematics in PDF

6.12.4 Floor plans

The contractor must provide floor plans that are the building CAD, all floor plans used must be the most current layout at the time of PC of the project.

- a. Floors must be broken down into logical sizes for optimised viewing
- b. Room number must be provided along with VAV, FCU, active chilled beam or package unit that services the space
- c. In larger spaces that are serviced by a single or multiple AHUs then the AHU names must be provided to the floor plans.
- d. Rooms must be thermographic showing a colour relating to the temperature with a legend identifying the colour and what it represents
- e. BMCS panel locations must be identified on the floor plans
- f. Where zones are ventilation\extraction only, thermographics must not to be used, fan link must be provided for the space it services

6.12.5 System/equipment pages

System and equipment pages must contain all of the associated inputs and outputs.

For equipment serviced by boilers and chillers they must be provided with the associated water temperatures on the page.

6.12.6 Summary Page

The following summary pages must be setup as a minimum

- a. Building Fan Coil Units
- b. Building Air Handling Units

- c. Building Humidifier
- d. Building Reheat Coils
- e. VAVs
- f. Active\Passive Chilled Beam Summary Page
- g. Building Fume Cabinet
- h. Water Cooled Package Units
- i. Louvres
- j. Ventilation Fans
- k. Cooling\heating call
- l. Afterhours call
- m. ChW valves and HW valves positions

6.12.7 Operational description

Included for each project system change must be a PDF operational description located on the building main page. See Attachment 3 for template. The description must include the following below:

- a. Each System schematic diagram (per asset type required)
- b. Network Schematic indicating controller location, address and communications status
- c. Control programming description
- d. Control loop parameters
- e. Alarm list
- f. Set points
- g. Project name
- h. Contractor performing works
- i. Document Version
- j. Document title
- k. Any specific notes
- l. Date of Drawing

6.12.8 Controller list

A Master controller list must be kept and updated when any change in network address or new/replacement controller is added to the system. Attachment 1 must be used as the template for the controller list.

The master list link must be provided on the campus map front page and contain all controllers and third party devices connected to the OEM's system, this includes items such as VRV or chiller HLI's.

6.13 Software requirements

6.13.1 System Help

An on-line help system must be available to assist the operator in managing and editing system from a beginner to an advanced level of user.

6.13.2 System security

The following are the minimum system security requirements

- a. Operators are to log on to the system with a user name and password to gain entry into the operator workstation software.
- b. System security must be role based and selectable for each individual operator and include a provision for granting privileges
- c. New Logins and access levels must be authorised only by University's Engineering team

- d. User privileges must be location dependent to provide the user different access levels based on where they are in the system

6.13.3 Operator Display

The operator workstation software is to display and provide operator access to all BACnet and proprietary objects associated with the project as specified in the drawings and/or points list. Right-clicking an object is to bring up a context sensitive pop-up menu of commands and functions that can be initiated directly for the highlighted object without opening the object.

6.13.4 Programming

- a. All programming must be available for live viewing and display of operating sequences.
- b. Pre-programmed Logic blocks that do not allow access to programming/settings will not be accepted.
- c. Programming must be laid out in a clear and flowing structure.
- d. Programming and Graphical software tools shall be provided under the same system software package using the same database. Separate or independent programming or graphic tools will not be accepted.
- e. Software lockout of equipment in fault will not be accepted, equipment must be auto-resetting unless PPR calls for lockout or piece of equipment goes out on fault multiple time during a set time period.

6.13.5 Global settings/override

Provide global override for all common points such as

- a. Chilled/hot/condenser water valves
- b. Outside air dampers
- c. FCU/AHU Set point
- d. Start/stop signal for all systems
- e. HVAC mode (for VRV/VRF systems)
- f. Demand management
- g. Water treatment flush cycle
- h. Cooling tower cleaning
- i. VAV damper position
- j. Bush fire mode to close all outside air dampers and open return air dampers

6.13.6 Schedules

The following items must be provided in the schedule page

- a. Weekly calendar capable of having segments programmed
- b. Special day time setting
- c. Annual special day calendar for programming special dates of running
- d. Holiday calendar for periods system not in use
- e. Seminar and lecture rooms shall have individual schedules
- f. Floor by floor schedule
- g. Equipment group schedules
- h. Ability to schedule multiple events within one day

Each project must be assessed on an individual basis to ensure fit-for-purpose schedules are developed for each area.

6.13.7 Trending

Operators must be able to create/change trend log setups.

All inputs, outputs and values shall be capable of trending by the operator.

Trend graphs must auto-update with live data as well as use backdated/historical/archived data.

Trends must be easily converted and saved to the following file formats:

- a. CSV
- b. XLS
- c. PDF
- d. JPEG

All trends must be initiated at the field level and initially setup for a 3 year trend period in the server.

6.13.8 Operator log

The system must have an operator log that tracks all operator changes and activities. The log shall include what is changed in the system, operator whom performed the change, date change performed and value before and after change.

The system must have the ability to request the user to enter a reason for change pop out. This function must be available to set at the equipment level.

6.13.9 Point\Value Changes

Users/Contractors are required to provide a reason for changing of values this is to include name of the operator and why the point/value has been modified.

6.13.10 User Auto- Logout

System must include an Auto Logout feature that shall automatically logout user when there has been no keyboard or mouse activity for a 15 minute period.

Auto logout may be enabled and disabled by administrator.

6.13.11 Data Storage

Historical data must be kept on the server for no less than a 3 year period.

6.14 Alarms

6.14.1 Security connections

The University operates a 24/7 operated security desk. All life threatening, safety and commercial critical alarms must be hard wired to the nearest Cardax communications room with a relay provided with a set of normally open and normally closed contacts for security to connect to.

General alarms shall be dealt with via e-mail, alarm logs and visual indications within the BMCS.

6.14.2 Alarm Priorities

Alarm priorities must be identified for each individual project and consultation must occur between the users and UI Engineering.

A project specific workshop must be held with the contractor and UI Engineering to develop alarm priorities to be programmed.

The following is the priorities used to classify alarms and the actions

- a. Priority 1 - Critical (E-mail to selected recipients and low-level signal sent to security)
- b. Priority 2 - High (E-mail to selected recipients)
- c. Priority 3 - Medium (E-mail to selected recipients)
- d. Priority 4 – Low (E-mail to selected recipients)
- e. Priority 5 - System Only (Not emailed to reside in the system only)

Faults for the following pieces of equipment must be included:

- a. Filter alarm
- b. Chiller fault
- c. Boiler fault
- d. Pump fault
- e. AHU fault
- f. FCU fault
- g. Fan fault
- h. Network/communication fault
- i. Power loss
- j. Lift fault
- k. Fire trip
- l. Hydraulic equipment fault
- m. Actuator failure zone temperature
- n. Status mismatch of equipment

The Following are the BACnet event class numbering for each vendor on site:

- a. Third party Devices 0-20
- b. Reliable Controls 25-60
- c. Automated Logic 100-150
- d. Delta Controls 200-250

Each vendor must program their alarms within the nominated number ranges as specified above.

6.14.3 E-mail alarms

Alarms that are designated to be e-mailed must be setup to have the following information.

Within the subject line of the email:

Example: G02 – High- BLR 1- Flow Failure

- a. Building code
- b. Alarm Priority
- c. Plant/equipment
- d. Fault description

Within the body of the e-mail it must contain:

- a. Building code: G02 -
- b. Plant/equipment: BLR-1 Boiler 1 Supply Air Fan
- c. Description: Boiler Status
- d. Fault description: Flow Failure
- e. Link to the plant/equipment
- f. Object monitored
- g. Recent alarm history
- h. BMCS system name

6.14.4 Alarm functionality

- a. Alarms must be viewable from workstation with a pop-up visual message for instances of alarm.
- b. Alarm messages shall be individually customisable for sending of alarm messages to selected operators and key personal.
- c. Alarm log shall be kept of all active alarms, with ability to refine log to building, floor and equipment level.
- d. Trending of cleared and active alarms shall be provided.
- e. System shall include alarm wizard for easy user setup of alarms.
- f. Wizard must have its own pull-down screen for selection of alarm parameters. There must be a function for acknowledging and clearing alarms.
- g. Alarms must be setup so that they do not cascade and cause nuisances alarms. i.e. if an AHU fails then the VAV's that it services and the spaces will not generate alarms as the AHU is the highest item in the alarm hierarchy.
- h. On power failure or fire trip alarms must not be generated for a period of time once the power/fire trip has been restored unless specifically identified in the BMCS alarm workshop.
- i. Timed thresholds must be applied to ensure nuisance alarms are not generated from items.

