



CLS Building Management and Control Systems Standard

The University of Sydney

Engineering & Sustainability Team

Document Control

Document Name:	CIS Building Management and Control Systems Standard
Document ID:	CIS-PLA-STD-Building Management and Control Systems
Document Status:	Final
Version No:	002
Author(s): Position: Signature:	David Dunn Services Engineer - Mechanical
Document Owner:	Engineering & Sustainability Team
Approved by: Position: Signature:	Director of CIS
Date Approved:	18 September 2015
Date of Issue:	18 September 2015
Issued by:	Campus Infrastructure & Services

Contents

1	PURPOSE	1
2	SCOPE	1
3	GLOSSARY OF TERMS.....	2
4	AUTHORITIES & RESPONSIBILITIES.....	3
5	TECHNICAL REQUIREMENTS.....	3
5.1	INTRODUCTION.....	3
5.2	DESIGN AND DOCUMENTATION.....	3
5.2.1	DESIGN APPROACH	3
5.2.2	DESIGN INPUTS AND PROCESS.....	3
5.2.3	ENGINEERING PROCESS.....	4
5.3	TECHNICAL COMPONENTS	4
5.4	BACNET PROTOCOL	4
5.4.1	STANDARD COMPLIANCE.....	4
	BACNET DOCUMENTATION.....	5
5.5	SYSTEM CONFIGURATION.....	5
5.6	CONTROL SYSTEMS	5
5.7	SERVERS	6
5.7.1	TAG NAMING CONVENTION.....	6
5.7.2	BACNET PRIORITY ARRAY	6
5.7.3	TREND LOGS.....	7
5.7.4	DEVICE INSTANCES AND ADDRESSES.....	7
5.8	BACNET DEVICE NUMBERING CONVENTION.....	7
5.9	QUALITY ASSURANCE.....	7
5.9.1	PRODUCTS.....	7
5.9.2	SYSTEM PERFORMANCE.....	7
5.9.3	SUBMITTALS.....	9
5.9.4	OWNERSHIP OF PROPRIETARY MATERIAL.....	9
5.9.5	SYSTEMS TO BE BMCS CONTROLLED/MONITORED	9
5.9.6	LIGHTING INTEGRATION WITH BMCS	10
5.10	NETWORK AND COMMUNICATION REQUIREMENTS.....	10
5.10.1	GENERAL	10
5.10.2	BACNET	10
5.10.3	EQUIPMENT	10
5.10.4	MAINTENANCE SUPERVISION	11
5.10.5	SEQUENCING	11
5.10.6	PID CONTROL.....	11
5.11	POWER SUPPLIES.....	11
5.11.1	GENERAL	11
5.11.2	SURGE DIVERTERS.....	11
5.11.3	DEDICATED CIRCUITS	11



5.1.2 GRAPHIC DISPLAYS.....	11
5.1.2.1 GENERAL	11
5.1.2.2 FRONT PAGE	12
5.1.2.3 BUILDING MAIN PAGE	12
5.1.2.4 FLOOR PLANS.....	12
5.1.2.5 SYSTEM\EQUIPMENT PAGES.....	12
5.1.2.6 SUMMARY PAGE	13
5.1.2.7 OPERATIONAL DESCRIPTION.....	13
5.1.2.8 CONTROLLER LIST	13
5.1.3 SOFTWARE REQUIREMENTS.....	14
5.1.3.1 SYSTEM HELP.....	14
5.1.3.2 SYSTEM SECURITY	14
5.1.3.3 OPERATOR DISPLAY	14
5.1.3.4 PROGRAMMING	14
5.1.3.5 GLOBAL SETTINGS\OVERRIDE	14
5.1.3.6 SCHEDULES	15
5.1.3.7 TRENDING.....	15
5.1.3.8 OPERATOR LOG	15
5.1.3.9 USER AUTO LOGOUT	15
5.1.3.10 DATA STORAGE.....	16
5.1.4 ALARMS.....	16
5.1.4.1 SECURITY CONNECTIONS	16
5.1.4.2 ALARM PRIORITIES	16
5.1.4.3 E-MAIL ALARMS	17
5.1.4.4 ALARM FUNCTIONALITY	17
5.1.5 EFFICIENCY	17
5.1.5.1 HVAC.....	17
5.1.5.2 SPACE CONTROL METHODS.....	18
5.1.6 BMCS POINTS.....	18
5.1.7 TRANSDUCERS.....	19
5.1.8 SENSORS.....	20
5.1.9 CABINETS/MECHANICAL SWITCH BOARDS.....	21
5.1.9.1 GENERAL	21
5.1.9.2 LOCATIONS	21
5.1.9.3 MAKE.....	21
5.1.9.4 WIRING.....	22

5.20 PRODUCT SUPPORT	22
5.21 SOFTWARE LIFE CYCLE.....	22
5.22 WARRANTY	22
6 COMMISSIONING	22
7 SAFETY IN DESIGN.....	23
8 DOCUMENTATION AND RECORDS	23
9 OPERATIONS	24
10 AUTHORISATION OF VARIATIONS.....	24
11 QUALITY CONTROL	25
11.1 DESIGN STANDARD COMPLIANCE.....	25
11.2 DESIGN STANDARD CERTIFICATION	25
12 REFERENCES.....	25
13 NOTES	26
14 DOCUMENT AMENDMENT HISTORY	26
15 ATTACHMENTS	26



1 PURPOSE

The CIS 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:
 - i. Workplace Health and Safety legislation
 - ii. Disability Discrimination legislation
 - iii. State Environmental Planning and Assessment legislation
 - iv. All other Commonwealth and State legislation
 - v. NCC and BCA
 - vi. AS/NZS
 - vii. This standard and other University standards

2 SCOPE

This standard describes the minimum requirements for the design, construction and maintenance of all BMCS services throughout all buildings owned, operated and managed by the University of Sydney.

