# Guideline Design Standard for Building Management & Control Systems (BMS)

## DOCUMENT HISTORY

| Version | Description | Date Issued |
|---|---|---|
| 1.4 | General Revision | 31/5/2012 |
| 1.41 | Revised to include underscore delimited tags | 28/6/2012 |
| 1.42 | Added the following:<br>7.4.12 – Status Effect requirement<br>7.4.13 – Popup menu requirement<br>Revised Section 7.8 – Alarms to reference Alarm Handling Subsystem (AHS) Requirements Specification Enterprise Building Management System (EBMS). | 5/6/13 |
| 2.0 | Version number updated to major version change to align with Alarm Handling Subsystem (AHS) Requirements Specification Enterprise Building Management System (EBMS).<br><br>Added the following:<br>7.4.14 – Mouse Over requirement. | 17/6/2013 |
| 2.1 | Minor revision | 31/12/2014 |
| 2.2 | General Revision to include N4 comment and other clarifications / revisions. | 6/10/2017 |

# Circulation Approval

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# 1 Purpose

The purpose of this Design Guide, covering requirements and specifications, is to provide a design guide for Project Managers and Designers (includes D&C contractors), developing specifications for Building Monitoring and Control Systems at the Macquarie University.

# 2 Scope

This document scopes the type of technology and systems that are compatible with the current MACQUARIE UNIVERSITY BMS system architecture.

**NOTE WHERE THIS SYMBOL APPEARS: Overview functionality is included in this document. It is expected that designers will customize the requirements within their documentation package, however this specification includes minimum requirements.**

Controllers and other system equipment are specified to the extent that compliance with BACnet and some basic architecture and functionality requirements are met. It is not intended to completely specify requirements that consultants may need, but is aimed at providing a minimum and encouraging vendors to offer innovative solutions. Vendors may offer equipment that exceeds these specifications.

# 3 References and Standards

1. Macquarie University, Sydney. MACQUARIE UNIVERSITY Design Guidelines
2. Macquarie University, Sydney, Alarm Handling Subsystem (AHS) Requirements Specification Enterprise Building Management System (EBMS)
3. National Institute of Standards and Technology (NIST). GSA Guide to Specifying Interoperable Building Automation and Control Systems Using ANSI/ASHRAE Standard 135-1995, BACnet
4. American Society of Heating Refrigeration and Air-conditioning Engineers. BACnet PICs (protocol Implementation Conformance Statement)
5. American National Standards Institute (ANSI). EIA-485 Communications Standard
6. AS/NZS 3000:2007 Standards Australia. Electrical Installations
7. Australian Communications and Media Authority: Radio-communications (Electromagnetic Compatibility) Standard 2008

# 4 Definitions and Abbreviations

**ACU,** Air Conditioning Unit
**AHU,** Air Handling Unit
**AI,** Analog Input a value that can be read from a controller
**AO,** Analog Output, value that be read from a controller and written to by software
**AV,** Analog Value, a holding variable such as a setpoint,
**BACnet,** Interoperability protocol ASHRAE Standard 135p.
**BACnet Advanced Application Controller (BACnet AAC),** application controller
**BACnet Application Specific Controller (BACnet ASC),** application controller for VAV, FCU etc.
**BACnet Building Controller (B-BC),** controller device profile for high level network based controllers.
**BACnet Operator Workstation (B-OWS),** network level workstation
**BCS,** Building Control Station, a high level BMS controller typically connected directly to the Macquarie University WAN. Commonly used to control chillers, large Air Handling systems and other complex equipment. Must conform to BACnet B-BC device profile.
**BI,** Binary Input, a digital value read from a controller
**BO,** Binary Output, a digital value that can be written to by software
**BV,** Binary Value, a digital holding variable
**BMCS Contractor,** company employed to deliver individual Macquarie University BMCS
**DSC,** Distributed Control System
**DMZ,** Demilitarized Zone
**FCU,** Fan Coil Unit
**ITP,** Inspection and Test Plans
**JACE**, Java Application Control Engine (trademark of Tridium Inc.)
**KVM Switch** Keyboard/Video/Mouse switching device
**LDAP,** Lightweight Directory Access Protocol
**Lonworks**, Echelon Corporation Lonworks network standard
**Modbus/RTU,** Modbus over serial link (RS-485)
**Modbus/TCP**, Modbus over IP (Transmission Control Protocol)
**MUP**, Macquarie University Property
**Native BACnet system,** a system that can be proven to be designed around the BACnet standard.
**NMS,** Network Management System, a software system for monitoring network devices.
**NTP,** Network Time Protocol
**OFM** Office of Facilities Management
**RDC,** Remote Distributed Controller, BACnet application oriented controllers, typically linked to a BCS or a BACnet router for supervisory functionality, may reside on a lower speed (78Kbs) peer to peer LAN. Commonly provide VAV, FCU, small AHU, and Packaged Equipment local control. Required to support B-AAC or B-ASC profile.
**RDP,** Remote Desktop Protocol (multi-channel allowing remote clients to connect to Microsoft Terminal Services).
**SAT,** Site Acceptance Testing
**SNMP,** Simple Network Management Protocol
**SMTP,** Simple Mail Transfer Protocol
**SDD,** System Design Document, includes all design information for approval prior to installation
**VAV,** Variable Air Volume (referencing the controller/actuator)
**VPN,** Virtual Private Network
**UTC,** Coordinated Universal Time (*Temps Universel Coordonné)*

# 5 Introduction

## 5.1 General Requirements

5.1.1 Each Building shall be installed with a Tridium Niagara based BMS system.

New buildings or total refurbishment of existing buildings will require a Niagara N4 system to be installed. This will be licensed to suit either the AX platform V3.8 or N4 V2.X if a new N4 server is available. Niagara Maintenance (3 Years) will be purchased for all new systems.

Designers should integrate any refurbishment proposed with the existing systems. Different vendors are not allowed in the same building.

Minor Upgrades shall use only equipment from the existing vendor installed and will supply N4 8000 equipment licensed to operate on the AX platform. This shall be used for building refurbishment to maintain consistency for maintenance of the building. Different brands in the same building are not allowed unless clear separation can be shown. It is preferable to maintain a single vendors product in each building.

5.1.2 Controllers shall be based on ANSI/ASHRAE Standard 135-2008, BACnet. The operator's workstation, all Building Control Stations (BCS) and Remote Distributed Controllers (RDC), shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135–2008, BACnet. Non-BACnet-compliant or proprietary equipment or systems (including gateways) will not be acceptable. New equipment must be N4 compliant.

5.1.3 Macquarie University has an enterprise wide architecture that incorporates a BMS server independent of the Building Management Systems. Each BMS will connect to this server for the purposes of:

- Web-user access (for viewing and control of equipment/space setpoints or other parameters required by MUP). A graphical interface.
- Clock Synchronisation and global scheduling
- Alarm Management, event archiving and email notification
- History Logging and trend archiving
- Supervisory Control and Monitoring
- Building energy and utility performance profiling

Note new systems must be set up to suit N4 or AX depending on the server available and whether the building BMS is a new replacement or addition to the existing system.

5.1.4 Each building will have a minimum of one Energy Jace and one or more BMS Jaces. Metering is to be kept separate from control functions. Metering is connected to the metering server. Field devices will not be connected to the energy metering Jace and vice versa.

5.1.5 Each BMS shall completely control all mechanical equipment, including all unitary equipment such as VAV boxes, heat pumps, fan-coils, AC units, etc., and all air handlers, boilers, chillers and cooling towers using native BACnet-compliant components.

5.1.6 Building Management Systems will allow for the use of industry standard protocols for the connection of various equipment. This equipment must terminate on a BACnet BCS or RDC:

- Modbus for devices (PLC, chillers, water meters, electricity meters etc.)
- C-Bus (lighting and other device networks)
- KNX (for metering devices and other device networks)
- M-bus (heat meters)
- Fieldbus, DNP, CIP (PLCs and other industrial controls for power generation etc.)
- SNMP for IT equipment

# 6 BMS Specifications

## 6.1 General

6.1.1 Each Building Management System provides a standalone function, independent of the Server or any other System, unless it is specifically designed to integrate with other buildings or plant.

6.1.2 Each Building Management System provides all local automatic control for mechanical plant and includes all hardware, software and programming necessary to achieve a complete Building Management System.

6.1.3 Each building will have a minimum of two systems installed. These will be one Energy Jace and one or more BMS Jaces. Metering is to be kept separate from control functions. Metering is connected to the metering server. Field devices will not be connected to the energy metering Jace and vice versa.

## 6.2 Scope by BMS Contractor

6.2.1 The BMS contractor is required to provide a complete system. That is, complete with all Software, Building Control Stations, Remote Distributed Controllers, field points, field instrumentation, cabling, actuators, controls programming, alarm programming, time schedules, histories (trend logs), graphics (with room numbers accurately matching current space planning floor plans), and all other requirements sufficient to meet the specification and hand over a fully operational system to MUP.

6.2.2 Interfacing with other systems as set out in the specification.

6.2.3 System engineering documentation and drawings provided in advance of installation works for approval. Prepare individual System Design Documents (SDD) for approval **prior to the commencement of installation** including hardware layouts, interconnection drawings, and software configuration from project design data:

- System Description (to achieve the tender design documents)
- Functional Specification of all controls and software functions
- System Interfaces
- Network topology
- Equipment locations
- Equipment installation and connection drawings
- Bill of Materials
- Maintenance Schedules
- Valve and Actuator selection and design data
- Test Plans

6.2.4 Properly trained and qualified technical specialists must be available during all phases of system installation, testing and commissioning. Specifically Tridium Niagara Certified (AX and N4) engineers must be used for Tridium system integration works.

6.2.5 A complete program of Site Acceptance Testing (SAT). Prior to commencement of Site Acceptance Testing, the contractor is required to provide completed graphics, database and Inspection and Test Plans (ITP). MUP will not commence SAT without prior submission of ITP's.

6.2.6 Complete testing documentation and O&M manuals. Full schematic drawings (electrical and DDC) must be supplied as part of the O&M manuals, as well as logic flow diagrams of the DDC control programming, workstation software, diagrams, and all other associated project operational documentation (such as technical manuals) on approved media, the total of which accurately represents the final system. The as-built drawings are to be provided in accordance with the MUP CAD Drawing Standards and to be a format fully compatible with the MUP Record Keeping System. Drawings are to be provided in Autocad DWG format with bound files included and in PDF format. Manuals are to be provided in Word format and PDF format. An electronic copy of all material is to be provided on DVD or USB drive. At least 2 hard copies are also required for proofing and final use.

6.2.7 Comprehensive competency based training (proportionate to the project size) for MUP maintenance representatives of at least 5 days for up to 5 people. The BMS contractor is required to supply competency based training for:

(a) Operators
(b) Administrators
(c) Maintainers

6.2.8 The BMS contractor is required to provide a detailed syllabus outlining the courseware to be covered in each of the three training competencies.

## 6.3 Scope by others

6.3.1 Where the system is required to interface with other building systems including but not limited to Air-conditioning, fire, security, laboratory ventilation, chilled water manager, lifts, and MACQUARIE UNIVERSITY Campus Area Network, the design is required to clearly set out the specification of each interface.

6.3.2 All IP network level devices (Building Control Stations) will be connected to the Campus Wide Area network. IP addresses will be furnished by Macquarie ITS.

## 6.4 System Engineering

6.4.1 Prepare detailed designs for all functions, equipment, analogue and binary objects, time schedules, system databases, graphic displays, controls and energy management programs, logs, and management reports and all other engineering designs based on the tender documents.

6.4.2 Prepare a statement certifying that the system is designed for reliable operation and ease of maintenance during its life. The supplier is to advise the design life of the system. Design life will not be less than 10 years.

6.4.3 All equipment will be designed for installation with AS3000:2007 Electrical Installations and all equipment supplied will comply with ACMA Radiocommunications (Electromagnetic Compatibility) Standard 2008, and carry the C-Tick approval mark.