6.15 Efficiency

6.15.1 HVAC

The BMCS is to be programmed to optimise energy efficiency in HVAC systems by including but not limited to the following:

- a. Start to operation schedule
- b. Optimum start/stops
- c. Plant ambient lockout
- d. Supply air reset
- e. Chilled water reset
- f. Static Pressure Reset in air systems
- g. Differential pressure reset in water systems
- h. Economy cycle – full outside air cycle
- i. Zero energy band/load reset
- j. Load shedding
- k. Demand Management
- l. Energy calculation
- m. Night Purge
- n. Optimum plant operation
- o. Practicable occupancy sensing and control arrangements

6.15.2 Space control methods

The following space control options are acceptable methods to controlling space HVAC usage. The consultant designing the rooms is to use these to provide the optimum control strategy for HVAC stop/start function.

- a. Passive Infra-Red (PIR)
- b. Wall mounted push button
- c. BMCS wall pad control
- d. BMCS time scheduling
- e. Room Booking system integration

Combinations that have been proven acceptable to the university are:

- a. For individual offices push button initiation with PIR controlling the switching off of the plant or a pre-programmed push button timer
- b. For grouped individual offices turned on/off during weekdays via scheduled time clock and also switch off during this schedule when no motion is detected, if motion is detected during the scheduled time system is turned back on. Weekends and afterhours system is started by a push button and turns off via a motion sensor.
- c. Large open plan office spaces turned on/off during weekdays via scheduled time clock and also switch off during this schedule when no motion is detected, if motion is detected during the scheduled time system is turned back on. Weekends and afterhours system is started by a push button and turns off via a motion sensor.
- d. Large central lecture theatres turned on/off during weekdays via scheduled time clock and also switch off during this schedule when no motion is detected, if motion is detected during the scheduled time system is turned back on. Weekends and afterhours system is started by a push button and turns off via a motion sensor.
- e. Seminar rooms turned on/off during weekdays via scheduled time clock and also switch off during this schedule when no motion is detected, if motion is detected during the scheduled time system is turned back on. Weekends and afterhours system is started by a push button and turns off via a motion sensor.
- f. General non occupied spaces operating from pre-programmed time schedule

6.15.3 Room Booking System

Room booking systems allowance must be made in the control functionality of every system systems to accept signal from the University room booking system to start-stop the space HVAC. The functionality must be programmed into each system.

6.16 BMCS Points

Attachment 2 outlines the minimum points required for equipment installed at the University for services to the BMCS, this list does not cover project particular requirements this must be formed as part of the design phase. Additional points must be derived from the functional description and system design process from consultant to contractor.

6.16.1 Control Valves

The following is required in relation to automatic control valves:

- a. Size control valve actuators provide a tight close off against system head pressures and pressure differentials with an authority of between 30% and 50%
- b. Design and materials of valves and motors to be such that leakage of water from the stem packing does not cause corrosion of any working part
- c. Minimum fully open resistance to the flow of 1.5 times that of the combined pressure drop of the branch pipe and the item served.
- d. Valve actuators will have 0-10 volt DC control voltage except where two position control is specified
- e. All Actuators shall provide feedback signal to allow alarm generation and position validation
- f. The University Shall not accept Butterfly or ball valves for control through coils Damper Actuators

6.16.2 Damper Actuators

The following is required in relation to damper actuators:

- a. Motors to be selected conservatively motors for the duty required
- b. Select or adjust operating speeds so that the motor will remain in step with the controllers without hunting, regardless of motor variations

- c. A motor operating in sequence with other motors to have adjustable operating ranges and starting points to permit adjustment of the control sequence as required by the operating characteristics of the system
- d. Actuators to be direct coupled for either modulating or two position control
- e. Actuators to be powered by an overload-proof synchronous motor. Provide 0-10 VDC control voltage for all proportional applications and either line or low voltage actuators for all two position applications
- f. Accept analogue or pulsed digital signal directly from the BAS control unit
- g. Life span to be in excess of 50,000 open-close operations

6.16.3 Transducers

Transducers must comply with the requirements set out in **Table 5**.

Accuracy	Employ active type with an accuracy of +1% of span. Accuracy to 3% of span and repeatable to 3% of span
Signal	Accept a signal from the necessary transformers (current and/or voltage. and convert the signal(s) to a signal compatible with the BAS control unit. Supply transducers to the relevant switchboard supplier for installation.
Types	Use electronic to pneumatic transducers of industrial quality
Temperature	Temperature compensated over the full span of the device
Input Range	Input range of 0 - 10 volts DC or 4 - 20 mA
Control Relay (Solid State)	
Capacity	40v 10amp capacity
Applications:	Normally open or normally closed to suit the application, suitable for switching inductive AC loads
Current Sensor (Analogue)	
Accuracy	Accuracy is to be +/- 2% of full scale at each range

Table 5 : Transducer requirements

6.16.4 Sensors

Particular care shall be taken for location of sensors and quantity of sensors in a space to allow for accurate and reliable space sensing, single sensors in large volume areas have proven to be inappropriate and will not be accepted.

Sensors must comply with the requirements set out in **Table 6**

Humidity Sensor	
Capacitance	Capacitance type compatible with BAS system.
Duct Sampling	Complete with duct sampling devices <input type="checkbox"/> Protected from airborne dust particles and free air moisture
Temperature Compensated	Relative humidity sensors to be temperature compensated such that when used in conjunction with the BMCS or separate controller
Accuracy	Accuracy of the display is +/- 3% of operating range.
Differential Pressure Sensor (Air)	
Type	Provide static pressure sensors of the differential pressure type.
Adjustable	Sensor range (span) to be adjustable

Accuracy	Accuracy of sensor including controller to be +/- 1% of span
Capacity	Sensors to be capable of withstanding a total pressure differential of 1000 Pa
Differential Pressure Sensor (Water)	
Type	Provide static and differential pressure sensors complete with span and zero point adjustment from both software and hardware techniques.
Accuracy	Accuracy of sensor to be +/- 1% of span.
Capacity	Sensors to be capable of withstanding pressure ranges of vacuum to 2000 kPa without permanent effect on the operation of the device
Type	Sensor encapsulated in a copper or stainless steel probe
Accuracy	Accuracy +/- 0.1 deg C
Assembly	Assembly complete with wiring housing and mounting flange
Outdoor Air Temperature Sensor	
Type	Thermistor sensor encapsulated in a probe, with weatherproof enclosure, sun shield and mounting bracket
Accuracy	Accuracy to be +/- 0.5 deg C over the entire operating range
Pipe Temperature Sensor (Well)	
Type	Thermistor sensor encapsulated in a long probe, with screw fitting for insertion into a standard thermo well
Accuracy	Accuracy to be +/- 0.3 deg C over the entire operating range
Pipe Temperature Sensor (Strap-On)	
Type	Thermistor sensor <input type="checkbox"/> Complete with solid state circuitry in an enclosure and connecting cable to the thermistor
Accuracy	Accuracy to be +/- 0.3 deg C over the entire operating range
Room Temperature Sensors	
Type	Temperature sensors of the thermistor type. <input type="checkbox"/> House sensors so that access to terminal strips and cabling can only be achieved by removal cover
Rapid Response	Mount sensors to ensure a rapid response to changing temperature
Accuracy	Accuracy to be +/- 0.25 deg C over the entire operating range
Gas Sensors	
Type	The detector element will be of the plug in type with either a 24V, 4-20mA output signal.

Casing	Include sensing elements and electronics mounted in an aesthetics single piece casing.
Measurement	Provide analogue measurement to the control system.
Sensor Range	Provide a sensor range of zero to 2000 ppm
Certification	Be NATA tested with a certificate provided at time of commissioning
Portability	Portable atmospheric gas sensors must be used when specified and be also NATA tested as above
Display	Four digit LCD display
Safe Lights (Operating Normally)	Two green safe lights illuminated
Danger Lights	When tunnel gas levels exceed recommended explosive levels the red lights will turn on Two Red lights will turn on, the warning light will flash and an alarm will be sent to the control system
Analogue sign	Will enable the current TWA valve to be displayed on the control system
Alarm Level	Set point adjustment
Alarm Flow	Flow fail alarm
Power Supply	12 hour battery life (rechargeable. unit complete with recharger)
Casing	P65 casing

Table 7 : Sensor requirements

6.17 BMCS Cabinets

6.17.1 General

A Power point must be installed in board and clearly labelled Laptop PC use only.

Surge Diverters must be installed in each panel

The University shall not accept Cabinets, switchboards or system controllers mounted in ceiling spaces, unless associated with VAV boxes, or fan coil units

Boards shall comply with the University electrical standard Locks must be a T-Bar CL001 type, no other type of lock will be accepted.