The Standard applies to 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 BMCS Services 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



3 GLOSSARY OF TERMS

BCA	Building Code of Australia
CIS	Campus Infrastructure Services
EP&AR	Environmental Planning & Assessment Regulation
FIP	Fire Indicator Panel
NCC	National Construction Code
PC	Practical Completion
PUG	Project User Group or Project Working Group
AS	Australian Standard
BACnet	Building Automation Control Networks
PICS	Protocol Implementation Conformance Statement
MSDS	Material safety data sheets
NATA	National Association of Testing Authorities
VOC	Volatile organic compound
HVAC	Heating Ventilation and Air Conditioning
I/O	Input/output
HLI	High Level Interface
PID	Proportional-Integral-Derivative
BMCS	Building Management control System
PPR	project principal requirements
RAC	Room Air conditioner (window mounted)
CIBSE	Chartered Institution of Building Services Engineers
AIRAH	Australian Institute of Refrigeration Air Conditioning and Heating
FCU	Fan Coil Unit
VRV	Variable Refrigerant Volume
VRF	Variable Refrigerant Flow
DDC	Direct Digital Control
IP	Internet Protocol
VAV	Variable Air Volume

4 AUTHORITIES & RESPONSIBILITIES

This standard is issued by CIS. It is approved and signed off by the Director, CIS. CIS is responsible for maintaining the standard and keeping it up-to-date. The Standard must be reviewed biennially.

5 TECHNICAL REQUIREMENTS

5.1 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.

5.2 DESIGN AND DOCUMENTATION

5.2.1 DESIGN APPROACH

The University expects consultants and designers to provide designs that meet the project briefs. The following are priorities that consultants and designers must consider in their designs:

- a. Provide controls and strategies to meet the required environmental conditions
- b. BMCS system design to be dynamic to allow for individual nuances
- c. Take a long term balanced view of capital costs, energy costs, maintenance costs and longevity
- d. As educational and research both progress at rapid rates, usage of buildings and areas within buildings can change a number of times within the life of a building, systems must be designed to be adaptable for such changes
- e. For new buildings, the emphasis should be on the delivery of a system that provide good and reliable functional outcomes, adopt sensible sustainable practices and minimize University owning costs on energy and maintenance

For existing buildings and small system additions, the emphasis must be on build ability, minimisation of disruptions and the neat and tidy integration of systems and reticulation of services, within the application and without the compromising of this standard. When existing systems are present in buildings, the system type must be expanded through the building, this is emphasised to ensure consistency in buildings and maintainability. Where existing multiple systems are in a building confirmation of the dominate system must be provided by CIS Engineering.

5.2.2 DESIGN INPUTS AND PROCESS

The University expects consultants and designers to proactively inform, advise and contribute to the design process. In particular, the following aspects:

- a. Control logic- The consultant must provide specific logic on the operation of the systems. This advice is to be formed through the design of the equipment being controlled and the overarching system operational description.
- b. Points lists must be formed during the HVAC system design phase and provided at the tender phase for approval

5.2.3 ENGINEERING PROCESS

The University expects consultants and designers to be fully qualified, experienced and capable of carrying out all engineering design, equipment selection and construction/installation quality checks.

In selecting equipment, the University expects consultants and designers to select products and system configurations of proven and reliable quality.

In the designing of all systems, the University expects consultants and designers to follow good industry practice. Additionally, the following are some particular points of note:

- a. 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.
- b. For critical environments such as animal houses, special laboratories, clean room, museum or the like, stable operation of systems and/or other refrigeration systems are 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.
- c. Ensure industry best practice energy efficiency control algorithm and strategies are utilised

5.3 TECHNICAL COMPONENTS

The following sections contain technical requirements on equipment, materials and installations. Consultants and designers are required to adhere to these. In the preparation of consultants' specifications, they are required to ensure that those project specifications do not contain any conflicting requirements or information with this document.

5.4 BACNET PROTOCOL

5.4.1 STANDARD COMPLIANCE

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

BACnet Compliance

The BACnet protocol is supported and maintained by ASHRAE Standing Standard Project Committee 135.

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



Figure 1 : BTL Logo

Note. The BACnet Testing Laboratories (BTL), which is part of the BACnet Manufacturers Association (BMA), provides a product testing and listing program for products that have BACnet capability.



Products that have been successfully tested by the BACnet Testing Laboratories are eligible to display the BTL logo as part of the listing process.

BACnet Controllers

Building Controllers (BCs) shall conform to the following device profile requirements as specified in ASHRAE/ANSI 135-2001, BACnet Annex L.

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

BACNET DOCUMENTATION

All installations shall include a PICS statement as part of the tender.

Details of each product offered should be provided with the tender including all information described in **Table 1**.

BACnet Conformance Statements (PICS)

Provide a full list of those BACnet conformance statement PICS that the system will support and that must be included in the system software. Obtain approval of the list before proceeding with the utilisation of those approved PICS in the system software and firmware.

This information is to include:

- a. product description
- b. conformance classes supported
- c. functional groups supported
- d. BACnet Standard Application Services supported
- e. standard object types supported
- f. data links and physical layer options supported

5.5 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.

5.6 CONTROL SYSTEMS

The following equipment is deemed to comply with this standard: below in table 1

Other alternative equivalent equipment maybe provided subject to approval via the variation procedure listed in section 9 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.



TABLE 1 : UNIVERSITY BMCS SYSTEMS

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

5.7 SERVERS

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

Virtual servers shall only be accepted that are within the University data centre, local PC's must not be used as servers as they are not supported devices.

5.7.1 TAG NAMING CONVENTION

The point name descriptions will comply with the Sydney 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.

5.7.2 BACNET PRIORITY ARRAY

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

TABLE 2 : BACNET PRIORITY ARRAY

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



Priority Level	Application
15	Available
16	Available

Priority levels 3 and 4 will 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.

5.7.3 TREND LOGS

Trend logs will 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.

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

5.7.4 DEVICE INSTANCES AND ADDRESSES

To ensure a seamless integration across all platforms and sites, the device instances and addresses of all of the BMCS equipment shall comply with the University conventions.

5.8 BACNET DEVICE NUMBERING CONVENTION

The university standard for BACnet Device numbering is Alphanumerical 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

5.9 QUALITY ASSURANCE

5.9.1 PRODUCTS

All products used in this installation shall be new, currently under manufacture, and shall be available in 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 shall be available for at least 10 years after completion of the contract in relation to BMCS installation.