6.4.4 Inter-connection between all Building Control Station (BCS) systems must be via an approved structured LAN cabling system. Where applicable Building Control Stations will be connected directly to the Campus Area Network and will be assigned IP addresses and BACnet addresses by MUP IT.

6.4.5 Provide complete manufacturer's specifications for all items that are supplied. Include vendor name of every item supplied. This information is to be provided to MUP for approval in advance of ordering.

6.4.6 The BMCS Contractor will be required to liaise with Macquarie University MUP to develop graphics and alarms that will be provided to MUP and integrated into the MUP BMS Server. All graphics templates for new systems are to be constructed on a common format such that they can be ported directly to the MUP Server from the test server. The BMS Contractor is to ensure that Graphics are built in accordance with Macquarie University Style-sheets (q.v. APPENDIX B) to allow their graphics to be smoothly integrated to the BMS Server. Prior to commencement of graphics preparation, the contractor is to liaise with MUP to familiarize themselves with the integration of Stations, Graphics, Schedules and Alarms to the MUP BMS Server.

6.4.7 All installations must be designed for safe operation and maintenance and comply with all WHS regulations and relevant Australian Standards. All controls emanating from the DDC to external devices must be 24VDC or 24VAC originating from a 240V/24V transformer mounted within the DDC cabinet or in external switchboards and switched by the internal relays within the DDC control panel. No DDC controller is to switch 240VAC. All 240 VAC switching must be done in a compliant mechanical Motor Control Centre complying with Australian Standards with relay isolation between DDC controllers and the mechanical electrical control circuit.

6.4.8 All field engineering software and passwords (including programming, administration and configuration tools) required to program all BCS and RDC class controllers will be supplied to MUP.

6.4.9 All software required to make any system configuration, administrative or program changes anywhere in the system, including scheduling and trending applications, or engineering parameters will be supplied to MUP. All software passwords required to program and make future changes to schedules, trends and related program changes will also become the property of MUP.

6.4.10 All software licenses (and license agreements) required to operate and maintain the system will be provided with written evidence that MUP is the beneficial end user.

## 6.5 Network Architecture

6.5.1 Each system will consist of a networked communication structure (with TCP/IP on gigabit or fast Ethernet at its highest level).

6.5.2 Inter-connection between BCS's connected to MACQUARIE UNIVERSITY WAN Data ports must be via an approved structured LAN cabling system, installed by an MUP qualified cabling contractor.

6.5.3 BACnet/MSTP (where used to link sub-controllers) must use approved EIA-485 cable with properly grounded and screened twisted pair. Distances must not exceed the EIA-485 specification.

6.5.4 Each BCS will be assigned private corporate class A IP addresses by the MACQUARIE UNIVERSITY IT Services.

6.5.5 Systems that support an internal System Manager (such as Chilled Water Manager or Lighting Manager) are to be monitored through BACnet directly. The BMS should not independently measure data that is measured more accurately or at higher resolution by the System Manager.

6.5.6 BACnet Routing will be used to link from IP network segments to RS-485 network segments. Each floor is to contain routers to provide separation between IP backbone and floor networks of controllers connected to an RS-485 network. A BCS connected to the BACnet/IP network may act as a router to lower speed RS-485 BACnet MS/TP networks, with the limitation that no more than 64 devices be routed through the BCS.

6.5.7 Local Workstations or servers are to comply with BACnet Operator Workstation profile (B-OWS) and must be connected directly to the MACQUARIE UNIVERSITY WAN using BACnet IP.

6.5.8 All proposed BACnet controllers are to be furnished with a BACnet protocol Implementation Conformance Statement (PICS see APPENDIX C) for approval, prior to commencing design work.

6.5.9 All BACnet devices are to conform to a BACnet Standardized Device Profile (Annex L) and be provided with a list of all BACnet Interoperability Building Blocks supported (BIBBs, Annex K).

6.5.10 Preference will be given to BACnet controllers that are BACNET TESTING LABORATORIES (BTL) listed.

6.5.11 All top level controllers connected to the MACQUARIE UNIVERSITY IP Network must support BACnet/IP. At least one BACnet B-BC connected to the MACQUARIE UNIVERSITY VLAN will be able to communicate as if resident on a LAN, however any BACnet/IP device must support Annex J “Multicasting” or BACnet/IP Broadcast Management Device (BBMD).

6.5.12 Building Control Stations (BCS) must comply with BACnet B-BC and be connected directly to the MACQUARIE UNIVERSITY WAN.

6.5.13 BACnet controllers used in VAV, FCU, AHU and other application specific applications can use either Ethernet/IP (BACnetIP), or RS485 (BACnet MS/TP).

6.5.14 For all BACnet controllers the master BACnet addressing scheme is included in APPENDIX A. BACnet network addresses and controller devices ID’s will be allocated by Macquarie IT.

## 6.6 Field Controllers

6.6.1 Direct Digital Controls (DDC) will be distributed to the Building Control Stations (BCS) and Remote Distributed Controllers (RDC) in accordance with best practice distributed processing.

6.6.2 Building Control Stations (BCS) will support B-BC profile and incorporate sophisticated high-level capability.

6.6.3 Each AX based BCS must support a field point population of no more than 500 points (not including soft points) where the BCS is involved in the control strategy. Where a BCS is used solely for routing of points to the server, then this limit is raised to 1,000 points.

6.6.4 Where the BCS is a JACE (Java Application Control Engine), the following ultimate limits will apply for the population of field points (dependent on the memory available to the JACE): For AX based systems the following applies:

(a) JACE2 64MB 200 Points

(b) JACE2 128MB 500 Points

(c) JACE6 128MB 600 Points

(d) JACE6 256MB 1000 Points

For N4 based systems, the sizing is based on devices and the following applies:

Niagara 4 JACES shall be licenced with device / point limits as follows:

| No of Actual Devices / Points on JACE | | Device Limit Licence Required | Note |
|---|---|---|---|
| Devices | Points | | |
| Less than 16 | Less then 800 | 25 – J8025 | Minimum device limit licence accepted. |
| Up to 32 | Up to 1600 | 50 – J8050 | |

| No of Actual Devices / Points on JACE | | Device Limit Licence Required | Note |
|---|---|---|---|
| Devices | Points | | |
| | | | |
| Up to 50 | Up to 2500 | 100 – J8100 | Maximum of 50 devices per JACE in any system design. |

Table 1: N4 Device / Point Limits

**Notes on N4 Licensing / designs:**

1. **A 3-year maintenance must be supplied with each JACE from the manufacturer.**
2. **Minimum JACE to be used is 25 devices unless approved by MUP**
3. **System designs to allow for a maximum of 50 devices on any one JACE.**

6.6.5 Notwithstanding clause 6.6.4 all designs must ensure that CPU usage of JACE devices does not exceed 80% (including a spare capacity allowance of 20% of field points and devices). This shall be proven by providing a log of the CPU usage at Site Acceptance Testing (SAT).

6.6.6 Java Heap Memory of JACE2 type devices must not fall below 3MB under normal operations. This affects the selection of JACE2 devices as these have limited Heap Memory. Where Java heap memory usage causes available memory to fall below 3MB, a JACE6 or above must be specified. JACE6 should not fall below 8MB.

6.6.7 JACE engineering must be conducted generally in compliance with the Niagara AX platform guide or the N4 platform guide as appropriate.

6.6.8 Refurbishments of single systems can be upgraded to the N4 standard if the N4 server has been provided. Jaces from V3.4 upward can be updated. Refer to the availability of this upgrade which will include maintenance.

6.6.9 The BCS timeclock must be able to synchronize with MQU Time Server (Network Time Protocol), feature flexible block DDC programming, memory for standalone trend logging of all field points at 30 second intervals for 12 hours, and local alarm buffering for up 500 alarms offline from the server.

6.6.10 The BCS must support a variety of subsystem drivers to allow connection to a variety of device networks based on other protocols including MODBUS, C-BUS, EIB-KNX, MBUS and LONWORKS.

6.6.11 No AX BCS shall be loaded with more than 32 field devices (RDC) without the express approval of MUP at the system design stage. N4 BCS will be loaded to device / point level as shown on Table 1 for new installations. Additions to existing N4 installations will be allowed to add additional devices / points up to 80% of the licensed Device / point Limit.

6.6.12 Remote Distributed Controllers (RDC) typically support BACnet B-AAC or B-ASC profiles for lower level packaged or compact flexible air-conditioning controls are to be based on BACnet/IP or BACnet/MSTP as the field network. Controllers in MS/TP networks must be capable of operation at data rates up to 76kbs. No more than 48 field points to be connected to any individual RDC.

6.6.13 Each BCS and RDC shall be equipped with non-volatile memory for the protection of user programs, data, graphics and logs for at least 3 months without an external power source. Battery supply will maintain full operation of the BCS for at least 5 minutes without external power.

6.6.14 Preference is given to BCS and RDC the have browser based configuration interfaces. RDC's that require special programming software tools for viewing of field data and basic configuration (clock, BACnet addressing, local BACnet field variables) can only be used with prior approval of MUP. Such software programming tools, if approved, must be provided licensed to Macquarie University.

6.6.15 Lonworks tunneling on the MACQUARIE UNIVERSITY network (or VLAN) is not permitted. Any Lonworks device is to wire in FTT10A cabling direct to a BCS or BACnet to Lonworks gateway that will connect to the MACQUARIE UNIVERSITY network using BACnet protocols.

6.6.16 Programming must utilize block DDC logic techniques allowing MUP staff to easily read and understand the operational logic. B-BC, B-AAC and B-ASC must support a common set of core block programming objects (such as LOGIC, MATH etc.). Block libraries must contain all point types. It must include analog and digital inputs and outputs, Analog and Boolean Variables, and support enumerated and string variables. A full suite of logic functions, arithmetic functions, control loops, time schedules, alarm handling, point type conversion, unit conversion, energy management library must be available in the controller. In addition to block programming library, controllers may offer scripting language for complex programming but this must only supplement the block programming capability.

6.6.17 An RDC using BACnet MS/TP must support tunneling such that all field points, DDC programs, DDC logic functions, alarms, trend logs, control loops, schedules and all other functionality can be access via the IP network without requiring the use of a laptop directly plugged in to pre-program the controller.

6.6.18 Analogue to Digital resolution must be at least 12bits for Analog Inputs Universal and 8bits for Analogue Outputs Universal. All inputs and outputs shall be protected against noise and transient voltages.

6.6.19 RDC with profile B-BC must have flexible IO capacity. Inputs should be capable of configuration as either Binary Input (BI) or Analog Input (AI).