6.17.2 Locations

The following location requirement shall be adhered to:

- a. Panels and cabinets mounted in dedicated plant rooms
- b. Where cabinets are no located in plant rooms university approval shall be
- c. Cabinets shall not be located in places of extreme environmental conditions
- d. Cabinets shall not be located outdoors
- e. All transformers and power supplies shall not be installed in ceiling space

6.17.3 Quality

Refer to **UI Electrical Services Standard**.

6.17.4 Wiring

Wiring must comply with the following requirements:

- a. All wiring must comply with UI Electrical Services Standard.

- b. All communication cabling to comply with ICT Communication Cabling Standard.

6.18 Product Support

All products including software, hardware and programming shall be supported locally and internationally by factory trained service departments. All spare parts shall be available ex-stock factory for a period of 10 years from purchase date.

As part of a project all necessary points/software licences must be provided.

6.19 Software Life Cycle

Due to the relatively short life cycle of software-based technology, any software updates, patches or revisions shall be backwards compatible with the field devices and controller hardware for a minimum period of 10 years. Where this is not achievable, the system provider shall submit their product life cycle model for approval. The current status of the offered product life cycle shall be submitted at the time of tender and shall have a minimum of 24 months from DLP expiry, before any revision change is required. Any revisions within the 24 month period shall be provided to keep the system up to date.

7 Commissioning

Comprehensive pre-commissioning, commissioning and quality monitoring must be specified by the consultant/designer or contractor.

Detailed testing and commissioning requirements shall be specified for each project by the consultant/designer. The CIBSE and AIRAH DA27 commissioning codes are appropriate reference documents to be used.

Offsite testing shall be performed for the DDC control logic prior to site implementation to the satisfaction of the engineer and university representative.

A project specific commissioning plan must be developed and provided to the University for review and approval. UI have developed a **BMCS Commissioning Checklist (UI-ENG-F023)** which should be used as a minimum guide when preparing the project specific commissioning plan.

7.1 Building Tuning

The BMCS Contractor shall allow for 12 months of building tuning commencing from practical completion.

The BMCS Services Contractor shall provide a building operators log on the BMCS for the principal or principals representative to detail and report any functionality issues. During the tuning period, the principal shall maintain this log or a log in a form nominated by the principal's to provide building performance observations identifying any system performance issues, which are required to be addressed as part of the building tuning process. A quarterly tuning report and meeting with The University must be undertaken.

The BMCS Contractor shall provide a detailed tuning report on the BMCS as an audit trail of the tuning activities.

At a minimum, the BMCS Contractor shall allow for the following:

- a. Review and discuss the building operators report log
- b. Analysis of Trend logs and alarms

- c. Review EMS energy performance reports
- d. Review of any exception reports and analytics
- e. Functional performance review with the Principal to identify any required modifications
- f. Control logic modifications as required
- g. Control Loop tuning
- h. Review email alarms generated and address alarms with a high volume generated
- i. Update tuning report log on BMS
- j. Update all manuals and documents such as drawings, functional descriptions, points lists and the like to reflect the changes made and resubmit these sections to the Principal to be included in the user manuals.

8 Safety in design

The contractor must consider risk during the design. A design safety report must be submitted to the relevant UI Project Manager for every design project. Contractors must confirm, so far as it is reasonably practicable, that the structure is without risks to health and safety.

Design risks must be considered for the asset lifecycle covering construction, operational and maintenance, refurbishments and decommissioning.

The design safety report must include the following:

- a. Description of design element.
- b. Description of potential risks and hazards associated with the design element.
- c. A low/medium/high risk assessment considering likelihood and consequence.
- d. Proposed measures to eliminate risks where practicable.
- e. Control measures to mitigate and manage design risks.
- f. Nominating responsibilities for managing the design risks.

This may be provided as a design risk register where appropriate and must include results of any calculations, testing and analysis etc.

9 Documentation and Records

The following documents shall be provided at practical completion:

- a. Maintenance manual
- b. Commissioning records
- c. Points list
- d. Programming logic
- e. Controller network diagram
- f. LAN network Diagram
- g. Valve and controller selection data
- h. Product Manufacturer specific information
- i. Electrical & wiring diagrams
- j. Controller & Hardware diagrams
- k. System functionality and operation description
- l. System set point values
- m. Network and Hardware configuration (Attachment 1)

A project handover plan must be developed by the consultant/designer to allow systems to be handed over to the University, including updating all BMCS documentation (Operations and Maintenance manuals, configuration records, commissioning and equipment records) to ensure that it remains current.

9.1 Design Documentation

Prior to commencing construction of new or refurbishment projects, the consultant/contractor must fully investigate and document the requirements for the BMCS system required to be installed, altered or modified as part of the project works.

This must include:

- a. Review of the current metering installed for the building to determine the proposed BMCS Upgrade Strategy.
- b. Provision of a BCA/ NCC Compliance Report.
- c. Return Brief defining the systems proposed and any deviations from this standard.
- d. Future allowances are to be included in all calculations\ sizing.
- e. Calculations & selections on the proposed equipment.
- f. Budget calculations.
- g. Points list
- h. Programming logic
- i. Controller network diagram
- j. LAN network Diagram
- k. Valve and controller selection data
- l. Product Manufacturer specific information
- m. Electrical & wiring diagrams
- n. Controller & Hardware diagrams
- o. System functionality and operation description
- p. System set point values
- q. Network and Hardware configuration (Attachment 1)
- r. New Device ID schedule
- s. New Device configuration
- t. Product manufacturer specific information
- u. System schematics
- v. Network Addressing schedule
- w. Provision of Design Certification of BMCS.
- x. Requests for all variations to this Standard submitted using the **Request for Dispensation Form (USYD-ENG-F001)**.
- y. Complete the Design & Construct checklist using the **Design & BMCS Checklist Form (UI-ENG-F009)**.

This documentation must be provided by the consultant/contractor in both electronic and hard copy formats and approved by the University.

9.2 Completion Documents

At the completion of all projects, the following documentation must be provided by the contractor for each BMCS installed or altered as part of the project works:

- a. O&M manual(s).
- b. As-built drawings including all listed items in the design documentation (Cad and DPF format).
- c. All Design documentation in As built format
- d. Asset schedules and labelling (as per the Asset Identification and Labelling Standard).
- e. Commissioning test results.

- f. Product manufacturer specific information.
- g. Details of all usernames and passwords required to access all equipment and software.
- h. Warranty schedules for all major items of equipment
- i. Maintenance requirements for all items of equipment.
- j. Building User Guide.
- k. Supply authority completion forms and inspection record.
- l. Installers Statutory certificates.
- m. Fully surveyed and documented underground services drawings depicting all as built services both PDF and CAD format.
- n. Certification of compliance to Australian Standards, The University Standards and the National Construction Code.
- o. Confirmation all associated graphics, functional description and project documents are saved on the University server

This documentation must be provided by the contractor in both electronic and hard copy formats and approved by the University prior to Practical Completion being granted.

10 Assets and Warranties

Assets are to be tagged in accordance with the Universities Asset & Labelling standard for the purpose of maintenance and operation of University Assets. For refurbishment projects the project manager is to provide the existing asset list to the contractor to ensure modified and redundant equipment are captured in the contractor's submitted asset list.

Each asset required to be collected can be found in the **Form (COS-ASSET-F001)**, each asset required to be coded will be identified by a unique equipment code.

The equipment code will be one of the three following types:

- a. Virtual asset (This is a concatenation *Building Code - Floor - Room number*)
- b. Item count asset (This is a concatenation *Building Code - Floor - Room number*)
- c. Unique bar code asset (Unique bar code in the million series number affixed to the asset)

Asset lists are to be submitted prior to practical completion of the project for review and approval by COS.

Equipment Warranties are to be provided for a minimum of 12 months from the date of practical completion. Warranties are to be provided as certificates as part of the O&M from the supplier of the equipment. It is the responsibility of the installation contractor to ensure all maintenance\servicing required to the equipment is provided to ensure warranties are valid at the end of the project DLP period.

11 Defects and Liability Period

Consultants/designers must include in the project specification detailed requirements for the defects and liability period following completion of the BMCS installation.

The contractor must include and allow for recommissioning of all major plant and equipment in the last month of the 12-month defects and liability period and confirm they achieve the original design requirements. In addition, all commissioning must be witnessed by UI Engineering staff with

commissioning reports/results formally submitted to UI Engineering. Where specific items are required to be re-witnessed after PC, the 12-month DLP period will commence from this re-witnessing date.