5.9.2 SYSTEM PERFORMANCE

The system shall have the following functionality:

- a. Graphic display-the system shall display a graphic with 20 dynamic points/objects with all current data within 5 seconds.
- b. Graphic refresh – the system shall update a graphic with 20 dynamic points/objects with all current data within 5 seconds



- c. Object command - the maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analogue objects should start to adjust within 2 seconds
- d. Object scan – all changes of state and change of analogue values will 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 shall not exceed 5 seconds
- f. Program execution frequency - custom and standard applications shall be capable of running as often as once every 1 second. The contractor shall be responsible for selecting execution times consistent with the mechanical process under control
- g. Performance – programmable controllers shall be able to execute DDC PID control loops at a frequency of at least once per second. The controller shall 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** or better
- J. Stability of control - control loops shall maintain measured variable at set point within the tolerances listed in **Table 4**

TABLE 3 : REPORTING ACCURACY

Measured Variable	Reported Accuracy
Space Temperature	$\pm 0.5^{\circ}\text{C}$
Ducted Air	$\pm 0.5^{\circ}\text{C}$
Outside Air	$\pm 1.0^{\circ}\text{C}$
Dewpoint	$\pm 1.0^{\circ}\text{C}$
Water Temperature	$\pm 0.5^{\circ}\text{C}$
Delta-T	$\pm 0.15^{\circ}\text{C}$
Relative Humidity	$\pm 1\% \text{ RH}$
Water Flow	$\pm 2\%$ of full scale
Airflow (terminal)	$\pm 5\%$ of full scale
Airflow (measuring stations)	$\pm 2.5\%$ of full scale
Air Pressure (ducts)	$\pm 0.5\%$ of full scale reading
Air Pressure (space)	0.5% of full scale reading
Water Pressure	$\pm 2\%$ of full scale
Electrical (A, V, W, Power factor)	2% of reading
Carbon Monoxide (CO)	$\pm 3\%$ of full scale
Carbon Dioxide (CO ₂)	$\pm 50 \text{ ppm}$

TABLE 4 : CONTROL STABILITY AND ACCURACY

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	$\pm 50 \text{ Pa}$	0- 1.5 kPa -



Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	± 1 Pa	-25 to 25 Pa
Airflow	$\pm 2\%$ of full scale	
Temperature	$\pm 0.25^\circ\text{C}$	
Humidity	$\pm 2\%$ RH	
Fluid Pressure	± 1 kPa	0-1 kPa
Fluid Pressure differential	± 250 Pa	kPa

5.9.3 SUBMITTALS

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

- A complete description of the System including hardware and software.
- All BACnet products offered must include a PICS statement as part of the tender documentation
- A complete description of the operation of the control system, including sequences of operation. The description shall include an complete system architecture
- 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. Software flag points/objects, alarm points/objects, etc.
- Selection of valves make and model
- Selected Valve pressure drop at Design flow
- Valve Flow Coefficient (kv)
- Pressure drop of item served at design flow and valve actuator

5.9.4 OWNERSHIP OF PROPRIETARY MATERIAL

All project-developed software and documentation shall become the property of the university upon project handover. These include, but are not limited to:

- Project graphic images
- Drawings
- Databases
- Application programming code
- All documentation

5.9.5 SYSTEMS TO BE BMCS CONTROLLED/MONITORED

The following systems shall be monitored/controlled by the BMCS

- Lifts (monitoring only)
- Lighting control



- c. Hydraulic services
- d. Fire trip (monitoring only)
- e. Mechanical services
- f. Weather station
- g. Building Louvers

5.9.6 LIGHTING 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 a PIR located in it is to display the status of the PIR on the associated rooms HVAC units graphic.

Emergency lighting system is not to be connected to the BMCS. Please refer to the CIS Essential Fire Safety Measures Standard.

5.10 NETWORK AND COMMUNICATION REQUIREMENTS

5.10.1 GENERAL

The network must not be used to transfer data from a control to a device such as a VSD from one network chain to another, where devices are passing data they must be on the same network chain or be directly wired.

Example; A controller must not use the network to receive and send control signal to a VSD unless it is on the same network chain or the control signal is directly wired.

5.10.2 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 where required to integrate system on the network.

5.10.3 EQUIPMENT

Only native BACnet equipment shall be designed and installed.



5.10.4 MAINTENANCE SUPERVISION

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

5.10.5 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.

5.10.6 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.

5.11 POWER SUPPLIES

5.11.1 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 requirements cascades through to the associated for the space such as FCUs, AHUs, VAVs, chilled\heating\condenser water system or supply\extraction air system.

5.11.2 SURGE DIVERTERS

Provide surge diverts connected so as to protect the sensing devices and all BMCS equipment\controls from damage or spurious operation caused by voltage surges in the power source.

5.11.3 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.

5.12 GRAPHIC DISPLAYS

5.12.1 GENERAL

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



5.12.2 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 master list of all controller device schedule to be update with each controller installation and change (attachment 2)

5.12.3 BUILDING MAIN PAGE

The building main page shall 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

5.12.4 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 thermographic are not to be used, fan link must be provided for the space it services

5.12.5 SYSTEM\EQUIPMENT PAGES

System and equipment pages must contain all of the associated inputs and outputs.
For equipment serviced by boilers and chillers they will be provided with the associated water temperatures on the page.



5.12.6 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. Louvers
- j. Ventilation Fans
- k. Cooling\heating call
- l. Afterhours call

5.12.7 OPERATIONAL DESCRIPTION

Included for each project system change shall be a PDF operational description located on the building main page see Attachment 1 for template. The description shall 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. Set points
- f. Project name
- g. Contractor performing works
- h. Document Version
- i. Document title
- j. Any specific note
- k. Date of Drawing

5.12.8 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 2 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.

5.13 SOFTWARE REQUIREMENTS

5.13.1 SYSTEM HELP

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

5.13.2 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 is to be role based and selectable for each individual operator and include a provision for granting privileges
- c. New Logins and access levels shall be authorised only by University Mechanical Services Engineer.
- d. User privileges shall be location dependent to provide the user different access levels based on where they are in the system

5.13.3 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.

5.13.4 PROGRAMMING

- a. All programming shall be available for live viewing and display of operating sequences.
- b. Pre-programmed Logic blocks that do not allow access to programming/settings shall 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.

5.13.5 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

5.13.6 SCHEDULES

The following items shall 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.

5.13.7 TRENDING

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

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

Trend graphs shall have the ability to Auto Update with live data as well as the ability to use backdated data.

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

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

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

5.13.8 OPERATOR LOG

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

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

5.13.9 USER AUTO LOGOUT

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

Auto logout may be enabled and disabled by administrator.