## 6.7 Minimum Field Data Requirements

### 6.7.1 Mechanical Services

#### 6.7.1.1 VAV controllers

Must support BACnet ASC or AAC profile and must support as a minimum the following variables:

| Point Name | AI | BI | AO | BO | AV | BV |
|---|---|---|---|---|---|---|
| Occupied Mode | | | | | | R/W |
| Start/Stop | | | | R/W | | |
| Space Temp | R | | | | | |
| Supply Temp (from VAV) | R | | | | | |
| CO2 (IAQ) | R | | | | | |
| Damper (2) | | | | R/W | | |
| Air Flow | R | | | | | |
| Air Flow Setpoint | | | | | R/W | |
| Min. Heating Airflow | | | | | R/W | |
| Cooling/heating | | | | | R/W | |
| Cooling/Heating mode | | | | | | R |
| EDH | | | | R/W | | |
| EDH Safety Trip Fault | | R | | | | |

#### 6.7.1.2 FCU controllers

Must support BACnet ASC or AAC profile and must support as a minimum the following variables:

| Point Name | AI | BI | AO | BO | AV | BV |
|---|---|---|---|---|---|---|
| Occupied Mode | | | | | | R/W |
| Start/Stop | | | | R/W | | |
| Status (CT Relay) | | R | | | | |
| Space Temp | R | | | | | |
| Space Setpoint | | | | | R/W | |
| Supply Temp | R | | | | | |
| Return Temp | R | | | | | |
| Filter Condition (pd) | R | | | | | |
| Heating Valve | | | R/W | | | |
| Cooling Valve | | | R/W | | | |
| EDH | | | | R/W | | |
| EDH Safety Trip Fault | | R | | | | |

#### 6.7.1.3 AHU (Variable Volume) controllers

Must support BACnet B-BC or B-ASC profile and must support as a minimum the following variables:

| Point Name | AI | BI | AO | BO | AV | BV |
|---|---|---|---|---|---|---|
| Occupied Mode | | | | | | R/W |
| Fire Mode | | | | | | R/W |
| Start/Stop | | | | R/W | | |
| Status (CT Relay) | | R | | | | |
| Supply Pres SP | | | | | R/W | |
| Supply Air Pressure | R | | | | | |
| Supply Fan Speed | | | R/W | | | |
| Supply Temp Setpoint | | | | | R/W | |
| Supply Temp (P/Room) | R | | | | | |
| Return Air Temp | R | | | | | |
| Return Air Humidity | R | | | | | |
| Damper Cycle (OA/RA) | | | R/W | | | |
| Min OA Damper | | | | R/W | | |
| Filter Condition (pd) | R | | | | R | |
| Heating Valve | | | R/W | | | |
| Cooling Valve | | | R/W | | | |

#### 6.7.1.4 AHU (Constant Volume) controllers

Must support BACnet B-BC or B-ASC profile and must support as a minimum the following variables:

| Point Name | AI | BI | AO | BO | AV | BV |
|---|---|---|---|---|---|---|
| Occupied Mode | | | | | | R/W |
| Start/Stop | | | | R/W | | |
| Status (CT Relay) | | R | | | | |
| Supply Temp Setpoint | | | | | R/W | |
| Space Temp | R | | | | | |
| Return Air Temp | R | | | | | |
| Return Air Humidity | R | | | | | |
| Damper Cycle (OA/RA) | | | R/W | | | |
| Min OA Damper | | | | R/W | | |
| Filter Condition (dp) | R | | | | R | |
| Heating Valve | | | R/W | | | |
| Cooling Valve | | | R/W | | | |

#### 6.7.1.5 Chiller Manager

Must support BACnet B-BC or B-ASC profile and must support as a minimum the following variables. Chiller data must be delivered directly from the Chiller controller via BACnet such that data is synchronized between BMS and Chiller Manager. Pumps data may be derived from a VSD.
DP and temperature sensors are to be supplied together with HLI data.

| Point Name | AI | BI | AO | BO | AV | BV |
|---|---|---|---|---|---|---|
| Cooling Call | | | | | | R/W |
| ChW Entering Temp | R | | | | | |
| ChW Leaving Temp | R | | | | | |
| CW Leaving Temp | R | | | | | |
| CW Entering Temp | R | | | | | |
| Amps | R | | | | | |
| COP | R | | | | Alt. Calc | |
| Load kWh | | | R/W | | | |
| ChW Setpoint | | | R/W | | | |
| Evap refrig Press | R | | | | | |
| Evap refrig temp | R | | | | | |
| Cond refrig Press | R | | | | | |
| Cond refrig temp | R | | | | | |
| Comp Disch refrig temp | R | | | | | |
| Oil Temp | R | | | | | |
| Oil press | R | | | | | |
| CW Water Flow Status | | R | | | | |
| ChW Flow Status | | R | | | | |
| Chiller Operating Status | | R | | | | |
| Chiller Alarm | | R | | | | |
| Chiller Start/Stop | | | | R/W | | |
| ChW Pump Start | | | | R/W | | |
| ChW Pump Status (CT Relay) | | R | | | | |
| ChW Supply Temp (S) | R | | | | | |
| ChW Return Temp (S) | R | | | | | |
| CW Pump Start | | | | R/W | | |
| CW Pump Status (CT Relay) | | R | | | | |
| CW Supply Temp (S) | R | | | | | |
| CW Return Temp (S) | R | | | | | |
| CT Fan Start | | | | R/W | | |
| CT Fan Status | | R | | | | |
| CT Fan speed | | | R/W | | | |
| ChW Pump kWh | R | | | | | |
| CW Pump kWh | R | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| CT Pump kWh | R | | | | | |
| Evaporator DP (S) | R | | | | | |
| Condenser DP (S) | R | | | | | |

#### 6.7.1.6 Boiler Controller

Must support BACnet B-BC or B-ASC profile and must support as a minimum the following variables.

| Point Name | AI | BI | AO | BO | AV | BV |
|---|---|---|---|---|---|---|
| Heating Call | | | | | | R/W |
| HW Entering Temp | R | | | | | |
| HW Leaving Temp | R | | | | | |
| HW Water Flow Status | | R | | | | |
| Boiler Start | | | | R/W | | |
| Boiler Status | | R | | | | |
| Boiler Fault | | R | | | | |

#### 6.7.1.7 Ambient Air Conditions (Local Building)

A local set of sensors provide the fresh air conditions

| Point Name | AI | BI | AO | BO | AV | BV |
|---|---|---|---|---|---|---|
| Ambient Temperature | R | | | | | |
| Ambient Humidity | R | | | | | |
| Dew Point | | | | | R | |
| Solar energy sensor (optional) | R | | | | | |
| Humidity Ratio | | | | | R | |
| | | | | | | |
| | | | | | | |

#### 6.7.1.8 Weather Station (Provide only if required by MUP. Not normally provided)

The system will receive global variables from the local weather station.

| Point Name | AI | BI | AO | BO | AV | BV |
|---|---|---|---|---|---|---|
| Ambient Temperature | R | | | | | |
| Ambient Humidity | R | | | | | |
| Wind Speed | R | | | | | |
| Wind Direction | R | | | | | |
| Cloud Cover | R | | | | | |
| Dew Point | R | | | | | |
| Rain Condition | R | | | | | |
| Temp prediction Day+1 | R | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Temp prediction Day+2 | R | | | | | |
| Temp prediction Day+3 | R | | | | | |
| Temp prediction Day+4 | R | | | | | |
| Temp prediction Day+5 | R | | | | | |
| Barometric Pressure | R | | | | | |

#### 6.7.1.9 Variable Speed Drive

Must be operated via BACnet or Modbus. The following tables indicates the minimum points required.

| **Point Name** | **AI** | **BI** | **AO** | **BO** | **AV** | **BV** |
|---|---|---|---|---|---|---|
| VSD Status | | R | | | | |
| VSD Fault status | | R | | | | |
| Speed (%) | | | R/W | | | |
| Output Power | R | | | | | |
| VSD Start/Stop | | | | R/W | | |
| VSD setpoint | | | | | | R/W |
| Controlled Input | R | | | | | |

#### 6.7.1.10 Hydraulic and Lift Services/Compressed Air

| **Point Name** | **AI** | **BI** | **AO** | **BO** | **AV** | **BV** |
|---|---|---|---|---|---|---|
| Booster Pump Fail | | R | | | | |
| Booster Pump low press | | R | | | | |
| Hot Water Pump Start | | | | R/W | | |
| Hot Water Pump Status | | R | | | | |
| LMR Hi Temp | | R | | | | |
| Sump Pump Status | | R | | | | |
| Sump Pump Fault | | R | | | | |
| Tank Low Level | | R | | | | |
| Tank Extra Low Level | | R | | | | |
| Tank High Level | | R | | | | |
| Supply Pressure | R | | | | | |
| Compressed Air Fault | | R | | | | |

## 6.8 Electrical and IT

### 6.8.1 Switchboards

6.8.1.1 Provide to monitor all major Circuit Breakers status, trip and Phase fail relays.

6.8.1.2 Provide an electrical meter in all mechanical switchboards above and provide inputs to the university's energy monitoring systems. A metering JACE must be added to the building if none is present.

6.8.1.3 Chillers should be metered independently or measured from the HLI.

6.8.1.4 Electricity meters must be the type having serial data connectivity using Modbus or BACnet.

6.8.1.5 Modbus/RTU (serial RS-485) may be used for daisy chaining meters within a single building.

6.8.1.6 Modbus/TCP can be used where data is to be routed from building to building across the MACQUARIE UNIVERSITY network.

6.8.1.7 Meters must conform to Standard Class 0.5s for Power (IEC62053-22) and Class 1 (IEC62053-21) for Reactive Power.

6.8.1.8 Volts, Current and other variables should be measured at an accuracy of at least 0.5%. Current Transformers should be specified in accordance with AS 60044.1 (2007).

6.8.1.9 Match CT classes with metering, however where it is impractical to do so, recommend alternatives using existing CTs.

6.8.1.10 Meters must provide Total Harmonic Distortion as a percentage.

6.8.1.11 Meters must be the type able to be fitted to a standard 90mm square cutout with illuminated display and buttons for configuration and interrogation.

6.8.1.12 Meters must comply with the MUP Metering Standard.

### 6.8.2 Server Room, Comms Room and Equipment rooms

6.8.2.1 Server Room, Comms Rooms and Equipment temperature is to be monitored.

6.8.2.2 Provide selected monitoring for Server Rooms, TSG and Equipment rooms.

6.8.2.3 Monitor Computer Room AC (CRAC) units (these will have local failover controls). CRAC units and Emergency power systems are to be monitored via BACnet or MODBUS. Fault monitoring of CRAC units is to include hardwire fault input. Supply air and room temperature to be monitored.

6.8.2.4 Monitor Emergency power systems including generators, batteries, chargers and fuel supplies (where required, unless monitored by Data room NMS).

| Electrical Points | AI | BI | AO | BO | AV | BV |
|---|---|---|---|---|---|---|
| Circuit Breaker Status | | R | | | | |
| Circuit Breaker Trip | | R | | | | |
| Phase Fail | | R | | | | |
| Room Temp | R | | | | | |
| Mains Fail | | R | | | | |
| CRAC Status | | R | | | | |
| CRAC Temp | R | | | | | |
| CRAC Fault | | R | | | | |
| CRAC Force Start | | | | R/W | | |
| Generator Status | | R | | | | |
| Generator Run | | R | | | | |
| Generator Start | | | | R/W | | |
| Generator Fault | | R | | | | |
| Generator Fuel Low | | R | | | | |
| Battery Charger Fault | | R | | | | |
| 3ph Volts | R | | | | | |
| Current – A phase | R | | | | | |
| Current – B phase | R | | | | | |
| Current – C phase | R | | | | | |
| 3ph kW | R | | | | | |
| 3ph kWr | R | | | | | |
| 3ph kVA | R | | | | | |
| Power Factor | R | | | | | |
| Frequency | R | | | | | |

### 6.8.3 Lighting

6.8.3.1 Lighting system integration with the BMS must be considered within the design to allow flexible programming of lighting functions with overrides and status's available to the BMS. Where a lighting management system (based on C-Bus, DYnalight, KNX, or other type) is specified, the interface to the BMS must include the following points.

6.8.3.2 Where a contactor based hardwired interface is specified, this must be configured to provide group control as necessary.

6.8.3.3 Each BMS controlled lighting circuit is to be equipped with status monitoring to confirm operation of the lighting circuit to the BMS.

6.8.3.4 Each floor is to be provided with separate lighting controls and a labelled BMS override switch to permit afterhours users access to lighting.

| Point Name | AI | BI | AO | BO | AV | BV |
|---|---|---|---|---|---|---|
| External Lighting | | R | | R/W | | |
| Foyer Lighting | | R | | R/W | | |
| Corridor Lighting | | R | | R/W | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| BMS Override | | R | | | | |
| Stairwells | | R | | R/W | | |
| Toilets | | R | | R/W | | |
| Security | | R | | R/W | | |

#### 6.8.4 Fire Services

6.8.4.1 Fire alarm monitoring is to provide to the BMS such the BMS is capable of operation in “fire” mode. Where hardwired fire signals control plant, the BMS is required to place automatic controls in a mode consistent with the presence of a fire alarm.