11.1 Maintenance and Testing

For BMCS services installed as part of a refurbishment project of an existing building, regular statutory maintenance, manufacturer recommended maintenance and testing must be carried out by the projects BMCS Services contractor during the Defects Liability Period (DLP). The installation contractor must provide a comprehensive handover and the required completion documentation at Practical Completion. It is the responsibility of the BMCS contractor to provide the mechanical contractor\builder with feedback on the system operation and faults for rectification. The BMCS contractor must tune the email generated alarms during the DLP period to ensure that only minimal number are being generated.

All defects arising from regular statutory/manufacturer maintenance and testing performed during the DLP are the responsibility of the installation contractor.

For new buildings, the installation contractor must provide statutory maintenance and testing of all mechanical services and associated statutory testing for the building, throughout the DLP. Prior to the completion of the DLP, the installation contractor will perform all annual maintenance procedures in the presence of the University Engineering team and provide documentation confirming the provision of all maintenance has been performed during the DLP. In these instances.

Any details which will affect the future maintenance and performance of the new or upgraded equipment must be supplied by the installation contractor at Practical Completion.

Prior to completion of the DLP, a final inspection and full meter validation must be undertaken by the: installation contractor, appropriate UI and COS staff, and University maintenance contractor, in order to reconcile the performance of the equipment during DLP to produce a final list of project defects. All project defects identified must be rectified by the installation contractor prior to finalisation of the DLP.

12 Operations & Maintenance Manuals

Consultants/designers must include in the project specification detailed requirements for operation and maintenance manuals, including system description, operation procedures, testing and commissioning records, maintenance instructions, product support information and recovery protocols for any computer related systems. Contractors must provide these to the satisfaction of the consultant/designer. Providing a collection of manufacturers' brochures and catalogues is not acceptable to the University.

Discuss with UI to understand what format to submit the O&M Manuals. Typical submissions come via soft copy (editable) and used via a system like Aconex.

Contractors must submit the university designed Asset Management Master **Asset Data Capture Spreadsheet (COS-ASSET-F001)** designed for recording operational and maintenance activities including materials used, test results, comments for future maintenance actions and notes covering asset condition. Completed log book pages recording the operational and maintenance activities undertaken for Practical Completion and during the Defects Liability Period must also be provided.

Facilities Maintenance must establish, document and implement procedures for operation and maintenance of software, plant and equipment to ensure BMCS are fit-for-purpose, provide secure, efficient, safe and reliable electrical power, and comply with requirements of this standard.

13 Authorisation of variations

Project managers, consultants, contractors, commissioning agents and facilities maintenance personnel must ensure compliance with these requirements is achieved.

Variations to this standard must only be considered where:

- a. the University Standard's requirement cannot physically or technically be achieved.
- b. the alternative solution delivers demonstrated and proven superior performance for the same capital and life cycle cost or better.

Consultants and contractors must identify and justify requirements of the standard that do not apply to the project or which need to be varied and these which must be approved by the issuer of this standard. Formal requests for all variations to this Standard must be submitted using the **UI Request Dispensation from Standard Form (UI-ENG-F001)**. The issuer of this standard or their delegated authority must review and consider requirements of stakeholders from clients, projects and facilities management before deciding whether to approve variations. Their formal sign-off is required for acceptance of any non-compliances and departures from this standard's requirements.

14 Quality control

14.1 Design Standard Compliance

Compliance with requirements of this standard must be checked throughout the design, construction and commissioning phases of projects by UI' services consultant. Any issues or deviations from this standard must be reviewed and approved in writing by the issuer of this standard.

Competent UI consultants and representatives must check compliance with this standard during design reviews and formal site inspections. Any non-conformances with requirements of this standard must be documented and provided to the UI Project Manager for issue to contractors and their consultants.

Project Managers must maintain a formal register of non-conformances and manage close out of outstanding non-conformances. Contractors and their consultants issued with non-conformances must take appropriate corrective actions. The UI Project Manager must ensure:

- a. Proposed corrective actions are implemented.
- b. Close out of non-conformances in relation to this standard is formally approved and signed off by the author of the standard or their delegate.

14.2 Design Standard Certification

Contractors and Consultants must certify compliance to the design standard by submitting a company Design Certification Form to the UI Project Manager at each of the following project phases:

- a. Design and Documentation.
- b. Tender.
- c. Construction.

Notwithstanding UI' internal quality control processes, contractors and their consultants must implement their own robust quality assurance and control procedures to ensure compliance with requirements of this standard.

14.3 Construction Compliance

Consultants and contractors are expected to include check sheets for each system component detailing each item that needs to be checked, tested and verified during the installation process. Such check sheets must be completed and verified by the project consultant/contractors, including the identification of any defects and the closing out of such defects.

14.4 Acceptance

The University will only accept projects as complete when all of the above have been carried out, submitted and verified.

The above standards are not an exhaustive list of the relevant requirements. The consultant/contractor must incorporate all relevant standards and Authorities requirements into project specific design, documentation and installation.

15 Document Amendment History

Version	Amendment	Commencing
001	First Issue	4 September 2013
002	5.1.1 General clause added 5.1.2 Calculations/Selections clause added. 5.1.3 Drawings and Documentation clause added. 5.5.1 Hard Wired Architecture clause added. 5.5.2 Wireless Architecture clause added. 5.7.3 Serial to Ethernet Gateways clause added. 5.7.4 Gateway/Wireless Receiver Enclosure and Location clause added. Table 3 Building Specific Dashboards added. 7 Safety in design clause added. New Forms added to the website; UI Design & Construct Services Checklist Form (UI-ENG-F009)	18 September 2015
3.0	5 Year Revision a. Through projects lessons learnt, industry and consultant feedback we have updated the requirements in the standards where they had a cost impact to align with industry practice as well ensuring any items that are being kept in the standards that are above industry standard level have an ROI.	26 August 2020

Version	Amendment	Commencing
	<ul style="list-style-type: none"> b. Project Definition stage added at 5.1. referring to Project “Gate Paper” and requirement for site inspection / briefing. Requirement for “Return Brief” formalised. c. Documents required for Submission & Approval updated, tightened up, aggregated and clarified. d. Safety in Design legislation reinforced. e. Commissioning Checklists added. f. Supersession of Codes & Standards between project initiation and execution is addressed. A major issue immediately and ongoing given long project gestations. g. Scope / Technical cover increased to include; h. Solar invert connectivity i. Metering coverage increased j. Dashboard requirements updated k. Update of alarms section l. Update Space control methods to align m. Update BMCS Cabinet section to include keying requirements n. Room booking system requirements updated o. Graphics displays requirements updated and clarity provided for the minimum displays p. Network and Communication Requirements q. Update of Attachment 2. Services points list to align with Hydraulics and electrical services. r. Update of Attachment 2. Services Points list to align with feedback from Facilities Management team s. Defects period maintenance; include requirements for maintenance and testing during DLP t. Documentation and Records section updated to include new requirements u. Building tuning section updated to clarify Usyd requirements for tuning period in DLP v. Asset and Warranties section updated w. New dashboard screen shots included in attachments section <p>Asset Standard Owner is now COS.</p>	