5.13.10 DATA STORAGE

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

5.14 ALARMS

5.14.1 SECURITY CONNECTIONS

The university operates a 24/7 operated security desk. All life threatening, safety and commercial critical alarms shall 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.

5.14.2 ALARM PRIORITIES

Alarm priorities must be identified for each individual project and consultation must occur between the users and CIS Engineering. A project specific work shop must be held with the contractor and CIS 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 is to program their alarms so they within the nominated number ranges.

5.14.3 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: High – G02- BLR 1 - Flow Failure

- Alarm priority
- Building code
- Plant\equipment
- Fault description

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

- Building code: G02 -
- Plant\equipment: BLR-1 Boiler 1Supply Air Fan
- Description: Boiler Status
- Fault description: Flow Failure
- Link to the plant\equipment
- Object monitored
- Recent alarm history
- BMCS system name

5.14.4 ALARM FUNCTIONALITY

Alarms shall be viewable from workstation with a popup visual message for instances of alarm. Alarm messages shall be individually customisable for sending of alarm messages to selected operators and key personal. Alarm log shall be kept of all active alarms, with ability to refine log to building, floor and equipment level. Trending of cleared and active alarms shall be provided. System shall include alarm wizard for easy user setup of alarms. Wizard shall have its own pull down screen for selection of alarm parameters. There shall be function for acknowledging and clearing alarms.

Alarms Must be setup so that they do not cascade and cause nuisances alarms example if a AHU fails then the VAV's that it service and the spaces will not generate alarms as the AHU is the highest item in the alarm hierarchy.

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.

Timed thresholds must be applied to ensure nuisance alarms are not generated from items.

5.15 EFFICIENCY

5.15.1 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

5.15.2 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

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. Large open plan office spaces controlled via a scheduled time clock with a pre-set after hours push button for out of normal hours
- c. Large central lecture theatres operating from a central time clock with afterhours present push button, PIR to be utilised to switch off system when space not occupied
- d. Seminar rooms either push button initiation\time clock initiation with PIR controlling the switching off of the system
- e. General non occupied spaces operating from pre-programmed time schedule
- f. Room booking systems allowance must be made in the control functionality to accept a signal from the room booking system to control the space HVAC.

5.16 BMCS POINTS

Attachment 3 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.

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

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

5.17 TRANSDUCERS

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

TABLE 5 : TRANSDUCECR REQUIREMENTS

Accuracy	<ul style="list-style-type: none"> Employ active type with an accuracy of +1% of span. Accuracy to 3% of span and repeatable to 3% of span
Signal	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Use electronic to pneumatic transducers of industrial quality
Temperature	<ul style="list-style-type: none"> Temperature compensated over the full span of the device
Input Range	<ul style="list-style-type: none"> Input range of 0 - 10 volts DC or 4 - 20 mA
Control Relay (Solid State)	
Capacity	<ul style="list-style-type: none"> 40v 10amp capacity
Applications:	<ul style="list-style-type: none"> Normally open or normally closed to suit the application, suitable for switching inductive AC loads
Current Sensor (Analogue)	
Accuracy	<ul style="list-style-type: none"> Accuracy is to be +/- 2% of full scale at each range



5.18 SENSORS

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

TABLE 6 : SENSOR REQUIREMENTS

Humidity Sensor	
Capacitance	<ul style="list-style-type: none"> Capacitance type compatible with BAS system.
Duct Sampling	<ul style="list-style-type: none"> Complete with duct sampling devices <input type="checkbox"/> Protected from airborne dust particles and free air moisture
Temperature Compensated	<ul style="list-style-type: none"> Relative humidity sensors to be temperature compensated such that when used in conjunction with the BMCS or separate controller
Accuracy	<ul style="list-style-type: none"> Accuracy of the display is $\pm 3\%$ of operating range.
Differential Pressure Sensor (Air)	
Type	<ul style="list-style-type: none"> Provide static pressure sensors of the differential pressure type.
Adjustable	<ul style="list-style-type: none"> Sensor range (span) to be adjustable
Accuracy	<ul style="list-style-type: none"> Accuracy of sensor including controller to be $\pm 1\%$ of span
Capacity	<ul style="list-style-type: none"> Sensors to be capable of withstanding a total pressure differential of 1000 Pa
Differential Pressure Sensor (Water)	
Type	<ul style="list-style-type: none"> Provide static and differential pressure sensors complete with span and zero point adjustment from both software and hardware techniques.
Accuracy	<ul style="list-style-type: none"> Accuracy of sensor to be $\pm 1\%$ of span.
Capacity	<ul style="list-style-type: none"> Sensors to be capable of withstanding pressure ranges of vacuum to 2000 kPa without permanent effect on the operation of the device
Type	<ul style="list-style-type: none"> Sensor encapsulated in a copper or stainless steel probe
Accuracy	<ul style="list-style-type: none"> Accuracy ± 0.1 deg C
Assembly	<ul style="list-style-type: none"> Assembly complete with wiring housing and mounting flange
Outdoor Air Temperature Sensor	
Type	<ul style="list-style-type: none"> Thermistor sensor encapsulated in a probe, with weatherproof enclosure, sun shield and mounting bracket
Accuracy	<ul style="list-style-type: none"> Accuracy to be ± 0.5 deg C over the entire operating range
Pipe Temperature Sensor (Well)	
Type	<ul style="list-style-type: none"> Thermistor sensor encapsulated in a long probe, with screw fitting for insertion into a standard thermo well
Accuracy	<ul style="list-style-type: none"> Accuracy to be ± 0.3 deg C over the entire operating range
Pipe Temperature Sensor (Strap-On)	
Type	<ul style="list-style-type: none"> Thermistor sensor <input type="checkbox"/> Complete with solid state circuitry in an enclosure and connecting cable to the thermistor
Accuracy	<ul style="list-style-type: none"> Accuracy to be ± 0.3 deg C over the entire operating range
Room Temperature Sensors	
Type	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Mount sensors to ensure a rapid response to changing temperature
Accuracy	<ul style="list-style-type: none"> Accuracy to be ± 0.25 deg C over the entire operating range
Gas Sensors	