6.8.4.2 VESDA and Gas systems are required to be monitored by the BMS.

| Point Name | AI | BI | AO | BO | AV | BV |
|---|---|---|---|---|---|---|
| General Fire Alarm | | R | | | | |
| FIP Fault | | R | | | | |
| VESDA Fault | | R | | | | |
| VESDA Level 1 | | R | | | | |
| VESDA Level 2 | | R | | | | |
| VESDA Level 3 | | R | | | | |
| Gas Discharge | | R | | | | |
| Gas Fault | | R | | | | |
| Gas Isolate | | R | | | | |
| | | | | | | |

## 6.9 Field Sensors and Actuators

6.9.1 Dampers, actuators (other than VAV actuators), valves, transducers, relays and field instrumentation are to be based on standard industrial signaling techniques (4-20mA or 0-10VDC).

6.9.2 Field signaling 0-10VDC is preferred such that the signal can be easily independently measured.

### 6.9.3 Temperature sensors

6.9.3.1 Thermocouple (type K or type T) must be specified for critical or wide range temperature measurement and provided with suitable industrial grade transmitter providing 0-10vdc or 4-20mA signaling.

6.9.3.2 RTD may be used for general temperature measurement. May be used to measure to ±0.5°C with low drift.

6.9.3.3 Thermistor (NTC 10K, 30K) may be used for space temperature measurement to approximately ±0.3°C with appropriate linearization. Where applications call for greater long-term stability and low drift. These thermistors should not be used without suitable calibration at recommended intervals.

### 6.9.4 Temperature - Fluid Measurement

6.9.4.1 Indirect Immersion sensors are required that penetrate the pipe to no deeper than half the pipe diameter. Immersion sensors are to be located so that fluid is mixed sufficiently to measure a true indication of the temperature. Lagging is to be patched properly such that the immersion well is not exposed to the ambient. Thermo-conducting paste is to be used to provide an efficient coupling between the well and the sensor element. Stainless steel wells are required for corrosive liquids such as seawater or brine.

6.9.4.2 Strap on type sensors are not acceptable for control applications, other than for general monitoring.

6.9.4.3 For chilled water systems, the following accuracy is mandatory, inclusive of transmitter error, with maximum non-cumulative drift of ±0.1 °C/year (annual field calibration is required for sensors specified at higher accuracy):

- Outside air Temperature ±1.0 °C
- Relative Humidity ±5.0 %
- Chilled and Condenser Water Temp mains ±0.1 °C
- Chilled and Condenser Water Temp other ±0.3 °C
- Water Temp Delta-T (where used for load measure) ±0.05 °C
- Water Flow ±1 % FSD
- Water Pressure ±2 % FSD
- Electrical Power ±1% of reading, 3kHz for VSD

6.9.4.4 Mechanical trade is to be directed to fit a Binder type fitting into the pipework adjacent to every liquid sensor for the purposed of calibration. (Temperature and Pressure).

6.9.4.5 Critical temperature sensors are required to be “field calibrated” to a NATA traceable master instrument and the certificate is to be furnished with the commissioning records. This is mandatory for any liquid sensor participating in BUILDING OR CHILLER LOAD CALCULATIONS, or CHILLER STAGING DECISIONS.

### 6.9.5 Temperature – Air measurement

6.9.5.1 Space temperature sensors are to be installed 1500mm above the finished floor level.

6.9.5.2 Sensor housings are to be the aspirating type sealed from wall cavities.

6.9.5.3 Accuracy of space temperature measurement is to be at least ±0.5 °C, with non-cumulative drift of no more than 0.1 °C/year.

6.9.5.4 Space temperature sensors generally should not be co-located with occupancy override buttons where design required these features. Sensors shall be mounted in a location (generally 1500AFFL) consistent with accurate space measurement. Buttons shall be mounted on a standalone standard sized wall plate conveniently close to the entrance door and shall have a momentary press mechanism labeled “Air-conditioning” and a GREEN lamp to denote that air-conditioning is active and a RED lamp to denote that air-conditioning is off.

6.9.5.5 Duct temperature sensors shall be designed to provide average indication across a section of the duct, not a point measurement.

6.9.5.6 Accuracy of Duct temperature measurements is to be at least ±0.3 °C, with non-cumulative drift of no more than 0.1 °C/year.

6.9.5.7 Active sensors are to be 24VAC powered and provide 0-10vdc or 4-20mA output.

### 6.9.6 Humidity Measurement

6.9.6.1 For non-demanding environments such as occupied spaces, humidity is to be measured at ±5.0 % in spaces or ducts, non-condensing environment from 0% to 95% RH and temperature of 23°C.

6.9.6.2 For demanding environments (such as environmental controlled laboratories) humidity is to be measured at better than ±3.0 % in spaces or ducts, non-condensing environment from 0% to 100% RH and temperature of 23°C.

6.9.6.3 Active sensors are to be 24VAC powered and provide 0-10vdc or 4-20mA output.

### 6.9.7 Flow Measurement - liquids

6.9.7.1 For chilled water and condenser water applications line size magnetic flow meters are required. Accuracy required is ±1% of reading. Approved unit Siemens Magflow.

6.9.7.2 Active sensors are to be 24VAC powered and provide 0-10vdc or 4-20mA output.

### 6.9.8 Absolute Pressure or Differential pressure - liquids

6.9.8.1 For chilled water and condenser water applications measuring accuracy shall be at least ±0.5% FSD with a maximum pressure of 25bar. Measuring range shall be selected for equal or better than ±2% of the measuring range.

6.9.8.2 Pressure devices shall be fitted with valves for isolation, equalization, and draining. Connections shall be properly plumbed with 6mm copper tube coiled for vibration isolation.

6.9.8.3 Active sensors are to be 24VAC powered and provide 0-10vdc or 4-20mA output.

6.9.8.4 Mechanical trade is to be directed to fit a binder type fitting into the pipework adjacent to every liquid sensor for the purposed of calibration.

### 6.9.9 Differential pressure – air

6.9.9.1 For air sensing applications (such as VAV AHU pressure control) accuracy must be at least ±3% FSD and time constant of no greater than 1 second.

6.9.9.2 Active sensors are to be 24VAC powered and provide 0-10vdc or 4-20mA output.

### 6.9.10 Pressure Switch – air

6.9.10.1 For air monitoring applications (such as filter condition monitoring) switching must be capable of calibration at less than 2.5Pa in 300Pa range and less than 5Pa in 1000Pa range.

6.9.10.2 Output shall be voltage free contact (rated at 24VAC/VDC, 250VAC 1A resistive) and capable of at least 1,000,000 operations.

### 6.9.11 Fan and Pump proving – CT Relay

6.9.11.1 Properly calibrated CT Relays shall be used to prove pump or fan motor operation.

#### 6.9.12 Other instrumentation

6.9.12.1 Other instrumentation shall be selected and sized to meet the consulting engineers' design.

#### 6.9.13 Valves and actuators

6.9.13.1 Valves for AHU/FCU shall be selected according to design requirements.

6.9.13.2 For smaller valves characterized ball valves are acceptable.

6.9.13.3 Butterfly valves are not to be used for critical control applications. Control Valves are to be specified.
Bypass valves are to be characterized control valves and not butterfly valves.

#### 6.9.14 Damper actuators

6.9.14.1 Damper actuators shall be selected according to requirement. The designer shall specify the power, torque rating, action, coupling, spring return, limit switches, manual functions and all other as necessary to provide clear and consistent specification.

## 6.10 Specification of the local Headend computer

6.10.1 The local BMS head end computer/server will provide a small footprint tower format (minimum 3 Ghz Intel i7 CPU, 1333FSB, 4GB 800Mhz RAM, 1TB HD, DVD writer, Windows 10). The purpose of this PC will be for local configuration, but also for local browsing to the MUP Server located in the datacenter.

6.10.2 A HMI is only to be provided where the building is to be a standalone tenanted building. The graphics will still be mirrored on the main enterprise server. The local server must be networked to the main server for viewing using the main introduction page.

6.10.3 Where a fixed PC is provided as a HMI, it shall be 24inch WUXGA widescreen (1920x1080 pixel)

## 6.11 Specification of enclosures, colour, cabling and labeling

6.11.1 All BMS equipment is to be enclosed appropriately to provide environmental, electrical, RFI and mechanical protection, security against unauthorised access and indication of function. Where controllers and field equipment are fitted externally (without housings – such as VAV controllers), the equipment must be endorsed by the manufacturer for such use. FCU controllers mounted in plant rooms shall be housed in a suitable MSB or MCC compliant with the above enclosure. Individual FCU's in ceiling spaces will have the controller mounted in a plastic box with a clear lid.

6.11.2 All equipment enclosures are to be labelled using a robust, long life and permanent labelling system. Each enclosure must be fitted with a document pocket allowing local storage of key information and indication of the drawing numbers where the equipment details will be found.

6.11.3 Cables are to be selected and affixed in accordance with Australian standards and manufacturers recommendations. Slotted cable trunking will be used inside the cabinet to retain the wiring in a neat manner.

6.11.4 All cables within electrical switchboards or controls boards are to be clearly labelled. BMS cables must be clearly identifiable on drawings and schedules to ensure easy traceability. Labels on control wiring will contain numbers and input/output wiring will have text descriptions fitted to describe the connection.

6.11.5 The colour of enclosures for controls cabinets will be compliant with the Mechanical Design Guide for MSSB and MCC enclosures. These will be Orange with a white backing plate and escutcheon if fitted.

6.11.6 Controller connection diagrams and network diagrams will be plastic coated and placed in a pocket in each cabinet or in a metal holder A4 size next to the enclosure.

# 7 Software

These guidelines relate to the detailed software functionality of each BMS and how this interacts with the MUP Server. The following guidelines are to be used by the BMS contractor to interface and integrate with the MUP BMS network.

## 7.1 Security

7.1.1 The BMS will only be accessible offsite via secure VPN.

7.1.2 Any BMS computer will be defaulted to deny Remote Desktop, Telnet and other remote access functions unless approved by MUP. The programming and configuration requirements will be carried out using built in configuration tools direct to the BMS. These will be protected from unauthorized access by passwords.

7.1.3 All BMS computers will be equipped with Anti-malware protection as prescribed by MUP IT.

7.1.4 Building to Building Communication will be restricted by firewalls to permit only the necessary BACnet application ports to be opened for data to pass between each building or the MUP Server.

7.1.5 Workstations will be provided with Patch and Hotfix management by MUP IT. Auto-update on Windows systems is to be turned off unless advised by MUP.

7.1.6 All email services will be re-directed via the University SMTP mail service from the MUP BMS server. These mail accounts will be protected by antivirus and anti-spamming software.

7.1.7 The local BMS will be accessible only by the system maintainer and the MUP. Profiles will be required on the system to permit a Supervisor (full access), Engineer (Read/Write/Initiate) and User (Read Only).

## 7.2 Common Network and Addressing scheme

7.2.1 A master device addressing scheme is required for each building that has a BACnet BMS.

7.2.2 The BACnet network number will be coded to the building group starting at 11 (BACnet networks have a unique address from 1 to 64,000)

7.2.3 BACnet Device IDs (BACnet Devices must have a unique ID in the range 0 to 4,000,000)

7.2.4 BACnet device IDs will be numbered again according to Building Group and Building Group Number.

7.2.5 The BACnet network and device map is available in APPENDIX A.

7.2.6 All network numbers and device IDs will be allocated by MUP.

## 7.3 Point Naming Convention

The naming of IO points is to be kept uniform, AND IS A MAXIMUM of 40 CHARACTERS.

This guide applies to field IO points and Software Points equally.