16 Attachments

Attachment 1 Network and Hardware Configuration

Attachment 2 Services Points List

Attachment 3 Operational Description Template

ATTACHMENT 2. SERVICES POINTS LIST

HVAC POINTS

<p>Chillers</p> <p>HLI to Chiller</p> <p>Start/stop</p> <p>Status</p> <p>Fault</p>	<p>Boiler</p> <p>Start/stop</p> <p>Status</p> <p>Fault</p> <p>HLI to Boiler</p> <p>Fault</p>	<p>CW System</p> <p>Differential Pressure system</p> <p>Floor/take off CW Isolating Valve</p> <p>By-pass Valve</p> <p>CW Supply Water Temperature</p> <p>CW Return Water Temperature</p> <p>Package unit isolation valves</p> <p>Chiller condenser vessel differential pressure</p> <p>Differential Pressure per floor</p> <p>Differential Pressure per loop</p> <p>Common CW Supply Water Temperature</p> <p>Common CW Return Water Temperature</p> <p>CW Supply loop Water Temperature</p> <p>CW Return loop Water Temperature</p> <p>Tenancy Supply Water Temperature</p> <p>Tenancy Return Water Temperature</p>	<p>Fan Coil Unit</p> <p>Start/stop</p> <p>Status</p> <p>filter differential pressure</p> <p>CHW Valve</p> <p>HW Valve</p> <p>Supply Air Sensor</p> <p>Outside\return\relief Air Damper</p> <p>Fault</p>
<p>CHW System</p> <p>Individual Chiller supply Water Temperature</p> <p>Individual Chiller Return Water Temperature</p> <p>Individual Chiller Isolation Valves</p> <p>Chiller Evaporator Differential Pressure</p> <p>System By-pass Valve</p> <p>Differential Pressure per floor</p> <p>Differential Pressure per loop</p> <p>Differential Pressure system</p> <p>Common CHW Supply Water Temperature</p> <p>Common CHW Return Water Temperature</p> <p>CHW Supply loop Water Temperature</p> <p>CHW Return loop Water Temperature</p> <p>Floor/take off CHW Isolating Valve</p> <p>Tenancy Supply Water Temperature</p> <p>Tenancy Return Water Temperature</p>	<p>HHW System</p> <p>By-pass Valve</p> <p>Common HW Supply Water Temperature</p> <p>Common HW Return Water Temperature</p> <p>Individual Boiler supply Water Temperature</p> <p>Individual Boiler Return Water Temperature</p> <p>Individual Boiler Isolation Valves</p> <p>Individual Boiler vessel differential Pressure</p> <p>Differential Pressure per floor</p> <p>Differential Pressure per loop</p> <p>Differential Pressure system</p> <p>Floor/take off HW Isolating Valve</p> <p>Tenancy Supply Water Temperature</p> <p>Tenancy Return Water Temperature</p>	<p>Plate Heat Exchanger</p> <p>Control Valve - Primary</p> <p>Supply Water Temperature – Primary</p> <p>Return Water Temperature – Primary</p> <p>Control Valve – Secondary</p> <p>Supply Water Temperature - Secondary</p> <p>Return Water Temperature – Secondary</p>	<p>Cooling Tower</p> <p>Start/stop</p> <p>Status</p> <p>Isolation Valves</p> <p>Leaving water temperature</p> <p>Entering water temperature</p> <p>Spray pump status</p> <p>Spray pump stop\start</p> <p>Fault</p>
			<p>Pumps</p> <p>Start/stop</p> <p>Status</p> <p>Fault</p>

HVAC POINTS CONTINUED

MISC Outside Air Temperature/humidity sensor	Package unit Start/stop Status Supply Air Pressure filter differential pressure Outside\return\relief Air Damper Compressor stages call Reversing Valve/heat cool call Supply Air Temperature Return Air Temperature HLI to Package Unit Fault	Humidifier Humidifier enable Humidifier Status Humidifier Fault HLI Fault	Air Handling Unit Start/stop Status Supply Air Pressure Filter Differential pressure sensor CHW Valve HW Valve Supply Air Temperature Return Air Temperature Outside\return\relief Air Damper Fault Floor take off pressure sensor
Split System Start/Stop Status Room Temperature Fault		Air to Air Heat Exchanger Supply Air Temperature Return Air Temperature Exhaust Supply Air Temperature Supply Air Temperature Fault	
Ducted VRV Indoor and Split Ducted Indoor Start/Stop Status Supply Air Sensor Filter DP Sensor Room Temperature Fault	Chilled Beams Zone CHB Valve Dew Point Sensor Return Air Temperature/Humidity	Rotary wheels Status Start/Stop Supply Air Temperature Return Air Temperature Exhaust Supply Air Temperature Supply Air Temperature Fault	Refrigerant Leak Detection Unit Refrigerant Leak Detection status Refrigerant PPM
VAV Room Temperature Supply Air Temperature HW Valve\Electric Heater Supply Air Pressure Damper Position Fault	Hot Water Reheats Zone HW Valve		VSD Start/stop Status Speed HLI to VSD Fault
	After Hours Push Buttons After hours AC After hours AC Indication Lamp	VRV System HLI to VRV	
	Natural Ventilation Window Reed Switches		

HVAC POINTS CONTINUED

Thermal meters Chilled Water System Heating Hot Water System Condenser Water System Tenancy Systems Process Chilled Water Loops Process Chilled Water Loops Building Take offs from Central Chilled\Heating Condenser Water Systems	Cool\Freezer Room Fault Unit Status Room temperature	Automated Water Treatment System Status HLI Fault
	Flow Meters Individual chiller Individual Boiler Condenser water system Process Water loops	CARPARK CO Sensor NO Sensor
FAN Start/stop Status Differential Pressure filter differential pressure Fault	Steam Boiler Start/stop Status Fault Supply pressure HLI to Boiler	Dehumidifier Dehumidifier enable Dehumidifier Status Dehumidifier Fault HLI Fault
Pressurisation Units Status Fault		
Lab/PC2 Environment Differential pressure at PC2/lab zone entrance		

HYDRAULICS POINTS

<p>Individual Pump (<i>Sewer, subsoil, Storm Water, Oil separator, Hot water, Solar circulating, cold-water, Non Potable & recycled</i>)</p> <p>Status</p> <p>Speed</p> <p>HLL to pump controller</p> <p>Fault</p>	<p>Water Treatment Plant (<i>UV, Automatic Backwash Filter & Chemical Dosing</i>)</p> <p>Status</p> <p>Fault</p>	<p>Tanks (<i>Blackwater, rainwater storage, sewer, stormwater, Potable & Non Potable water storage</i>)</p> <p>High\Low level positions</p>
<p>HW System</p> <p>Common HW Supply Water Temperature</p> <p>Common HW Return Water Temperature</p> <p>Fault</p>	<p>RO\DI Plant</p> <p>Status</p> <p>HLL</p> <p>Fault</p>	<p>VSD</p> <p>Start/stop</p> <p>Status</p> <p>Speed</p> <p>HLL to VSD</p> <p>Fault</p>
	<p>Irrigation for Greenhouses</p> <p>Solenoid valve</p>	

ELECTRICAL POINTS

UPS	Diesel\Gas Generator	Power factor correction unit	Surge Diverters
HLI	HLI	HLI	Fault
Status	Status	Status	
Fault	Fault	Fault	

BUILDING POINTS

Louvers	Thermal/Sun Screens
Status	Status
Fault	Fault

LIGHTING POINTS

Lighting

PIR status (HLI) for each space
Status of BMCS interface with Lighting control system (confirming communications)

LIFT POINTS

LIFT

(HLI)
Lift position
Lift status
Lift Fault

FIRE SYSTEMS POINTS

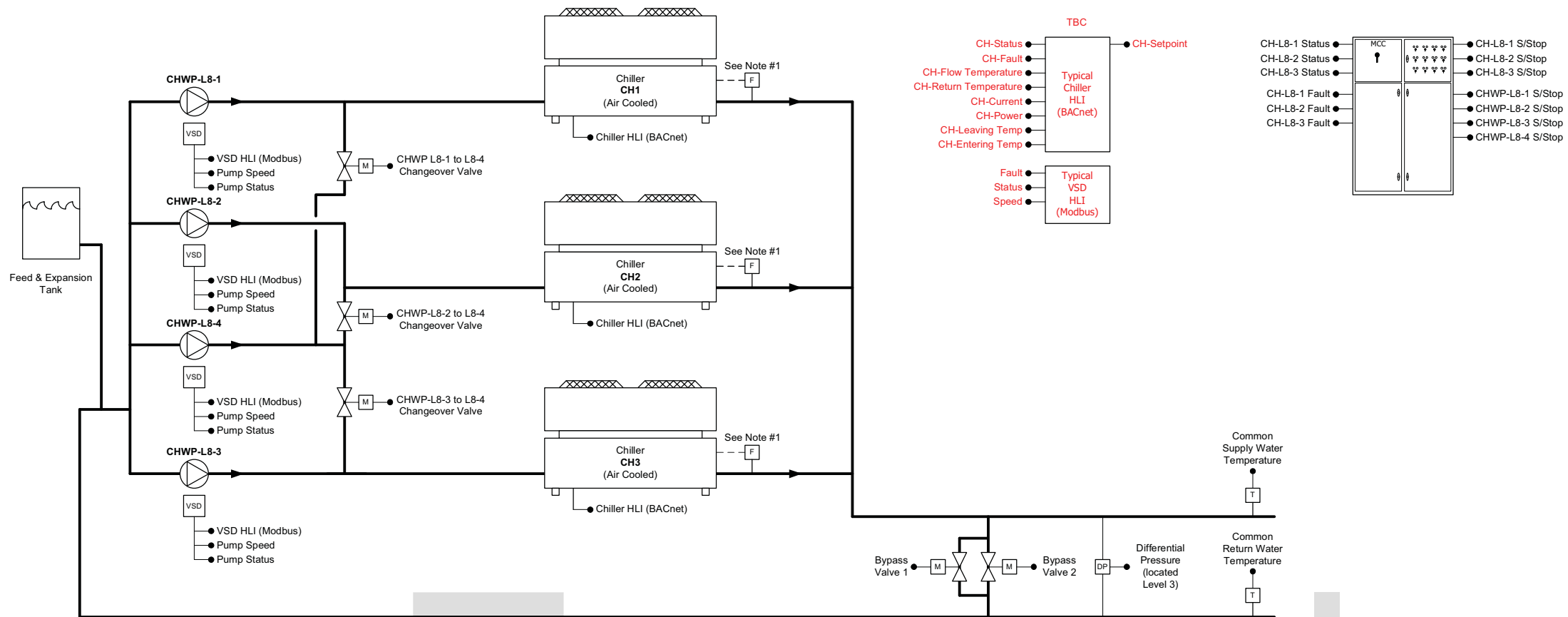
FIP

Fire Trip

PROCESS EQUIPMENT AND GASES POINTS

<p>Vacuum Pump system</p> <p>Status HLI Fault</p>	<p>Compressed Air System</p> <p>HLI Status Fault System Supply Pressure Air Dryer status Air Dryer Fault</p>	<p>Fume Cabinets</p> <p>Sash Position HLI Fault Status</p>
<p>Medical\Lab Gas Panel Including each floor panel</p> <p>Status Gas Low level Warning activation Alarm activation Fault HLI</p>		