Type	<ul style="list-style-type: none"> The detector element will be of the plug in type with either a 24V, 4-20mA output signal.
Casing	<ul style="list-style-type: none"> Include sensing elements and electronics mounted in an aesthetics single piece casing.
Measurement	<ul style="list-style-type: none"> Provide analogue measurement to the control system.
Sensor Range	<ul style="list-style-type: none"> Provide a sensor range of zero to 2000 ppm
Certification	<ul style="list-style-type: none"> Be NATA tested with a certificate provided at time of commissioning
Portability	<ul style="list-style-type: none"> Portable atmospheric gas sensors must be used when specified and be also NATA tested as above
Display	<ul style="list-style-type: none"> Four digit LCD display
Safe Lights (Operating Normally)	<ul style="list-style-type: none"> Two green safe lights illuminated
Danger Lights	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Will enable the current TWA value to be displayed on the control system
Alarm Level	<ul style="list-style-type: none"> Set point adjustment
Alarm Flow	<ul style="list-style-type: none"> Flow fail alarm
Power Supply	<ul style="list-style-type: none"> 12 hour battery life (rechargeable. unit complete with recharger
Casing	<ul style="list-style-type: none"> P65 casing

5.19 CABINETS/MECHANICAL SWITCH BOARDS

5.19.1 GENERAL

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

5.19.2 LOCATIONS

The following location requirement shall be adhered to:

- Panels and cabinets mounted in dedicated plant rooms
- Where cabinets are not located in plant rooms university approval shall be
- Cabinets shall not be located in places of extreme environmental conditions
- Cabinets shall not be located outdoors
- All transformers and power supplies shall not be installed in ceiling space

5.19.3 MAKE

Refer to **CIS Electrical Services Standard**.

5.19.4 WIRING

Wiring must comply with the following requirements:

- a. All wiring must comply with University electrical Design Standard
- b. All communication cabling to comply with University communication cabling standard

5.20 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.

5.21 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.

NOTE: 12 or 24 months period depending on project size and duration.

5.22 WARRANTY

The contractor is to provide a warranty for all hardware and software components supplied under the contract for a period of twelve (12) months from the date of practical completion. The warranty is to be included in tender documentation. The warranty must include all parts, programming and labour during the warranty period.

6 COMMISSIONING

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.

Detailed testing and commissioning records shall be provided for each system and each component as appropriate. All such records shall be witnessed and verified by the project consultant/designer.

Project hand over plan shall be developed by the consultant/designer to allow the system to be handed over to The University.

Tuning Period, there should be a tuning period specified for 12 months, example of scope below.

.



Building Tuning

The BMCS Contractor shall allow for 12 months of building tuning commencing one month after practical completion of the system. The frequency of tuning shall be one day per month.

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.

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. Update tuning report log on BMS
- i. 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.

7 SAFETY IN DESIGN

The contractor must consider risk during the design. A design safety report must be submitted to the relevant CIS Project Manager for every design project. Contractors must confirm, so far as it is reasonable practicable (SFAIRP) 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.

8 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 2)

9 OPERATIONS

Access to all plant rooms within the University is controlled by a UNIVERSITY OF SYDNEY BMCS ACCESS PERMIT.

This permit provides the University with vital information about the applicant. Permits must be submitted to the University delegate.

The University delegate will review risk assessments and SWMS before access is granted. Before updating or shutting down of the system a risk analysis must be performed highlighting areas served by plant and implications of shutting plant down. The risk analysis must be provided to University project manager for approval.

Operators who lock points in manual must provide notes on who, why and when the point was locked into the manual position.

10 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 **CIS Request Dispensation from Standard Form (CIS-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.

11 QUALITY CONTROL

11.1 DESIGN STANDARD COMPLIANCE

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

Competent CIS 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 CIS 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 CIS 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

11.2 DESIGN STANDARD CERTIFICATION

Contractors and their consultants must certify compliance to the design standard by completing and submitting the CIS Project Design Certification Form, CIS-PROJ-F001 to the CIS Project Manager at each of the following project phases:

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

Notwithstanding CIS' 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.

12 REFERENCES

Design and documentation utilising these standards is to incorporate the requirements of the following current standards and requirements as a minimum:

- a. National Construction Code
- b. Building Code of Australia (including all relevant clauses of Section J)
- c. Environmental Planning & Assessment Regulation
- d. Work Health & Safety Act
- e. All CIS Standards
- f. AS 1668.1 Mechanical Ventilation & Air Conditioning code, Part 1
- g. AS 1668.2 Mechanical Ventilation & Air Conditioning code, Part 2
- h. AS 60947.8 Low voltage switchgear and control gear - Control units for built-in thermal protection (PTC) for rotating electrical machines
- i. AS/NZS 2982-2010 Laboratory Design and Construction



- j. AS/NZS 2243.1-2005 Safety in laboratories – Planning and operational aspects
- k. AS/NZS 2243.2-2006 Safety in laboratories – Chemical aspects
- l. AS/NZS 2243.6-2010 Safety in laboratories – Plant and equipment aspects
- m. AS/NZS 2243.8-2006 Safety in laboratories – Fume cupboards
- n. AS/NZS 1677.2 - Refrigeration systems:
- o. AS/NZ 4776
- p. AS 1682 Fire dampers
- q. AS 2129 Flanges for pipes, valves and fittings
- r. ISO 16484-5:2012

13 NOTES

N/A

14 DOCUMENT AMENDMENT HISTORY

Revision	Amendment	Commencing
001	First Issue	16 August 2013
002	<ul style="list-style-type: none">• 5.7 Tag naming convention clause added.• 5.7.2 BACnet priority Array clause added.• 5.8 BACnet device numbering convention.• 5.12.4 Summary page clause added.• 5.16 BMCS Points Clause added.• 6 Commissioning clauses updated.• 7 Safety in design clause added.• Attachment 3 Services Points list added.• Design & construct checklist included in Attachment 4 • New Forms added to the website• CIS Design & Construct Services Checklist Form (CIS-ENG-F009)	21 August 2015