- Each Building or Facility has up to a 5-character name (W5A, W19F etc.).
- Within each Facility, MUP requires clear identification of the ROOM, examples are: SWPRM, or 203. The maximum is 5 characters.
- There is no space between the Building Name and the Room or Area Name:
- For example, W5A room203 will be W5A203
- After the Building and area locator fields, there will be an underscore then an Equipment Field. The equipment field may be up to 9 Characters. No space between the Equipment designator and the number. For example:
    - AHU2.2 = Air handling Unit 2.2
    - VAV11.23 = VAV Box level 11 number 23
    - MSB1.1 = Main Switch Board 1.1
    - Chiller 1 = Chiller 1
    - Boiler 2 = Boiler 2
    - BCS1.1 = Building Control Station 1.1
    - RDC2.2 = Remote Distributed Controller 2.2
- After the Equipment Field, there will an underscore then a 19 character Point descriptor.
- Examples are:
    - Heating_Setpoint
    - Supply_Air_Velocity
    - Average_Temp
    - Damper_Position
    - Fan_Status
    - Chiller_Start/Stop
    - Return_Air_Enthalpy
    - Supply_Air_Diff Pres
    - ChW_Pump_Start/stop
    - Return_Water_Temp
    - Supply_Water_Temp

7.3.1 Each point thereby named:

<Building> <Area><Equipment><Function>

<BBBBBAAAAA_EEEEEEEEE_FFFFFFFFFFFFFFFFFFF>

For example: "W5A203_VAV1.24_Room_Temperature" (Building W5A room 203, VAV 1.24, Room Temperature)

## 7.4 Graphics

7.4.1 The specification is indicative only. Designers should ensure that any special needs of the project are covered in the specification.

7.4.2 The graphics will be able to start/stop, monitor and adjust BMS control parameters within the system. All BMS systems will be required to provide a simple to use “web based (that is browser based)” user interface.

7.4.3 All programming functionality (not graphics) is to be provided via the local Web Based User interface (for ultimate fallback in the case of failure of the Server or networks).

7.4.4 In addition to the above requirement, all key graphics for new buildings are to be created in “Niagara Px” style pages. These pages will be hosted on the MUP Server. MUP may (at its sole discretion) approve hosting of Px pages on a dedicated server in larger buildings. Where graphics are locally hosted, they are to be provided according to MUP Style guide.

7.4.5 All access to graphics will originate from the MUP Server via hyperlinks created by MUP.

7.4.6 The BMS contractor will be provided with graphic style sheet templates by MUP that allow to build graphics within the frame required by MUP, consistent with the master web-site style sheets. The graphics template and sample graphics are located in APPENDIX B of this document.

7.4.7 Local graphics are to be built using this format such that MUP can transfer selected graphics layout to the MUP BMS Server. Content is to be built within the “useable viewing area”. MUP will create the titles and navigation panes required for display and navigation on the Server.

7.4.8 Navigation is being provided on a fixed pane as per the master template. It shall always be possible to navigate forward and back, to the master page and other relevant pages with one click. A maximum of three clicks will be required to any page.

7.4.9 All graphics dimensions are to be based on a 15.4 INCH WIDESCREEN LAPTOP, 1280 x 800 pixel screen resolution, or for larger graphics, on a 24 INCH WIDESCREEN USXGA format, 1920x1080 pixels resolution.

7.4.10 Graphics are to be prepared and sized in accordance with the style sheets such that the title, navigation pane, body and footer do not overlap the specified areas, measured in mm. Once transferred, the MUP BMS server will learn and map the graphic point data directly from the BMS. System Graphics are to be made available in the specified format such that the graphic templates will be copied to the MUP BMS server (supplied separately to these works).

7.4.11 The Common Interchange format for various elements will be as follows:

- backgrounds and photographic images are to be supplied in JPEG format
- Logos and Moving images are to be supplied in GIF or PNG format

- Line diagrams and schematics are to be supplied in TIF format

7.4.12 The Niagara Px **statusEffect** property shall be enabled for each point represented on the graphic. A key, as shown below shall be made accessible from the main graphic associated with the relevant building or area.

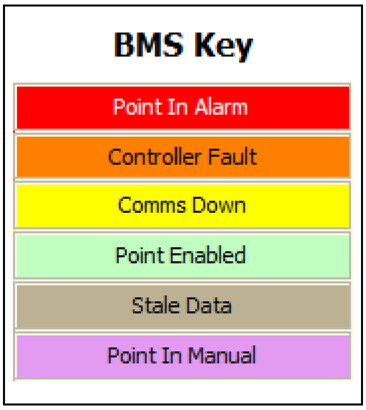



Figure 1: BMS Key representing standard Niagara point status.

7.4.13 The Niagara Px **popupEnabled** property shall be enabled for each controllable point represented on the graphic allowing a right mouse click to access the popup control menu (refer example below).

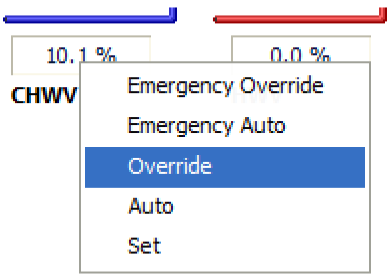



Figure 2: Example popup (right click) menu enabled.

7.4.14 The Niagara Px **mouseOver** property shall be enabled with the “Highlight” effect for each controllable point such that all controllable points shall be highlighted as shown in Figure 3.


**Figure 3: Example mouseOver effect showing controllable point highlighted when mouse hovers over..**

## 7.5 Schematic Graphics

7.5.1 Schematic Graphics will be provided for all items of plant (AHU, FCU, FAN, CHILLER, BOILER etc.) giving a clear system overview for trouble shooting purposes.

7.5.2 Present an accurate drawing representation of the plant, i.e. if the unit is a multi-zone unit the graphics shall clearly show this. MUP requires a faithful presentation of the plant, with all air paths, dampers, valves, pipework and other artifacts correctly represented in type, position, orientation and labeling.

7.5.3 Include all significant aspects or items associated with plant, i.e. economy cycles, dampers, return air fans, filters, chilled water and heating water coils, ductwork etc. Include CHW and HHW temperature on all graphics sheets showing coils for fault finding.

7.5.4 Indicate control variables and set points, zone temperatures, on/off/fault status etc. to provide clear present indication of the status and condition of the plant

7.5.5 Include fan status indication via current relay input for AHUs and current sensing devices for FCUs.

7.5.6 Include time schedules and trending

7.5.7 Include links with appropriate descriptors to floor plans and other elements or connections of the system

7.5.8 Include links to tabulated summary information.

## 7.6 Tabular graphics

7.6.1 For a system containing multiple FCUs (or VAV etc.), the tabulated information would contain, FCU number, rooms served, fan enable, fan status, chilled or hot water valve position, supply air temperature, room set point, room temperature, duct heater status etc.

7.6.2 The amount of information provided per page per table shall be such as to summarize as much information as possible on one page, yet remain legible. As an example, for a floor containing 10 FCUs it would be expected that this could be contained on one page. Include CHW and HHW temperature on all graphics sheets for fault finding.

## 7.7 Floor Plans

7.7.1 Floors plans must use colour legibly to ensure that adequate contrast is present, however zones are not to be coloured individually. Background colours shall be in accordance with the Style Sheets. The principle shall be that unless the operators' attention is required, each artefact should remain discretely coloured. Exceptions may use contrasting colours.

7.7.2 Include the latest version of the MACQUARIE UNIVERSITY floor plans for each new installation or update

7.7.3 Include the correct room numbers on each room. Where new work or refurbishments are carried out, IT WILL BE **THE RESPONSIBILITY OF THE CONTRACTOR** TO CHECK THAT THE ROOM NUMBERS ON FLOORS PLANS CORRESPOND TO CURRENT ARCHITECTURAL AND SPACE PLANNING DWG's AND THAT ROOM NUMBERS MATCH CURRENT RECORDS.

7.7.4 Indicate all FCU and AHU locations and also indicate in a single line format, the ductwork layout (excluding flexible ductwork) with any terminal reheats, VAV boxes or other items of significance shall be shown on the single line ductwork run. Hyperlink from each AHU or FCU directly to the relevant schematic.

7.7.5 Allow an operator who is skilled in operating a BMS graphical interface and who has a degree of familiarity with air conditioning systems to be able to quickly and effectively navigate the system without reference to external mechanical or architectural drawings for clarification.

7.7.6 A link shall be provided on each building home page to the chiller graphics. Each building shall also contain a box containing the building chilled water and HHW supply temperature.

## 7.8 Alarms

7.8.1 Refer to document ***2. Macquarie University, Alarm Handling Subsystem (AHS) Requirements Specification Enterprise Building Management System (EBMS)*** for details of how the integration of alarms to the Enterprise Building Management System is to be undertaken.

## 7.9 Time Scheduling

7.9.1 The BMS is to provide local time scheduling for all appropriate building services within the building. Time Schedules must be BACnet compliance and be readily accessible from each plant graphic.

7.9.2 The BMS time clock will be linked to the MACQUARIE UNIVERSITY DNS Server for synchronization with the MACQUARIE UNIVERSITY SNTP server (Simple Network Time Protocol). Global time synchronization is required where energy management functions require plant starts to occur at predictable times. To ensure this occurs, the server will be required to synchronise all systems to a centralised clock (set to provide GMT+10 hours). The mechanism will source from the Universities Network Time Protocol (NTP) server and will be distributed to the building by synchronization of the BMS with this clock.

7.9.3 The server clock will also provide synchronization to the change of Australian Eastern Standard Daylight-Saving Time. Each system will be expected to accept and support automatic change of AEST at the appointed dates.

7.9.4 The MUP server will provide a global scheduling system, distributed from the Server to the building systems and then linked down through BACnet to the individual building system.

7.9.5 The calendars time schedules within the BMS are to be exposed via BACnet to enable this information to be sourced from the MUP Server.

## 7.10 History and Trend Logging

7.10.1 Each BCS shall be capable of local trending into non-volatile memory with capacity for at least 3 days offline to the Campus WAN.

7.10.2 The BCS must be sized to ensure that field points are sampled at a rate sufficient to permit effective and efficient control and history logging functions.

7.10.3 Change of Value (COV) reporting is to be implemented where controllers support it. Changes in measured value or state shall be updated at the Local User Interface generally within 20 seconds.

7.10.4 History archiving will be a function of the MUP server such that trend logs in the BACnet system controllers can be learned and up-linked at intervals to the MUP server for archiving and display purposes.

7.10.5 Trend log requirements will be refined in design however the BMS contractor is to allow delivery trend logging initially for:

7.10.5.1 each point actioned or monitored, i.e. room temperatures, chilled and hot water valves

7.10.5.2 damper positions, supply air temperature, fan status, fan enable, etc.

7.10.5.3 Chiller and Condenser water temperatures and pressures

7.10.6 Trend logs will be programmed for selected critical tuning points (supply temp controlled by valves, chiller temp etc.) for two periods over a minimum period of 7 previous days in a rolling format in 15 minute intervals and the previous 12 hours in rolling format in 1 minute intervals.

7.10.7 Long term trends (temperature in spaces etc.) shall be uplinked to the MUP server for long term archiving (at least 2 years).

# 8 Plant Control Functions

**THE PROJECT ENGINEER SHALL PROVIDE THE STRATEGIES REQUIRED IN THE FUNCTIONAL DESCRIPTION OF THE SPECIFICATION. THESE STRATEGIES MUST BE INCLUDED WHEN APPROPRIATE.**

## 8.1 Functional Descriptions

8.1.1 Global energy management may be implemented by data point passing from a Building Control Station (programmed for global energy functions) direct to the local BMS, or ultimately from the MUP Server. Energy management functions are to be coordinated with MUP.

8.1.2 The intent of all control system strategies should be to provide appropriate comfort control strategies while minimizing energy consumption. The University is committed to reducing its Greenhouse Gas emissions. This will be achieved by a number of methods, which includes, but is not limited to;

8.1.3 Minimizing plant operating hours.

8.1.4 Providing local on/off control in lieu of automatic time clock operation where appropriate and engaging staff and students to turn plant on and off as necessary. i.e. staff should be encouraged to turn systems on and off, however an over-riding off function should be provided.

8.1.5 Providing for Air quality monitoring where approved by MUP to modulate ventilation within acceptance/safe limits while minimizing excess heating and cooling operations.

8.1.6 Where VAV systems or zoned systems are installed, allowing control separation of systems to allow zones to be shut down when not in use and only the occupied zones to have air supply provided. This would be achieved by providing multiple local start/stop stations and appropriate control. Any system that is included in an averaging calculation, if disabled or faulty, shall be excluded from the calculation.