ATTACHMENT 3. OPERATIONAL DESCRIPTION TEMPLATE



Chilled Water System

Lead Cooling Call

The lead call is turned on when any chilled water valve is greater than 90 % for a period of 10 minutes.

The lead call is turned off when all chilled water valves are less than 10 % for a period of 10 minutes.

Lag Cooling Calls

The lag call stage 1 is turned on when the lead call is on and the return water temperature is greater than [12.8] °C for a period of [30] minutes.

The lag call stage 2 is turned on when the lag call stage 1 is on and the return water temperature is greater than [12.8] °C for a period of [30] minutes.

The lag calls are turned off in reverse order to the above when the return water temperature is less than [12.0] °C for a period of [10] minutes.

When the lead call is off both lag calls are turned off.

Chiller Rotation

Chillers operate in a lead/lag sequence that is rotated weekly to equalise run times.

Should any happen to fail, the rotation is changed so that the failed chiller is last in the rotation.

Pump Rotation

The pumps are designated to their respective chillers (CH1-CHWP1, CH2-CHWP2 and CH3-CHWP3) and all share a common standby pump (CHWP-4).

The pumps follow the lead/lag designation of the chillers.

If all pumps are operational the standby pump (CHWP-4) is used in place the normal operation sequence

The duty/standby sequence of the pumps is automatically rotated to equalise run times.

However if any of the dedicated pumps happen to fail, the pumps are rotated so that the standby pump is brought into operation in place of the failed pump.

Chiller Start Sequence

When a chiller is required to start, the following start-up sequence is initiated. The associated pump is started and once the pump status has been verified for a period of 1 minute the chiller is enabled.

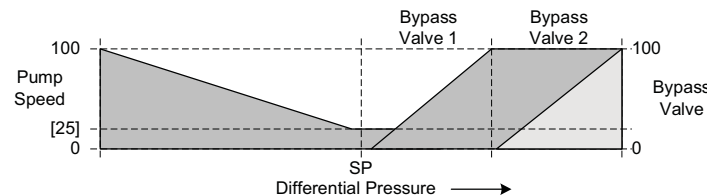
Chiller Stop Sequence

When a chiller is not required, the following run-down sequence is initiated. The chiller is stopped and the associated pump is run-on for a period of 5 minutes.

The BMS system does not control the chiller loading and unloading. This is handled by the on-board control system supplied with the chillers.

Pressure Control

The pump speed and the bypass valves modulate to maintain differential pressure, as shown below.



Proportional + Integral controller

Alarms

The following alarm conditions are monitored and notifications sent to the workstations.

- Chiller Fault
- Chilled Water Pump Failure
- High Supply Water Temperature
- Differential Pressure not maintained

Notes:

1. Chiller flow switches hard wired into the chiller safety circuit by others.

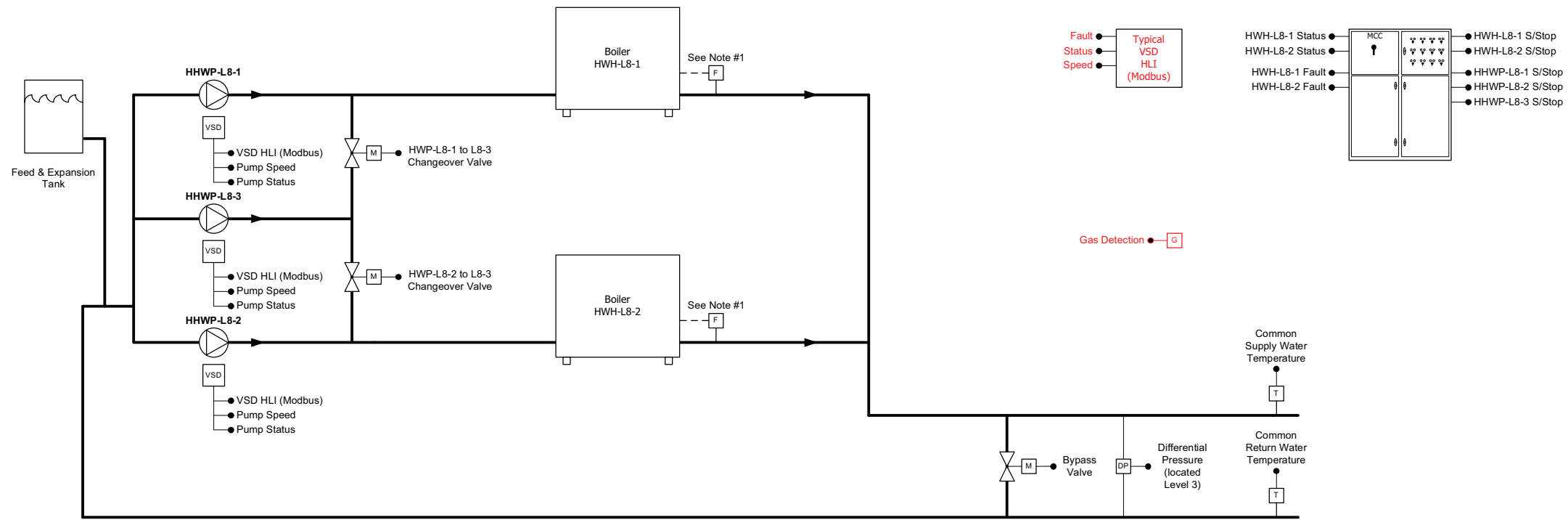
REV	DESCRIPTION	DATE
5	As Built	31/03/09
4	For Construction (Revised)	01/10/08
3	For Construction	11/01/08
2	For Approval	5/08/07
1	Preliminary	31/08/07

Client:

Project: **The University of Sydney**

Title: **Chilled Water System Control Schematics**

Job No:	Drawn:	Checked:
Drawing No:	Rev:	Date:



Notes:
 1. Boiler flow switches hard wired into the boiler safety circuit by others.

Example

Hot Water System

Lead Heating Call

The lead call is turned on when any hot water valve is greater than 90 % for a period of 10 minutes.

The lead call is turned off when all hot water valves are less than 10 % for a period of 10 minutes.

Lag Heating Call

The lag call is turned on when the lead call is on and the return water temperature is less than [37.0] °C for a period of [30] minutes.

The lag call is turned off when the return water temperature is greater than [43.0] °C for a period of [10] minutes.

When the lead call is off the lag call is turned off.

Boiler Rotation

Boilers operate in a lead/lag sequence that is rotated weekly to equalise run times.

Should any happen to fail, the rotation is changed so that the failed boiler is last in the rotation.

Pump Rotation

The pumps are designated to their respective chillers (CH1-CHWP1, CH2-CHWP2 and CH3-CHWP3) and all share a common standby pump (CHWP-4).

The pumps follow the lead/lag designation of the chillers.

If all pumps are operational the standby pump (CHWP-4) is used in place the normal operation sequence

The duty/standby sequence of the pumps is automatically rotated to equalise run times.

However if any of the dedicated pumps happen to fail, the pumps are rotated so that the standby pump is brought into operation in place of the failed pump.

Boiler Start Sequence

When a boiler is required to start, the following start-up sequence is initiated. The associated pump is started and once the pump status has been verified for a period of 1 minute the boiler is enabled.

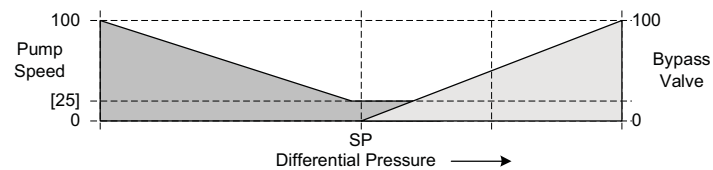
Boiler Stop Sequence

When a boiler is not required, the following run-down sequence is initiated. The boiler is stopped and the associated pump is run-on for a period of 5 minutes.