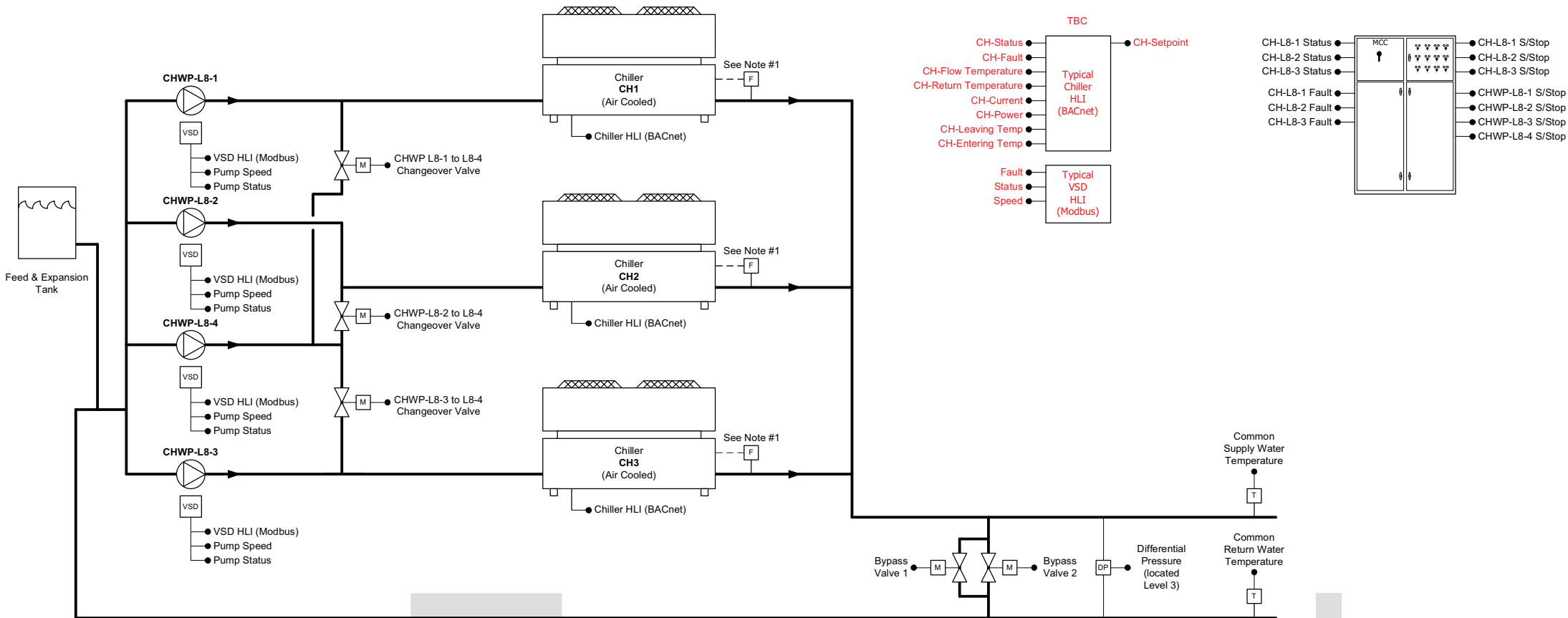
15 ATTACHMENTS

Attachment 1 Operational Description Template

Attachment 2 Network and Hardware Configuration

Attachment 3 Services Points List

ATTACHMENT 1- 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 (CHWP4).

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

If all pumps are operational the standby pump (CHWP4) 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.

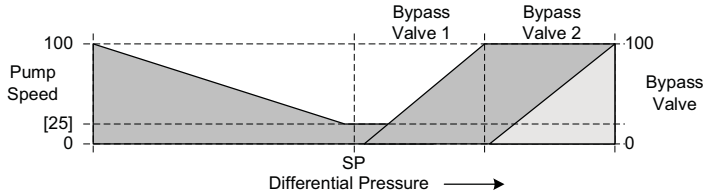
Chiller Stop Sequence

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.

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
REV	DESCRIPTION	DATE

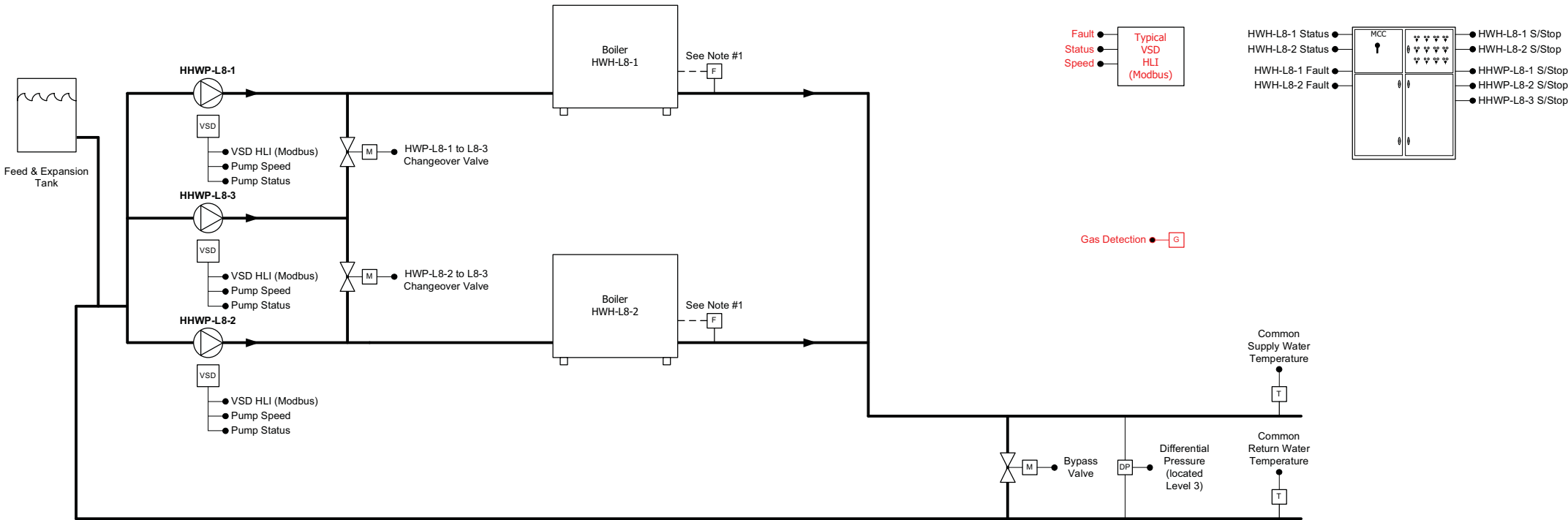
Client:

Project: The University of Sydney

Title:

Chilled Water System Control Schematics

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



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.