8.1.7 Providing the widest practicable dead bands on temperature control loops to avoid unnecessary energisation of zone heating or cooling.

8.1.8 All control systems must be furnished with fully programmable setpoints for heating and cooling. That is, an authorized operator must be able to independently adjust heating and cooling setpoints, while ensuring that software does not permit overlapping heating and cooling operations (other than specifically required – such as for dehumidification operations).

8.1.9 Not operating special purpose rooms during un-occupied times. For example, a local FCU serving a training room that is not continuously occupied would be locally started and stopped (or on demand by a space booking system), while providing over-riding off functionality via a timer or special purpose schedule.

8.1.10 A wall mounted switch should be the primary preferred means of energizing zone FCUs. Where motion sensing is specified, it must be clearly designed to operate effectively, be walk tested properly, and be suitable to the function required. When a user enters the room, they should energize the a/c via the wall switch, provided a master schedule permits continuous occupancy. Once energized the FCU should run, say, for one or two hours with a time delay off. Alternatively, the button may be “push to start” and “push to stop” during normal occupied hours. The time delay should be programmable via a simple adjustment on the user graphic interface. A green indicating light must be illuminated when the plant is running.

8.1.11 If an event of known duration is to be held in the room, i.e. for 5 continuous days, 9 am – 5 pm, then the control strategy shall allow either the time clock to be programmed by MUP to provide continuous running during this period, or the run on timer could be changed to operate for say 4 hours, for morning or afternoon sessions - the FCU would need to be energized once in the morning and once in the afternoon. If the time clock has been energized and the room is vacated earlier than expected, then the users should be able to turn off the FCU when the room is vacated, whether the FCU is operating under time clock mode or run on timer mode. Pressing the wall button should turn off the FCU and bring on the red indicating light. The currently activated time schedule should be over ridden but the next scheduled FCU start should take control again to start the unit. If the FCU is turned on before the time schedule has commenced and the delay off has not reached the end of its time period before the time schedule commences then the FCU should then run under the time schedule control until the schedule de-energizes the FCU or the occupant turns the FCU off on leaving the room by pressing the toggle button to stop the unit. The air conditioning room switches are to be located near the entrance to the room and grouped close to the lighting switches.

8.1.12 The above outline describes the intent of the operation of the control system. A similar control strategy is envisaged for office spaces and classrooms. Where VAV systems are used a similar control philosophy should be adopted and modified to suit the circumstances. The number of local stop/start points would need to be appropriate to the use of the facility. Ideally the control system for all VAV systems should provide the capability for each VAV box to be energized locally with a local start/stop push button. i.e. the main AHU should ramp up to meet only the demand of those VAV boxes that have been locally activated. VAV boxes should default to the closed position when not energized. A time clock function as described above should also be included. The consultant shall attempt to optimize the balance between the complexities of having too many start/stop zones and the energy efficiencies gained by zoning the system. i.e. if multiple classrooms are on a system they would be zoned individually, but an open plan office area may be provided with say only one stop/start station that might control a number of VAVs.

8.1.13 Chillers and Boilers will be staged on energy required by the field. Thermal energy meters will be installed to provide this data and must conform to the accuracy previously stated. The control strategy will be to start the equipment at design flow and design pump speed. As the head increases due to valves being closed down the pump will reduce speed to the minimum allowed by the pump motor and then the bypass valve will open to maintain minimum flow through the equipment. The bypass may have to open before the minimum speed of the motor is reached and this will be determined at design and commissioning. Chillers are not to have a mismatch alarm and lockout taken from the compressor run contactor. This is to prevent nuisance tripping at low load. Boilers should have a mismatch on temperature and flow.

8.1.14 Chillers and Boilers will have a set point reset applied for energy savings reducing temperature at low to medium loads. This will be based on valve positions. Similarly, the equipment will start when sufficient valves are open.

8.1.15 Cooling towers are to be controlled on the water temperature leaving the cooling tower. The design set point temperature of the water is to be wet bulb temperature plus 3°C. This will be limited to 18°C for Power Pax Chillers and 22°C for Screw Chillers subject to manufacturer's approval. Cooling tower fans will switch off at 18°C and switch on at 19°C and ramp up speed to provide a condenser water rise equal to the evaporator rise plus 0.5°C.

When the condenser water temperature is less than 16.5°C the bypass will start to open at 16.5°C and will be fully open at 15.5°C to allow the water to heat up to the desired operating temperature as above.

A warning alarm will be included on the cooling tower if the supply water from the tower exceeds 32°C. The pump and fan must ramp to full speed until the water temperature falls to 28°C. The tower controls will then return to normal operation. A counter is required to be shown on the graphical page to indicate cycles that have occurred. Counter to be re-settable from the page.

Multiple Cooling towers will be operated as single units (one chiller one tower) and will change over once per week if two or more chillers/ towers are used.

## 8.2 Miscellaneous Comments

8.2.1 Local exhaust fans (other than toilet exhaust) must all be provided with local manual controls

8.2.2 Economy cycles should be used where ever possible with air handling units. The preferred method is to use a db temperature between 12 and 19 C and a specific humidity ratio between 6 and 11 g/kg. This envelope provides air suitable for use to cool the space.

8.2.3 All lecture theatres capable of seating 100 or more persons must incorporate the use of economy cycle control or heat transfer systems on outside air.

8.2.4 All chilled water pumps and large air-handling units incorporating VAV boxes must have variable speed. Variable frequency drives must be capable of being controlled by the BMS.

8.2.5 Solid State relays and heater contactors are mandated to provide analog control of the heater in space environments. The controller must reduce peak energy consumption of the heater.

## 8.3 People Counting

8.3.1 On a project by project basis a people counting system may be considered. The People Counting System (PCS) may also be interfaced with the BMS system. A separate People Counting Specification will be issued on a project by project basis and if applicable this must be read in conjunction with the BMCS design guidelines and BMCS project specification.

# 9 APPENDIX A. Standardized Methodology for BACnet addressing

## 9.1 Commonized Network and Addressing scheme

9.1.1 A master device addressing scheme is required for each building that has a BMS. This is important because the MUP BMS Server will need to have a unique address for each building and for each device.

9.1.2 The BACnet network number will be coded to the building group starting at 11. There are up to 64,000 BACnet network numbers.

**ALL CONTRACTORS REQUIRING BACNET ADDRESS SPACE ALLOCATIONS ARE TO REFER TO MUP IT FOR NETWORK AND DEVICE ID ALLOCATIONS.**

9.1.3 Networks in Building group “1” will be coded 11001 to 11999 (1,000 possible networks).

## 9.2 BACnet Device IDs

9.2.1 BACnet device IDs will be numbered again according to Building Group and Building Group Number. There are up to 4,000,000 devices IDs.

9.2.2 Devices in Building Group 1 will be coded 1100001 to 1199999 (100,000 possible devices in each Building Group/Building Number).

9.2.3 Within each Building Group/Number there could be several buildings sharing these device IDs. All device ID’s will be allocated by MUP.

## 9.3 MAC Addresses

9.3.1 These will be assigned by the contractors, 1 to 128 on each network (they are sometimes set by DIP switches). MUP will not control BACnet MAC addresses on MS/TP networks. However, BACnet/IP MAC addresses are the IP address so these are controlled by MUP.

## 9.4 IP Addresses

9.4.1 Only assigned to devices at the MACQUARIE UNIVERSITY IT LAN level (e.g. Building Controllers, Servers, or Workstations) – these will be assigned by MACQUARIE UNIVERSITY IT department.

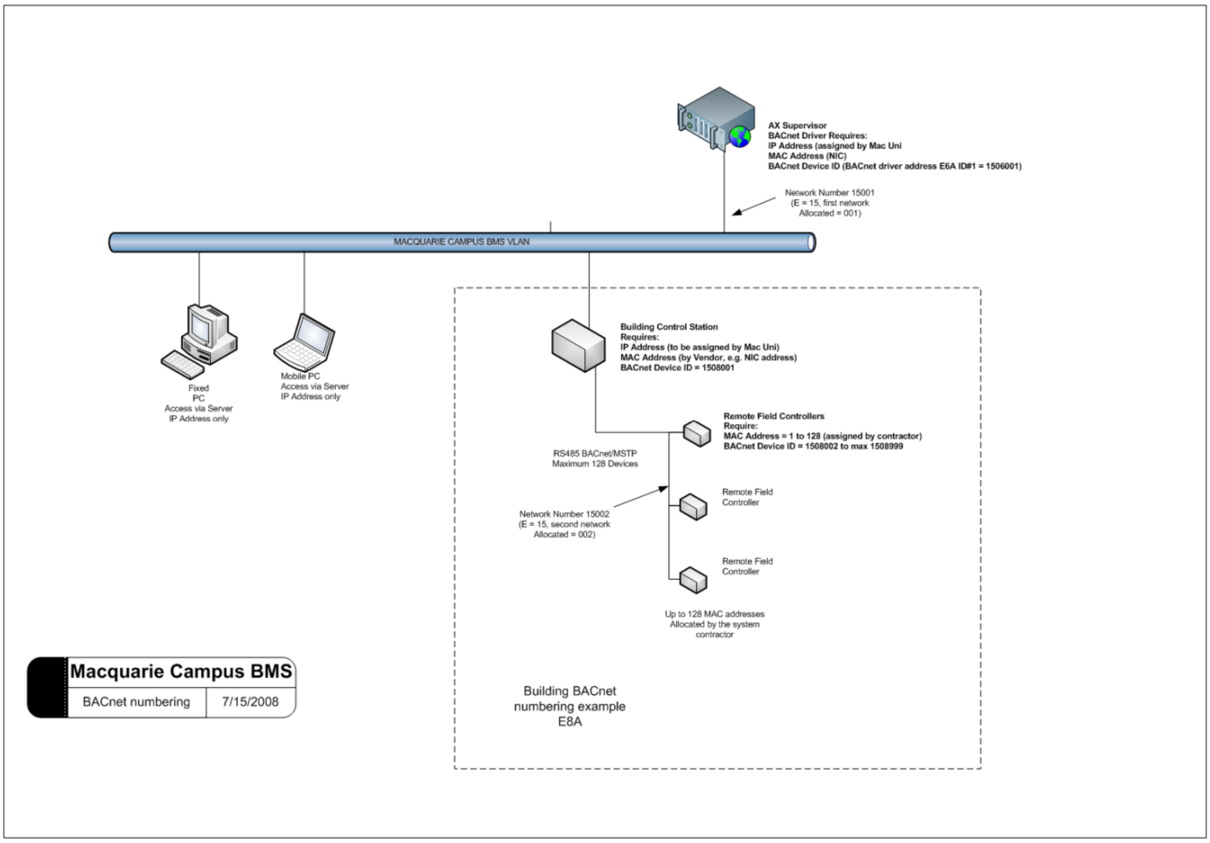



**Figure 4. MACQUARIE UNIVERSITY BACnet Addressing**

# 10 APPENDIX B. GRAPHICS STYLE SHEETS

## 10.1 Format

**General**

The graphics layout sheets used are indicated below as a minimum Each project should provide a list of sheets to be included in that project. MUP to approve the sheets to be provided. MUP to provide a list of the sample sheets to be used on each project

10.1.1 Graphics to be supplied in MUP BMS Server format. Graphics will be loaded in the test server and after approval the contractor will upload the graphics files to the MUP BMS Server. Points will be discovered and subscribed from the target system into the Server and graphics re-mapped to the Server Points. Alarms will be connected and tested to the alarm server.

10.1.2 Size: 15.4 inch Wide Screen Format for simple graphics, 24 inch Wide Screen Format for Complex Graphics –Vector Graphics preferred for scalability.

10.1.3 Resolution: 1280 x 800, or 1920 x 1080 (for detailed chiller graphics).

10.1.4 Usable Area: As defined in General Dimensions sheet.

10.1.5 Backgrounds: White.

10.1.6 header: colours per attached style sheets.

10.1.7 Points – Read Only: Display real time values in 11 Point Tahoma (BLACK) within an LT GREY BACKGROUND.

10.1.8 Points – Read and Write: Display real time values in 11 Point Tahoma (BLACK) within an OMACQUARIE UNIVERSITYET Border.

10.1.9 Points – In Alarm: All points in alarm must “Colour and Blink” – Red Alarms RED, Yellow Alarms YELLOW, acknowledge must stop flashing, Return to Normal must return to nominal colour scheme.

10.1.10 Clock shown in EST/DST 12pt BOLD SANS SERIF (INSET GREY BACKGROUND) to be placed top right of screen above RED colour bar.

10.1.11 Standard hyperlinks - All graphics to have inbuilt reverse (back arrow) link, link to Building Front Page and link to Campus Map.

10.1.12 Hyperlinking general – hyperlinks are required from Floor Plans to Schematics and tables and from Schematics to tables so that a user can navigate top to bottom and horizontally in no more than 3 clicks.

## 10.2 Style Sheet A – Floor Plans

10.2.1 CAD file input - Floor plans should derive from AUTOCAD architectural Plans.

10.2.2 Details required - Show perimeters, rooms and internal structures, de-cluttered and remove unnecessary detail and layers. Sufficient to allow maintainers to identify the ROOM Location, Plant Location and identification of Plant Items.

10.2.3 Room numbers - assigned by University Space planning (prefer direct from original AUTOCAD background) 11 Point Regular Tahoma BLUE.

10.2.4 Air distribution - Show basic single line duct or pipework layout (sufficient to allow maintainers to rapidly identify which rooms are served and where air is routed) – 4 point lines for main ducts, 2 point lines for "tee-offs", lines to be colour coded to MUP approved scheme. A commonsense approach should be applied to ensure that colour cluttering does not reduce clarity of floor plans or obscure significant details (such as room numbers, and other useful architectural detail).

10.2.5 Equipment Positions - Show positions of VAV's, FCU's, and AHU's (and other major plant) with hyperlink to a detailed schematic.

10.2.6 Colour Coding - Colour code to show zoning (Common colour for AHU and associated Zone Labels).

10.2.7 Hyperlinking - Show hyperlinked list of Plant on left hand navigation pane for quick navigation.

10.2.8 Real time values -Temperature values may be overlaid on diagram (if space permits). Alternatively place temperature values in a clearly labelled and colour coded table below the floor plan.

10.2.9 Font - Temp values to be in 11 Point Tahoma, INSET Border.

## 10.3 Style Sheets B, C, D and E – Plant Schematics

10.3.1 Use Panes to show physical schematic, with Panes behind for detailed controls and Logs.

10.3.2 User standard graphical objects by preference, unless it is necessary to represent a unique system or object clearly by other means. Any graphic design objects (line or diagrammatic art) must be supplied in PNG format. Photographic material must be provided in JPEG format.

10.3.3 If Photographic or schematic depiction of equipment is used – it must be accurate. If accurate graphics are not available, provide only a generally indicative functional object.

10.3.4 Three-dimensional pipe is not required (pipes may use 4 pt lines). Colours -CHW Flow Blue (RGB0,0,255); CHW Ret Lt Blue (RGB128,128,255); HW Flow Dark Red (RGB192,0,0); HW Ret Lt Red (RGB255,64,64); CW Flow Dk Green (RGB0,128,0); CW Ret Lt Green (RGB0,192,0).

10.3.5 Pipe corners must join accurately, if necessary to improve readability. Headers with blanking ends can be shown.

10.3.6 Labelling must clearly indicate where piping joins to other pages and hyperlinks provided.

10.3.7 Equipment to be labelled above graphic object (e.g. pump or fan etc.) in 11 pt Tahoma BOLD Black.

10.3.8 Display value tags (or labels) to use 11pt Tahoma BOLD BLACK.

10.3.9 Real Time Data is to be shown below equipment or to the right of labels (11 pt Tahoma REGULAR black INSET for display only, OMACQUARIE UNIVERSITYET for user input or control). It is not necessary to use Labels where it is clear to the user that real time data is associated with plant and the function of the real data is clear.

10.3.10 Status may be shown in “Animation”. If animation is used, do not include status field point on display (unless essential to prove or confirm function).

10.3.11 Real Time data “display states” to be self-explanatory (i.e. Filter “Dirty”, not Filter Dirty “Active”) where possible.

10.3.12 De clutter and simplify where possible allowing quick identification of problems (i.e. show the exceptions clearly).

10.3.13 Fail to start alarms should show a RED alarm “colour and blink” on the Start/Stop control display point.

10.3.14 Faults should show clearly as “Fault” or “Normal”.

10.3.15 Start/Stop command of equipment should be indicated as “Start” or “Stop” (OUTPUTS if READ/WRITE).

10.3.16 Status of equipment (where animation not used) should be shown as “Running” or “Stopped”.

10.3.17 System Enable should be shown as “Enabled” or “Disabled”.

10.3.18 VSD control signals should be shown as “value %” under the equipment.

10.3.19 Control loops will be shown as dotted lines (LT Blue) indicating control action between Controlling Variable and Output. Setpoint will be shown with Label “SP” (11 Pt Tahoma Bold Black) under the Controlled Variable.

## 10.4 Style Sheets F – Tables

10.4.1 Tables are required to display group data such as all VAV’s attached to a specific zone.

10.4.2 Hyperlinks to be created to allow navigation directly from relevant floors plans or Plant.

10.4.3 Tables to include all operational variables as required to clearly indicate “at a glance” the relative position of temperatures, modes, setpoints, valves, dampers, and all other real-time values as requires vertically aligned to permit maintainers easy review of all equipment. Chilled water and Hot water temperature supply values will be shown under the table.

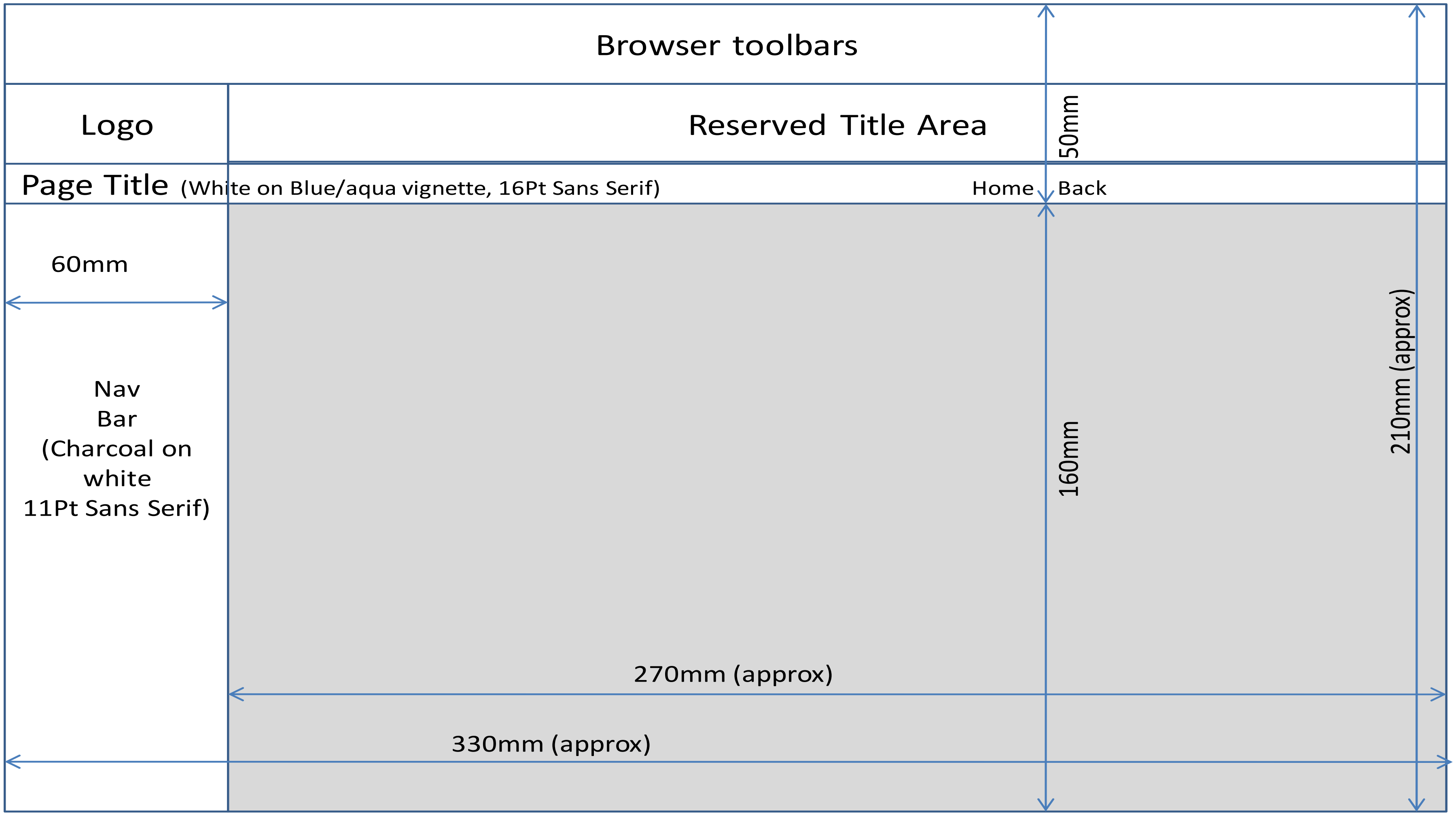
10.4.4 All table data is to be reference to Room Numbers and clearly colour coded to zone (where required).

**Also see the approved standard sample sheets document.**

## 10.5 Style Sheets – Layouts

#### 10.5.1 Sizing at 1280x800 (standard WXGA laptop)

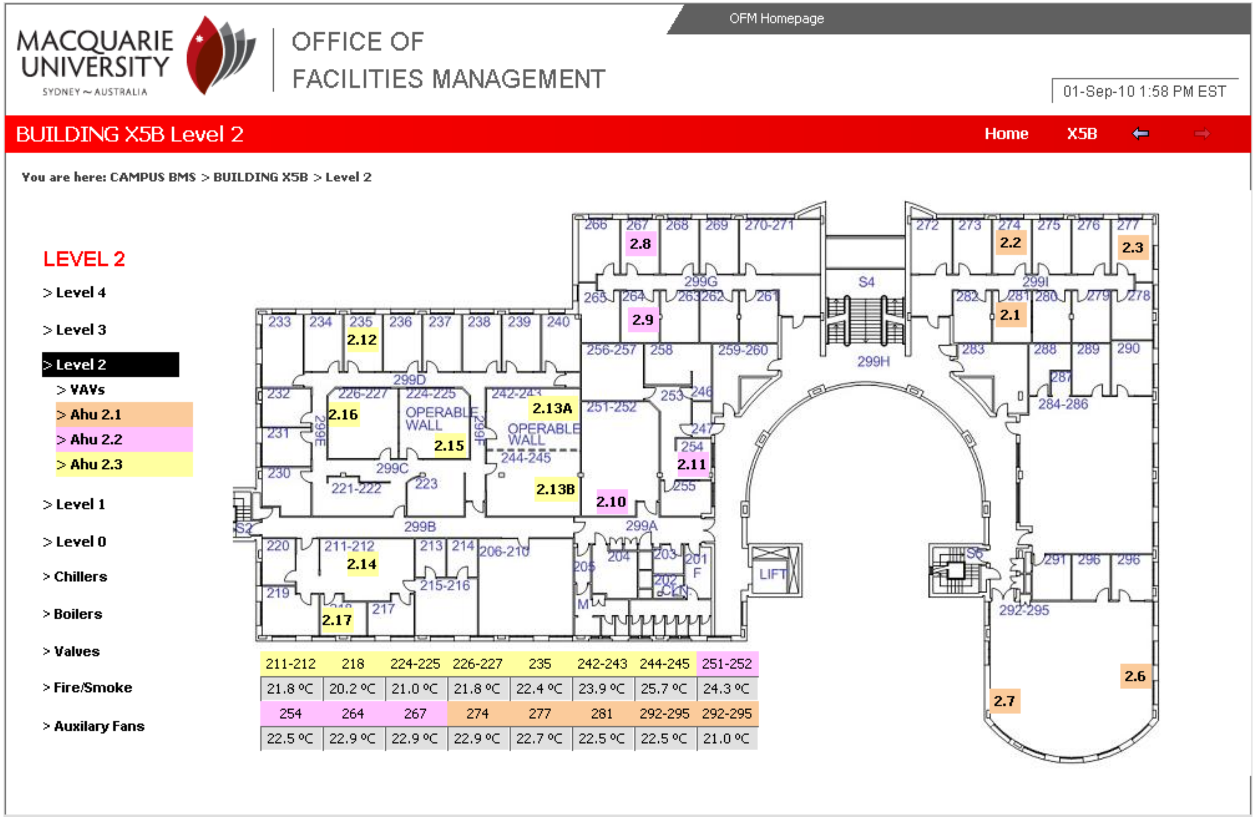
1



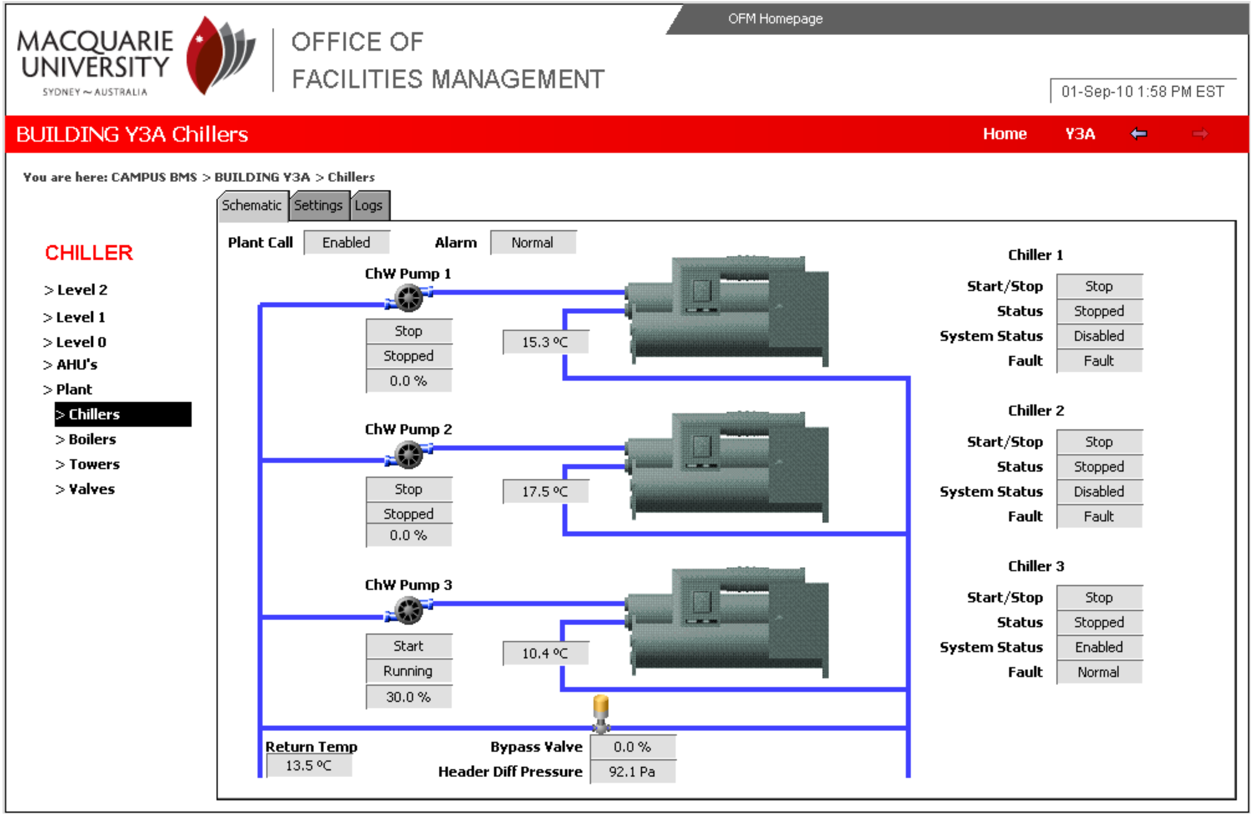

P

### 10.6.1 Style Sheet – Main Map

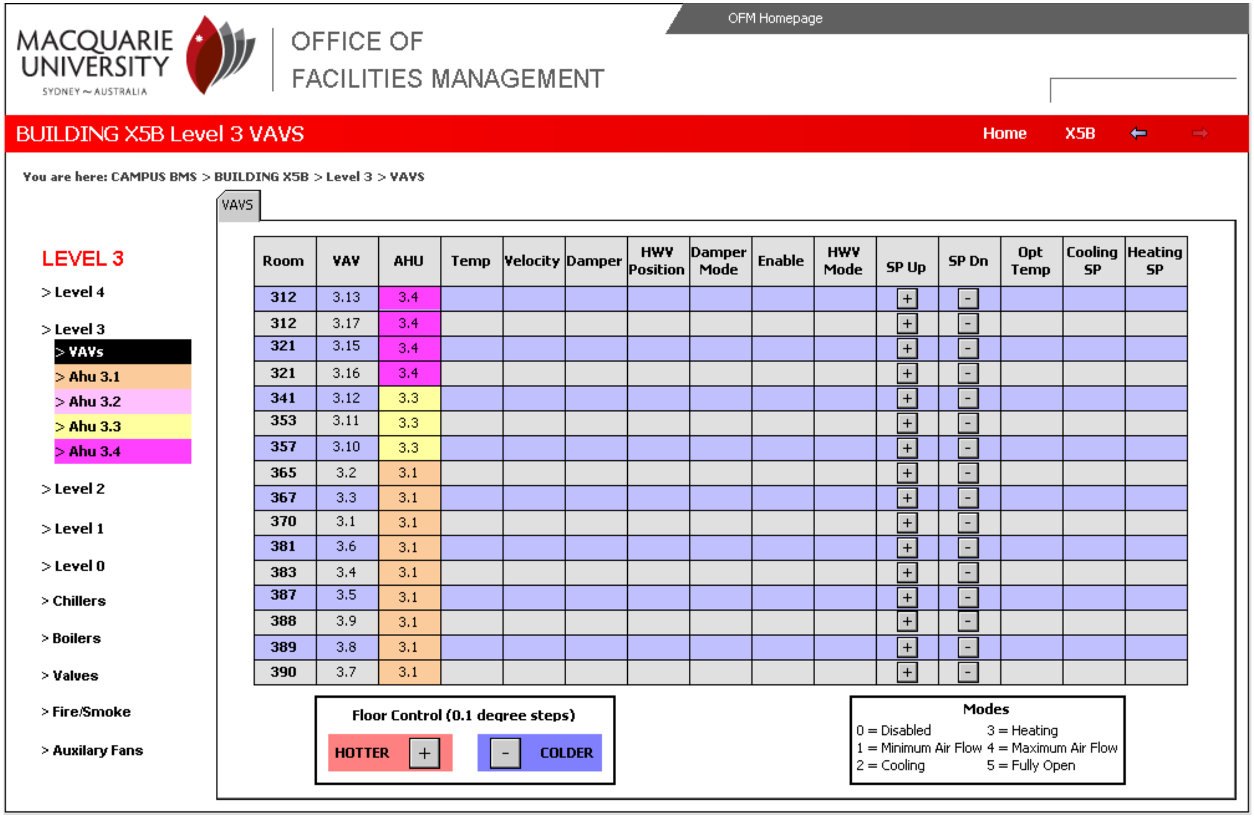
10.6.2 Style Sheet A – Floor Plans



### 10.6.3 Style Sheet C – Plant Schematics - Piped (large scale)



### 10.6.4 Style Sheet F – Tables



# 11 APPENDIX C - PROTOCOL IMPLEMENTATION CONFORMANCE STATEMENT (NORMATIVE)

(This annex is part of the BACnet Standard and is required for its use.)

**BACnet Protocol Implementation Conformance Statement**

**Date:** ____________________________
**Vendor Name:** ______________________________________________________________________
**Product Name:** _____________________________________________________________________
**Product Model Number:** ______________________________________________________________
**Application Software Version:** _________ **Firmware Revision:** ________ **BACnet Protocol Revision:** _____________

**Product Description:**
_____________________________________________________________________________________
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**BACnet Standardized Device Profile (Annex L):**

☐ **BACnet Operator Workstation (B-OWS)**
☐ **BACnet Advanced Operator Workstation (B-AWS)**
☐ **BACnet Operator Display (B-OD)**
☐ **BACnet Building Controller (B-BC)**
☐ **BACnet Advanced Application Controller (B-AAC)**
☐ **BACnet Application Specific Controller (B-ASC)**
☐ **BACnet Smart Sensor (B-SS)**
☐ **BACnet Smart Actuator (B-SA)**

**List all BACnet Interoperability Building Blocks Supported (Annex K):** _______________________________________
_____________________________________________________________________________________
__________________
__________________________________________________________________________________
_____________

**Segmentation Capability:**

☐ Able to transmit segmented messages Window Size _________
☐ Able to receive segmented messages Window Size _________

**Standard Object Types Supported:**

An object type is supported if it may be present in the device. For each standard Object Type supported provide the following data:

1) Whether objects of this type are dynamically creatable using the CreateObject service
2) Whether objects of this type are dynamically deletable using the DeleteObject service
3) List of the optional properties supported
4) List of all properties that are writable where not otherwise required by this standard
5) List of all properties that are conditionally writable where not otherwise required by this standard
6) List of proprietary properties and for each its property identifier, datatype, and meaning
7) List of any property range restrictions

**Data Link Layer Options:**

☐ BACnet IP, (Annex J)
☐ BACnet IP, (Annex J), Foreign Device
☐ ISO 8802-3, Ethernet (Clause 7)
☐ ATA 878.1, 2.5 Mb. ARCNET (Clause 8)
☐ ATA 878.1, EIA-485 ARCNET (Clause 8), baud rate(s) ____________
☐ MS/TP master (Clause 9), baud rate(s): ___________________
☐ MS/TP slave (Clause 9), baud rate(s): ______________
☐ Point-To-Point, EIA 232 (Clause 10), baud rate(s):___________
☐ Point-To-Point, modem, (Clause 10), baud rate(s): _________
☐ LonTalk, (Clause 11), medium: __________
☐ BACnet/ZigBee (ANNEX O)
☐ Other: ___________________

**Device Address Binding:**

Is static device binding supported? (This is currently necessary for two-way communication with MS/TP slaves and certain other devices.) ☐ Yes ☐ No

**Networking Options:**

☐ Router, Clause 6 - List all routing configurations, e.g., ARCNET-Ethernet, Ethernet-MS/TP, etc.
☐ Annex H, BACnet Tunneling Router over IP
☐ BACnet/IP Broadcast Management Device (BBMD)
☐Does the BBMD support registrations by Foreign Devices? ☐ Yes ☐ No

☐Does the BBMD support network address translation? ☐ Yes ☐ No

**Network Security Options:**

☐ Non-secure Device - is capable of operating without BACnet Network Security
☐ Secure Device - is capable of using BACnet Network Security (NS-SD BIBB)
☐ Multiple Application-Specific Keys:
☐ Supports encryption (NS-ED BIBB)
☐ Key Server (NS-KS BIBB)

**Character Sets Supported:**

Indicating support for multiple character sets does not imply that they can all be supported simultaneously.

☐ ISO 10646 (UTF-8) ☐ IBM™/Microsoft™ DBCS ☐ ISO 8859-1
☐ ISO 10646 (UCS-2) ☐ ISO 10646 (UCS-4) ☐ JIS X 0208

**If this product is a communication gateway, describe the types of non-BACnet equipment/networks(s) that the gateway supports:**

______________________________________________________________________________
__________

______________________________________________________________________________
__________