The BMS system does not control the boiler burners. This is handled by the on-board control system supplied with the boilers.

Pressure Control

The pump speed and the bypass valves modulate to maintain differential pressure, as shown below.



Proportional + Integral controller

Alarms

The following alarm conditions are monitored and notifications sent to the workstations.

- Boiler Fault
- Hot Water Pump Failure
- Low Supply Water Temperature
- Differential Pressure not maintained

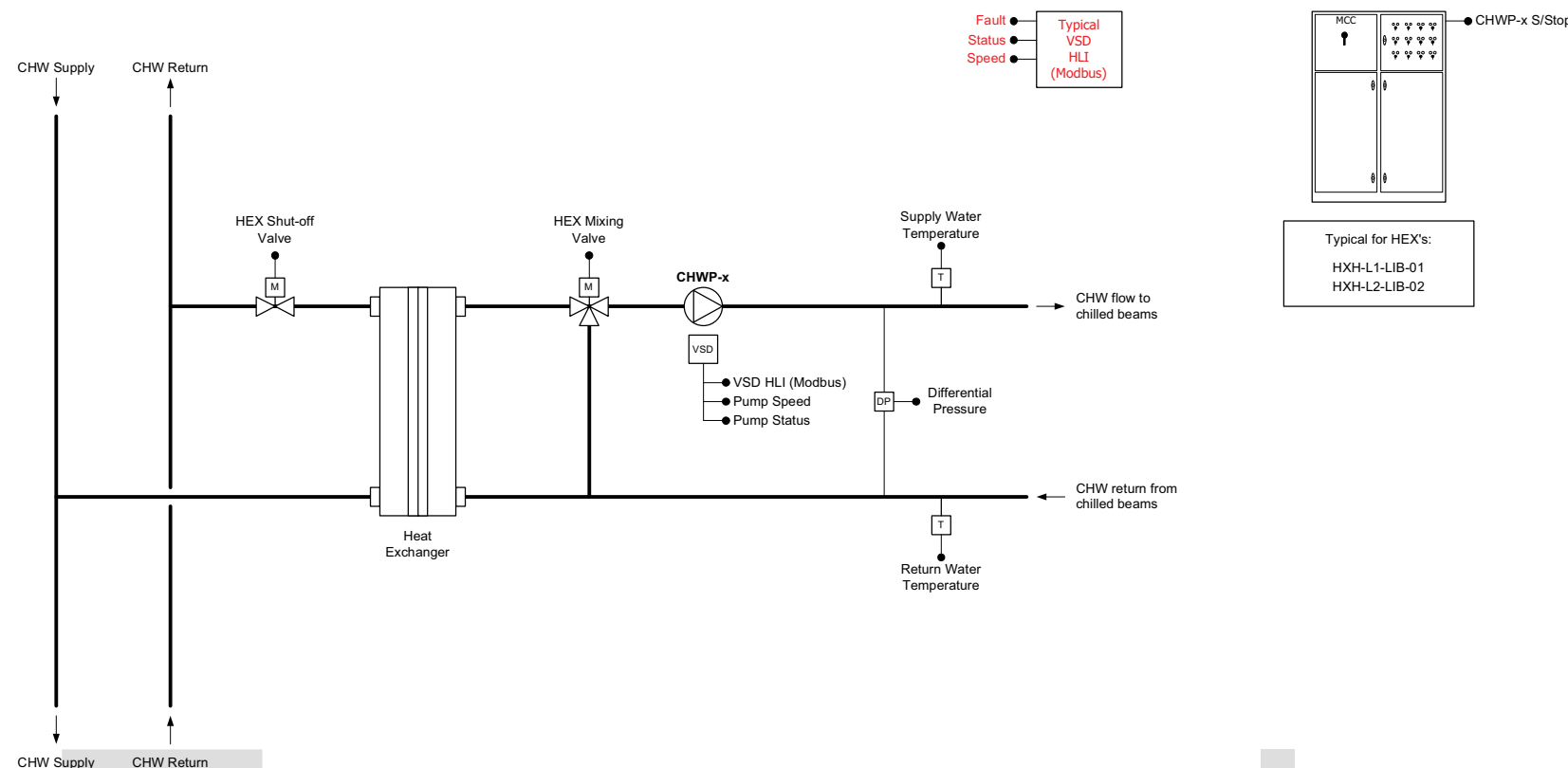
REV	DESCRIPTION	DATE
5	As Built	31/03/09
4	For Construction (Revised)	01/10/08
3	For Construction	11/01/08
2	For Approval	5/08/07
1	Preliminary	31/08/07

Client:

Project: **The University of Sydney**

Title: **Hot Water System Control Schematics**

Job No:	Drawn:	Checked:
Drawing No:	Rev:	Date:



Example

Chilled Beams

Cooling Call

The cooling call is turned on when any chilled beam valve is greater than 90 % for a period of 5 minutes.

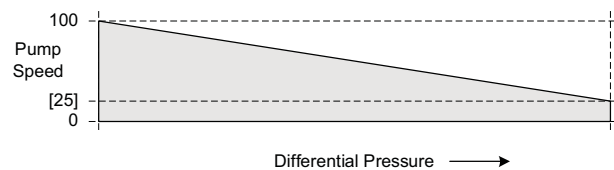
The cooling call is turned off when all chilled beam valves are less than 10 % for a period of 5 minutes.

Pump Start/Stop

The chilled water heat exchanger pump is started when the cooling call is on. When the cooling call is off the pump is stopped.

Pressure Control

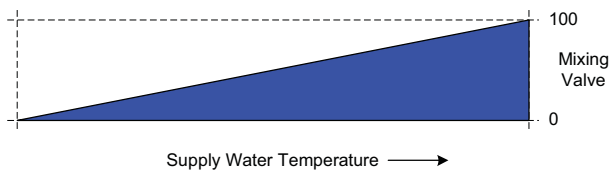
The pump speed modulates to maintain differential pressure, as shown below.



Proportional + Integral controller

Temperature Control

The mixing valve modulates to maintain the supply water temperature at [15] °C as shown below.



Proportional + Integral controller

Shut Off Valve Control

The shut off valve is opened and closed in response to the cooling call.

Alarms

The following alarm conditions are monitored and notifications sent to the workstations.
 Pump failure.
 High Supply Water Temperature
 Differential Pressure not maintained

Notes:

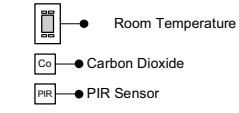
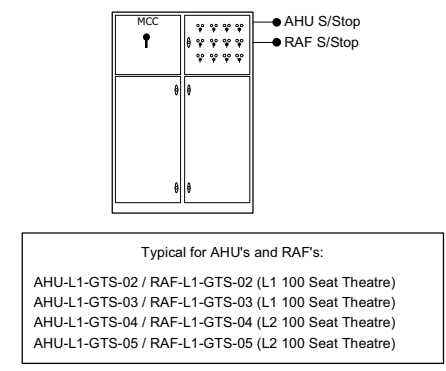
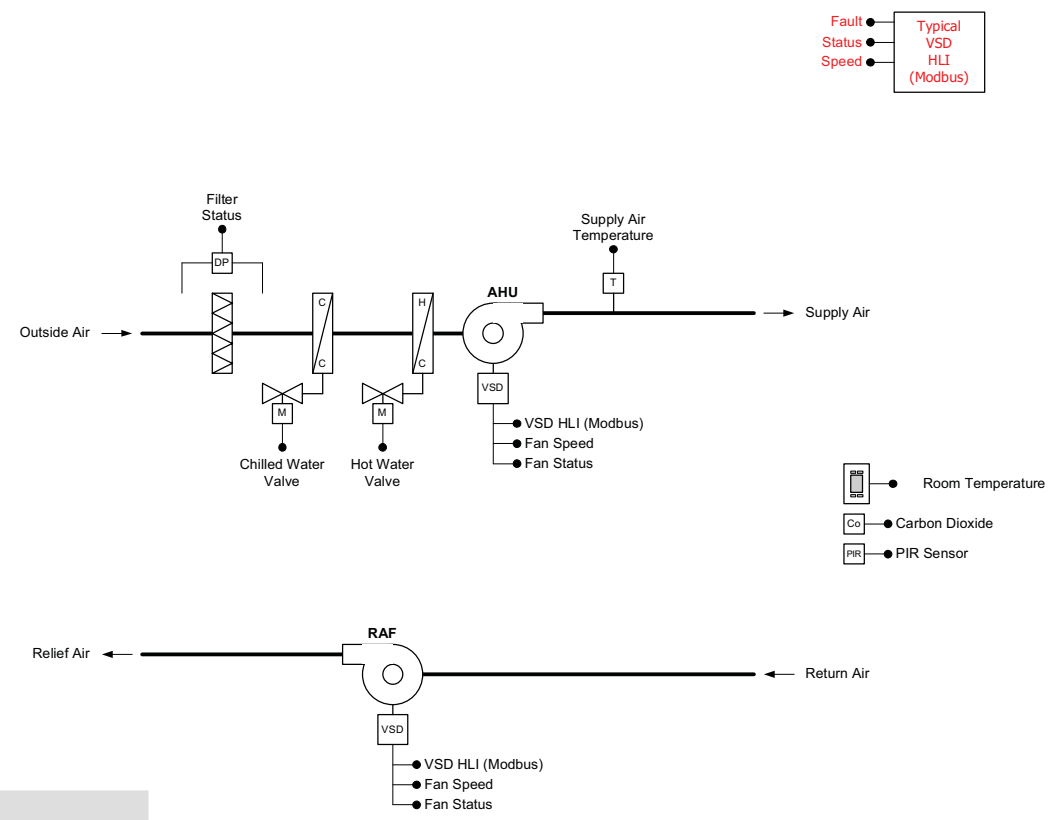
REV	DESCRIPTION	DATE
5	As Built	31/03/09
4	For Construction (Revised)	01/10/08
3	For Construction	11/01/08
2	For Approval	5/08/07
1	Preliminary	31/08/07