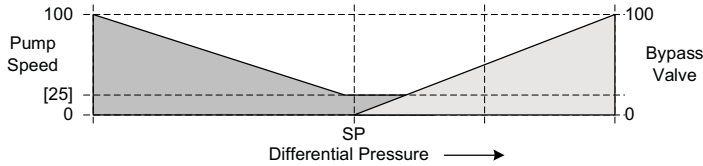
Boiler Stop Sequence

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

Notes:

- Boiler flow switches hard wired into the boiler 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

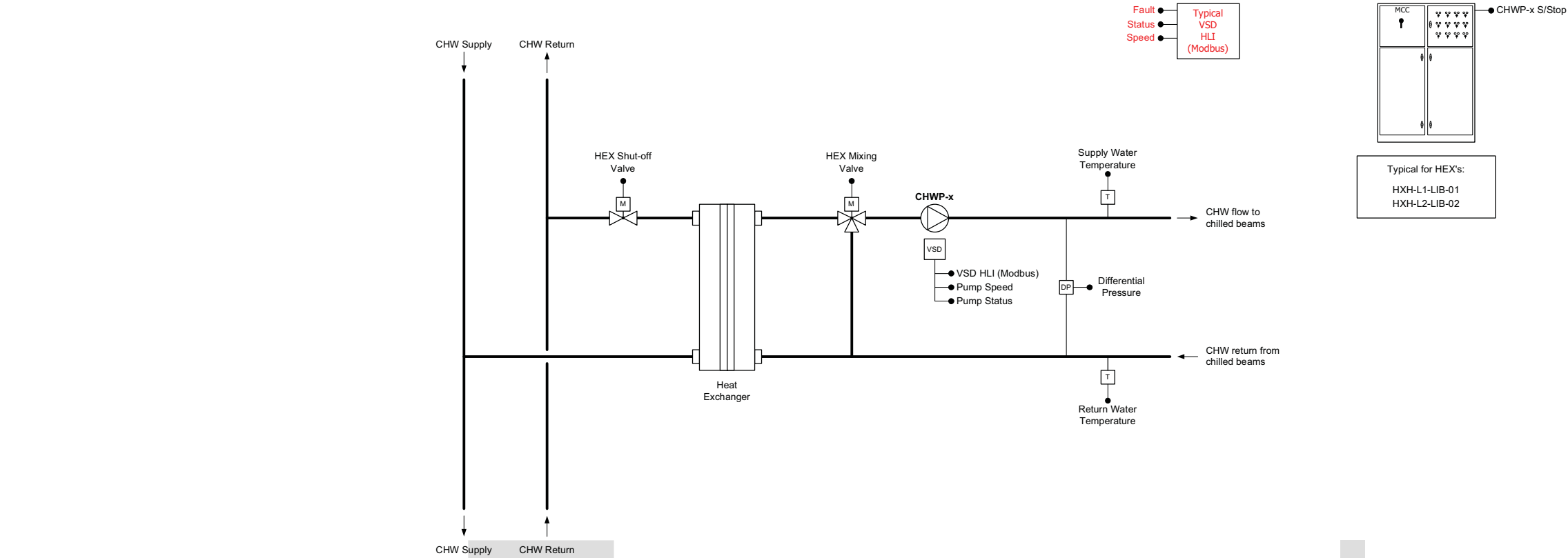
Client:

Project: The University of Sydney

Title:

Hot Water System Control Schematics

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



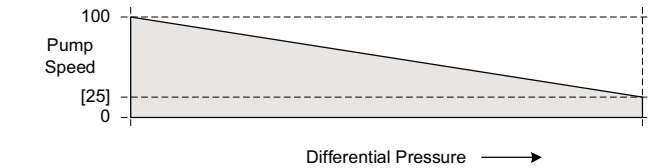
Chilled Beams

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

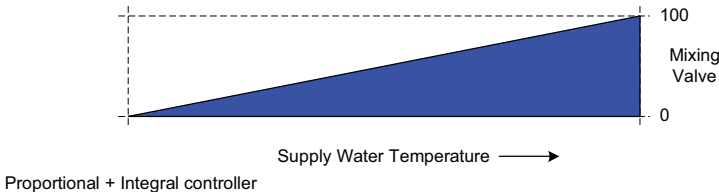
The cooling call is turned off when all chilled beam valves are less than 10 % for a period of 5 minutes.

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.



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



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:

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
REV	DESCRIPTION	DATE

Client:

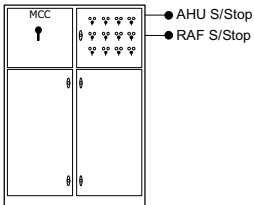
Project: The University of Sydney

Title: Typical Chilled Beam Heat Exchanger Control Schematics

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

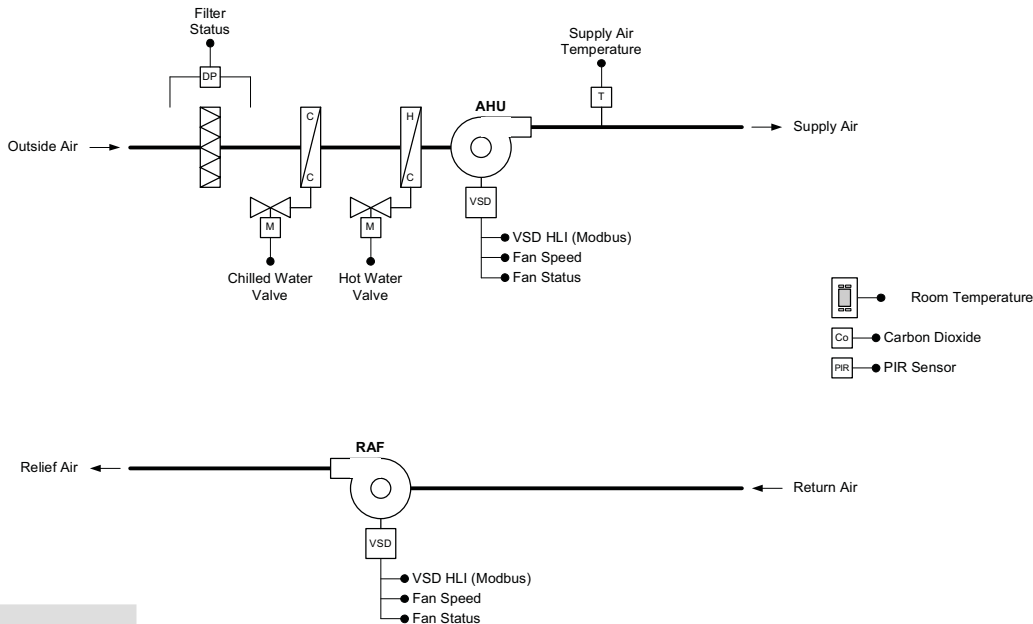
Fault
Status
Speed

Typical
VSD
HLI
(Modbus)



Typical for AHU's and RAF's:

AHU-L1-GTS-02 / RAF-L1-GTS-02 (L1 100 Seat Theatre)
AHU-L1-GTS-03 / RAF-L1-GTS-03 (L1 100 Seat Theatre)
AHU-L1-GTS-04 / RAF-L1-GTS-04 (L2 100 Seat Theatre)
AHU-L1-GTS-05 / RAF-L1-GTS-05 (L2 100 Seat Theatre)



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.

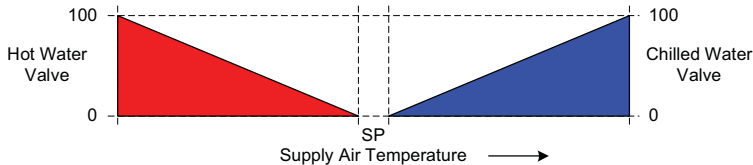
Once the Dynalite system signal is off and no motion is detected for a period of [20] minutes the occupancy is turned off.

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

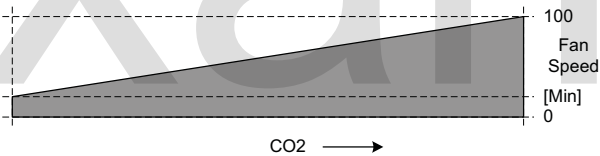
The chilled and hot water valves modulate to maintain a supply air temperature at a constant [18] °C as shown below.



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.

Notes:

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

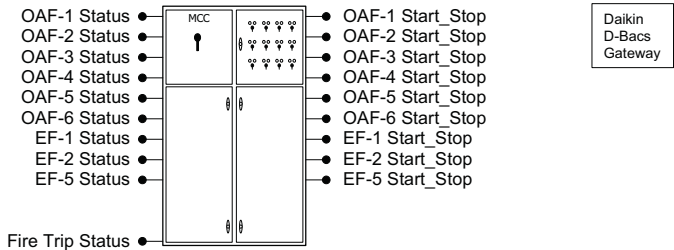
REV	DESCRIPTION	DATE
-----	-------------	------

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
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
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

[24/7]

[24/7]

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:



ATTACHMENT 2 - NETWORK AND HARDWARE CONFIGURATION

Building Code	Building Name	Device location	Device Name	Device Type	BACnet ID	MAC	Application Dev ID's	Net-1	Enabled	Net-2	Enabled	Ethernet	Enabled	UDP-1	Enabled	Type	Port N#	UDP-2	Enabled	Type	Port N#	IP Address	Subnet	Gateway	Ethernet MAC

ATTACHMENT 3 – SERVICES POINTS LIST

HVAC POINTS

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

HVAC POINTS CONTINUED

MISC Outside Air Temperature/humidity sensor	Package unit Start/stop	Humidifier Humidifier enable	Refrigerant Leak Detection Unit Refrigerant Leak Detection status
Split System Start/Stop Status Room Temperature Fault	Status Supply Air Pressure filter differential pressure Outside\return\relief Air Damper Compressor stages call	Humidifier Status Humidifier Fault HLI Fault	Refrigerant PPM
Ducted VRV Indoor and Split Ducted Indoor Start/Stop Status Supply Air Sensor Filter DP Sensor Room Temperature Fault	Reversing Valve/heat cool call Supply Air Temperature Return Air Temperature HLI to Package Unit Fault	Air to Air Heat Exchanger Supply Air Temperature Return Air Temperature Exhaust Supply Air Temperature Supply Air Temperature Fault	VSD Start/stop Status Speed HLI to VSD Fault
Supply Air system Including Fan Start/Stop Status Filter Differential Pressure Sensor 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	FAN Start/stop Status Differential Pressure filter differential pressure Fault
VAV Room Temperature Supply Air Temperature HW Valve\Electric Heater Supply Air Pressure Damper Position Fault	Hot Water Reheats Zone HW Valve After Hours Push Buttons After hours AC After hours AC Indication Lamp Natural Ventilation Window Reed Switches CARPARK CO Sensor NO Sensor	VRV System HLI to VRV Automated Water Treatment System Status HLI Fault	Pressurisation Units Status Fault Thermal meters Chilled Water System Heating Hot Water System Condenser Water System Tenancy Systems Process Chilled Water Loops Building Take offs from Central Chilled\Heating Condenser Water Systems

HVAC POINTS CONTINUED

Fan assisted VAV Supply Air Pressure HW Valve \Electric Duct Heater Supply Air Temperature Fan Speed Start/Stop Damper Position Fault	Hepa Filters Filter Differential Pressure Sensor	Steam System Steam Boiler isolation Valve System supply pressure Supply System Temperature System Boiler Supply Pressure Make up water tank low\high level Make up water tank temperature
	Kitchen Exhaust filtration Status Filter Differential Pressure Sensor Fault	
	UV lights Start/Stop Status Fault	
		CO2 Space CO2 sensor for plant with the ability to modulate outside air

HYDRAULICS POINTS

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

ELECTRICAL POINTS

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

BUILDING POINTS

Louvers	Thermal/Sun Screens
Status	Status
Fault	Fault

PROCESS EQUIPMENT AND GASES POINTS

Vacuum Pump system	Compressed Air System	Fume Cabinets
Status	HLI	Sash Position
HLI	Status	HLI
Fault	Fault	Fault
Medical\Lab Gas Panel	System Supply Pressure	Status
Status	Air Dryer status	
Fault	Air Dryer Fault	
HLI		

LIGHTING POINTS

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

FIRE SYSTEMS POINTS

FIP
Fire Trip

LIFT POINTS

LIFT
(HLI)
Lift position
Lift status
Lift Fault
Lift motor room high temperature

ACTUATOR FEEDBACK POINTS**Actuator Feedback**

VAV Damper

Bypass Valves

Outside Air Damper

Return Air Damper

Relief Air Damper

Floor Supply\Return Air Shut Off
Damper

AHU CHW valve

AHU HW Valve

Chiller Isolation Valve

Cooling Tower Isolation valve

Heat exchanger control valves