Client:

Project: The University of Sydney

Title: Typical Chilled Beam Heat Exchanger Control Schematics

Job No:	Drawn:	Checked:
Drawing No:	Rev:	Date:



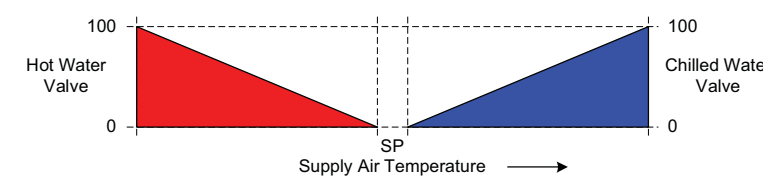
Air Handling Unit Operation Modes

Dynalite Interface
The BMS receives a signal from the Dynalite system to indicate that the room is in use and air conditioning is required.

Once the Dynalite system signal is off and no motion is detected for a period of [20] minutes the occupancy is turned off.

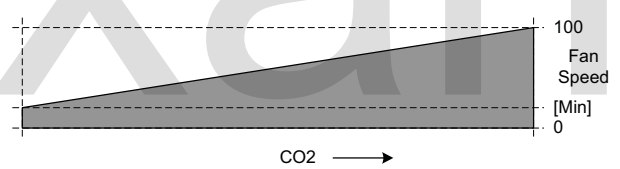
Supply and Return Fan Start/Stop
When the room is occupied the fan is started. Once the room is unoccupied the fan is stopped.

Temperature Control
The chilled and hot water valves modulate to maintain a supply air temperature at a constant [18] °C as shown below.



Proportional + Integral controller

CO2 Control
The fan speed modulates to maintain CO2 as shown below.



Proportional

Smoke Clearance
In smoke clearance mode the supply fan is started and set to full speed and conditioning is disabled.

Alarms
The following alarm conditions are monitored and notifications sent to the workstations.
Supply air fan failure.
Dirty filter.
Supply air temperature not maintained.

Example

Notes:

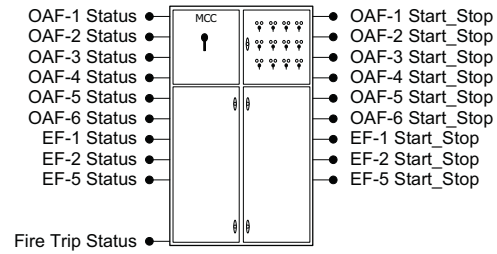
REV	DESCRIPTION	DATE
5	As Built	31/03/09
4	For Construction (Revised)	01/10/08
3	For Construction	11/01/08
2	For Approval	5/08/07
1	Preliminary	31/08/07

Client:

Project: **The University of Sydney**

Title: **AHU-GTS-02, 3, 4, 5
100 Seminar Displacement
Air Handling Units
Control Schematics**

Job No:	Drawn:	Checked:
Drawing No:	Rev:	Date:



Daikin BACnet Interface

A BACnet HLI has been provided for interfacing to the Daikin VRV System.

The following AC units are monitored and control by the BMCS System

- AC-1 to AC-8

The BACnet Interface allows for monitoring and control of each FCU as following:

- FCU start/stop
- Setpoint adjustment
- Room Temperature monitoring
- FCU status
- Common fault
- Alarm status

Occupancy.

Each FCU is individually time scheduled to operate between [08:00] hrs – [17:00] hrs, adjustable, except AC-1 Cool Room which is [24/7].

After Hours.

After hours selection is via the BMCS or locally via the VRV controller.

Outside Air Fans

OAF-1 is called to run whenever AC-7 is called to run (Office Area).
 OAF-2 is called to run whenever AC-6 is called to run (Animal Lab).
 OAF-3 serves the Bottle Store and runs 24/7.
 OAF-4 is called to run whenever AC-4, 5, 6 or 8 are called to run (Imaging Lab, Animal Lab, Primary Culture Lab).
 OAF-5 is called to run whenever AC-2, 3 is called to run (Molecular Cell Lab).
 OAF-6 is called to run whenever AC-2, 3 is called to run (Molecular Cell Lab).

Exhaust Air Fans

EF-1 is called to run whenever the Animal Lab is in operation
 EF-2 is a general exhaust fan that is called to run whenever AC-2, 3, 4 or 5 is called to run
 EF-3 & 4 are controlled by the fume cupboard and not under BMCS control
 EF-5 runs 24/7 (Bottle Store)

Visual Alarm

A visual alarm will be enabled should EF-5 or AC-1 be in fault (mismatch alarm).

Fire Trip

A fire trip is monitored from the MSSB.
 The BMCS has no control under fire / smoke conditions except to allow for an orderly re-start.

Fume Cupboards

The two fume cupboards sash position is monitored.
 Status & fault cabling has been provided for future use.
 EF-3 & 4 are controlled directly by the fume cupboards and not the BMCS.

Oxygen Monitoring Alarms

Three oxygen sensor alarms are monitored by the BMCS

Alarm Monitoring:

The following will raise an alarm on the BMCS system:

- Fan mismatch alarm
- Oxygen Alarms (3)
- FCU mismatch alarm
- Bottle Shop & AC-1 mismatch alarms

Archived Trend Logging

The following trend logs will be monitored on the BMCS:

- Space Temperature

Daikin VRV Units

AC-1	Cool Room	24/7
AC-2	Molecular Cell Lab	[08:00 – 17:00] M-F
AC-3	Molecular Cell Lab	[08:00 – 17:00] M-F
AC-4	Cell Culture Lab	[08:00 – 17:00] M-F
AC-5	Imaging Labs	[08:00 – 17:00] M-F
AC-6	Animal Lab	[08:00 – 17:00] M-F
AC-7	Office Area	[08:00 – 17:00] M-F
AC-8	Primary Culture Lab	[08:00 – 17:00] M-F

Fans

OAF-1	Serves AC-7	[24/7]
OAF-2	Serves Animal Lab	
OAF-3	Serves Bottle Store	
OAF-4	Serves AC-5, 6 & 8	
OAF-5	Serves AC-2	
OAF-6	Serves Cell Lab	
EF-1	Animal Lab	[24/7]
EF-2	General Exhaust	
EF-3	Fume Cupboard FC-01 (not BMCS Control)	
EF-4	Fume Cupboard FC-02 (not BMCS Control)	
EF-5	Bottle Store	

Notes:

1. LAN Requirements:

- - - - - = Category 5 Unshielded Twisted Pair Cable
- = 100-120 ohm Twisted Shielded Pair (Belden 9841 #24 AWG or equivalent) 1200 metres MAXIMUM
- - - - - = 2 core Unshielded Telephone Cable
- - - - - = Existing Coaxial Cable
- = End-Of-Line Termination (TRM-0768)



AI	As Installed	21/10/10
1	For Approval	09/03/09
REV	DESCRIPTION	DATE

Client:

Project:

**Kanematsu Lab
L3 Blackburn Building**

Title:

Daikin VRV System

Job No:

Drawn:

Checked:

Drawing No:

Rev:

Date: