SECTION 23

BUILDING MANAGEMENT SYSTEMS

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Version	Date	Authors	Summary of Changes
1	9 April 2013	Multitech for JCU	First Edition
2	30 September 2013	Manager, Infrastructure Services	Revised with JCU comments
	05/05/15	Manager, Infrastructure Services	Cross referenced with new sections
V3	02/07/18	Manager, Infrastructure Services	2018 general review update

23.0 BUILDING MANAGEMENT SYSTEM

This document is a section of the James Cook University (JCU) Design Guidelines and is not to be read in isolation. Consultants and Contractors are required to comply with all sections of the JCU Design Guidelines.

23.1 Design Process Requirements

The consultant shall be held responsible / liable for ensuring that all works necessary for the complete installation and successful operation are included in the design and specifications. Specific deliverables are required at the end of each project stage, namely:

23.1.1 Approvals Required during Design

Approval shall be obtained from the JCU Estate Directorate, Deputy Director, Planning and Development SD for the:

- Plant numbering sequence,
- Use of shunt trip type circuit breakers, and the
- Qualifications and experience of all technicians working on programming of JCU BMS systems.

23.1.2 Site Infrastructure Connection Approvals

Not Applicable to this section of the Design Guidelines.

23.1.3 Schematic Design (SD) Report / Design Review

Report Content in addition to requirements of Section 30:

- A high level description of the control philosophy for the project.

23.1.4 Developed Design (DD) Report / Design Review

Report Content in addition to requirements of Section 30:

- Detailed control philosophy, including any functional specification and lists of equipment to be controlled by the BMS.

23.1.5 Construction Contract Document Requirements

- In addition to requirements of Section 30, include any upgraded functional specification and lists of equipment to be controlled by the BMS.

23.1.6 Handover Requirements

Following commissioning, undertake a witness inspection of the operation of the BMS, verify accuracy of the data being monitored and quality of information presented in graphics pages. Ensure that the Consulting Engineer and JCU Manager, Asset Strategy and Maintenance and/or JCU Manager, Infrastructure Services (or representatives) are present.

Rectify any defects identified. Should re-inspection be required, the cost of consultants reinspections will be deleted from the contract sum.

23.2 BMS Design Requirements

New or refurbished buildings at JCU are controlled and monitored by a building management and control system (BMS) using direct digital control. Where an existing installation is being refurbished or expanded, all new controls must be readily compatible with existing controls at that Campus.

All field devices in plant rooms shall be labelled, including chilled water sensors and chilled water valves. Chilled Water Supply temperature to the building is to be labelled (T1). Chilled Water Return temperature from the building is to be labelled (T2).

The BMS contractor shall provide training to staff nominated by the Manager, Asset Strategy and Maintenance or Cairns Operations Manager.

23.2.1 Identification of Equipment

Confirm the plant numbering sequence with JCU Deputy Director – Planning and Development prior to Contract Documentation.

Prefix equipment with building number (xxx) for Townsville, the Cairns building number is an integral part of the sequence. Examples are given in each Engineering Section.

Generally all plant is to be numbered as follows (xxx is building identifier):

- Chilled water entering building temperature sensor “xxx-T-1” Townsville or “T-xxx-1” Cairns
- Chilled water leaving building temperature sensor “xxx-T-2” Townsville or “T-xxx-2” Cairns

23.2.2 Design for project and future

In addition to the requirements of Section 30, provide additional controller space to all BMS enclosures, being the greater of:

- For general academic and non-critical process buildings, the controllers shall be determined on known future requirements plus one additional controller over, or
- For Critical Process buildings (PC2/PC3 Laboratories, Data Centres, and Plant that is the single point of failure for business disruption) shall have a planned reliability strategy. The controllers shall be paired with one controller per control group so if the controller fails, it does not affect other plant operation, or
- Additional 10% of the BMS panel space, or
- one full additional controller and ancillaries
- all equipment required to run critical plant shall be connected to one controller and not across multiple e.g. for chiller operation all pumps, valves, etc. are to be connected to one controller.

These impacts are to be clearly articulated in the design documentation.

23.2.3 Controller Locations

All BMS controllers must be installed in lockable, dustproof BMS specific cabinets in plant rooms. Where mechanical services switchboards are provided, the BMS equipment may be located therein, in a separate segregated cubicle. Locks shall be keyed to the standard electrical key (L&F 31R key blank 92268 or CL003).

Provisions are to be made for heat dissipation, particularly for external panels, and panels containing high heat generating equipment such as SCR / SSR controls and similar.

23.2.4 Wiring Requirements

Provide wiring complying to:

- All flexible wires to be fitted with ferrules (bootlace).
- Cable to be Electra EAS7301P or equivalent to instrumentation and field devices.
- Wire numbers to all wire ends including field devices. Numbering system must follow JCU Design Guidelines specifications: standard point number for EcoStruxure (Townsville) or Tridium (Cairns). Devices not connected to a controller will use standard numbers which will be indicated on a circuit diagram
- ELV Control wiring is to follow the following code: 24Vac: orange; 0Vac: grey

All controller digital output I/O to use ELV (24V) slave relays with LED indicator lights.

All controls emanating from controllers to external devices must be 24VDC or 24VAC originating from a 240V/24V transformer mounted within the controller cabinet or in external switchboards and switched by internal relays within the controller panel

Where available, BMS controllers are to be connected to essential power supply via a filtered UPS.

Shunt trip type circuit breakers are not to be used unless approved by the JCU Estate Directorate, Deputy Director, Planning and Development.

All BMS controllers must be supplied with access to the JCU BMS network via an adjacent data outlet that is mount within the MSSB. The outlet shall be mounted in the BMS section of the board and include one (1) per controller plus one (1) for mobile computer access (n+1).

23.2.5 UPS Power Supply to BMS Controllers

All new buildings shall include UPS local or central supply as part of the BMS package. In the event the power supply is lost, the BMS shall drive all chilled water valves closed until the mains power is reinstated with the exception of critical plant, controllers, AHU's, pumps, valves which will be operated on emergency generator power.

23.2.6 Fire Mode VAV Box Settings

In fire mode, all VAV dampers shall modulate closed to ensure smoke is not spread between rooms and reinstated to automatic (open) position once the fire alarm signal is disabled.

23.2.7 Experienced Technicians

All technicians that work on the JCU BMS shall be approved by the JCU Estate Directorate, Deputy Director, Planning and Development after endorsement by the Manager, Asset Strategy and Maintenance or Cairns Operations Manager as appropriate. Technicians are required to be licenced for the works carried out and shall submit a resume showing relevant experience in programming.

23.3 BMS Cairns Campus

23.3.1 General

The system shall be a micro-computer based (Tridium N4) with stand-alone remote outstations communicating directly with the field sensors and actuators and a central monitoring and control station. The drivers currently used on the campus include Tridium N4, VykonPro, LonWorks, Niagara,

ASD, Sedona, tcom, oBix and ndio.

Current BMS controls structure is Vykon JACE controller, Vykon Nigara Direct I/O (NDIO) module, EasyIO digital IO device and field devices. The structure is capable of peer-to-peer(P2P), device to server communications and must be capable of communicating with devices on the same subnet.

In buildings with essential power, all BMS controllers are to be provided with power via a filtered UPS to support the controllers during change over. Actuators are not required to be supported by the UPS.

The UPS shall be fed from a dedicated power point located within the switchboard and suitably signed with an engraved Trafylite label. The BMS will monitor a set of dry contacts in the UPS and send an SMS/alarm to notify nominated persons in the event of an interruption to the building power supply.

Pipe sensors shall be thermowell with thermal contact with the bottom e.g. Invensys well-mounted temperature sensors TS-5721-853.

23.3.2 Graphics Colour Codes

Graphics for data points and equipment shall change to red for over temperature and when in fault.

Graphics for temperature data points shall change to blue when under temperature.

23.3.3 Active Graphics Standards

Supply Active Graphics that provides dynamic information for all plant equipment, point status or values which is to be continually updated to the current JCU standard. This is to including colour coding, alarms and adjustment points.

Supply floor plan Active Graphics, including temperatures and links to AHU graphics with room numbers.

These graphics are to have selectable active links for all control points required to control

- space temperatures and humidity
- for all PCU's, AHU's and VAV's
- any other equipment required to control the air conditioning
- all monitored equipment including but not restricted to compressed air plant, hot water systems, vacuum plant .

As a minimum the graphics shall provide the following

- Building and floor plans showing the locations of the plant rooms and other control and monitored points e.g. AHUs, VAVs, cold rooms, sensors, control panels (Cairns Graphic 3)
- A graphic for each plant room showing the equipment installed, its operational status (on off), and whether there are any alarms associated with that equipment
- A graphic for all AHUs and VAVs, (Cairns Graphic 4 and Cairns Graphic 6 showing)
    - the area/room supplied by the unit
    - space temperature
    - temperature set points

- supply air temperature from the unit, downstream of any heaters
- off coil temperature
- chilled water coil percentage open for AHU's
- fan status
- for AHU's supplying VAV's, all above plus, (Cairns Graphic 4)
    i. a table, with active links, to each VAV supplied showing the VAV's set point, space temperature cooling percentage
    ii. fan VSD percentage
    iii. fan fault
    iv. fan status
    v. static air pressure set point
    vi. static air pressure in duct
    vii. the ability to change the VAV control mode for the highest, second highest, average (excluding zero values) and lowest space temperature. This is to be selectable from a drop down box on the graphics, (Cairns Graphic 5)
    viii. a link to the PCOA (if applicable)
- for VAV's, (**Error! Reference source not found.**)
    i. current airflow
    ii. airflow set point
    iii. minimum and maximum airflows
    iv. VAV control mode. This is to be selectable for automatic, force to maximum and minimum air flow, force open and close, (Cairns Graphic 7)
    v. the ability to change the airflow set points
    vi. a link to the suppling AHU
    vii. supply air temperature from the AHU
    viii. cooling call percentage

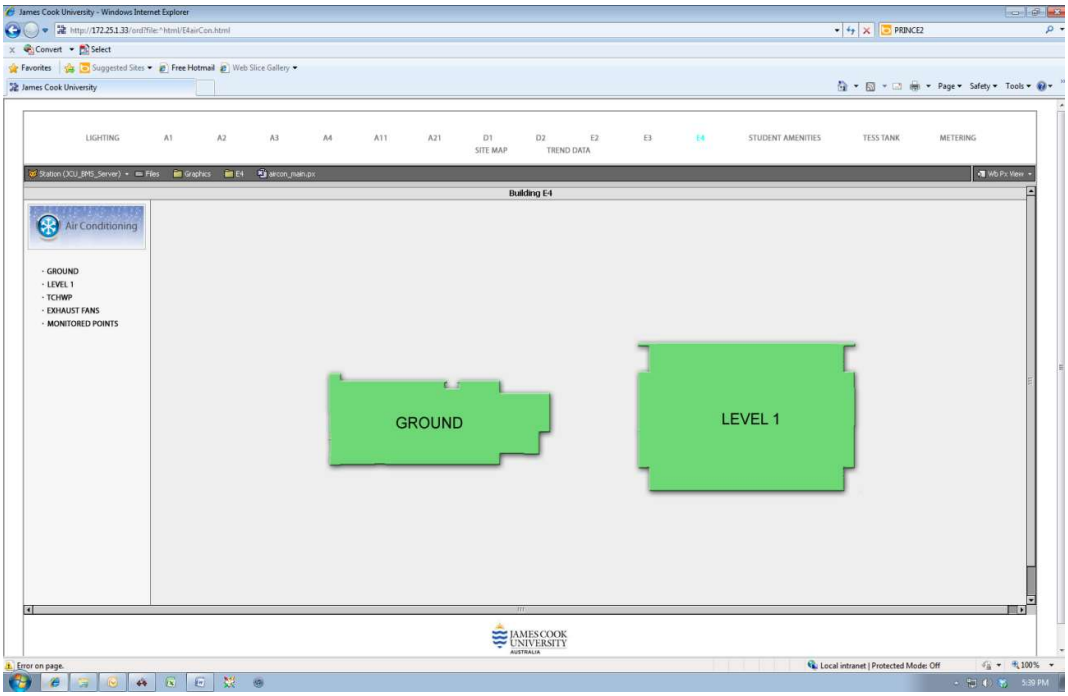
- A summary table, with selectable links, for all air conditioning equipment such as AHU and VAV for each floor of the building, (Cairns Graphic 8)
    - the name of the unit
    - schedule status
    - command status
    - current status
    - supply air pressure and set point
    - fault status
    - VSD %(for AHU's)
    - current temperature and set point
    - humidity(if monitored)
    - chilled water valve %
    - percentage cooling

- A graphic/table summarising the exhaust and ventilation fan status (Cairns Graphic 9)

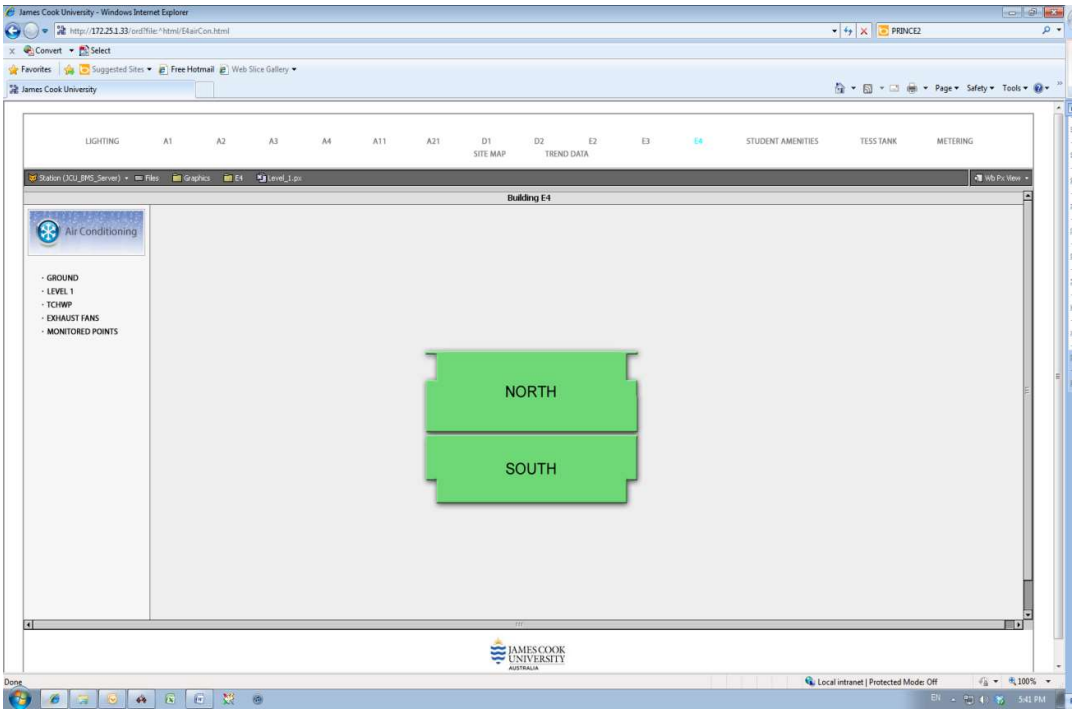
- A graphic/table summarising any other monitored points in the build, (Cairns Graphic 10)
-

- A representation of the tertiary pumps, (Cairns Graphic 11)

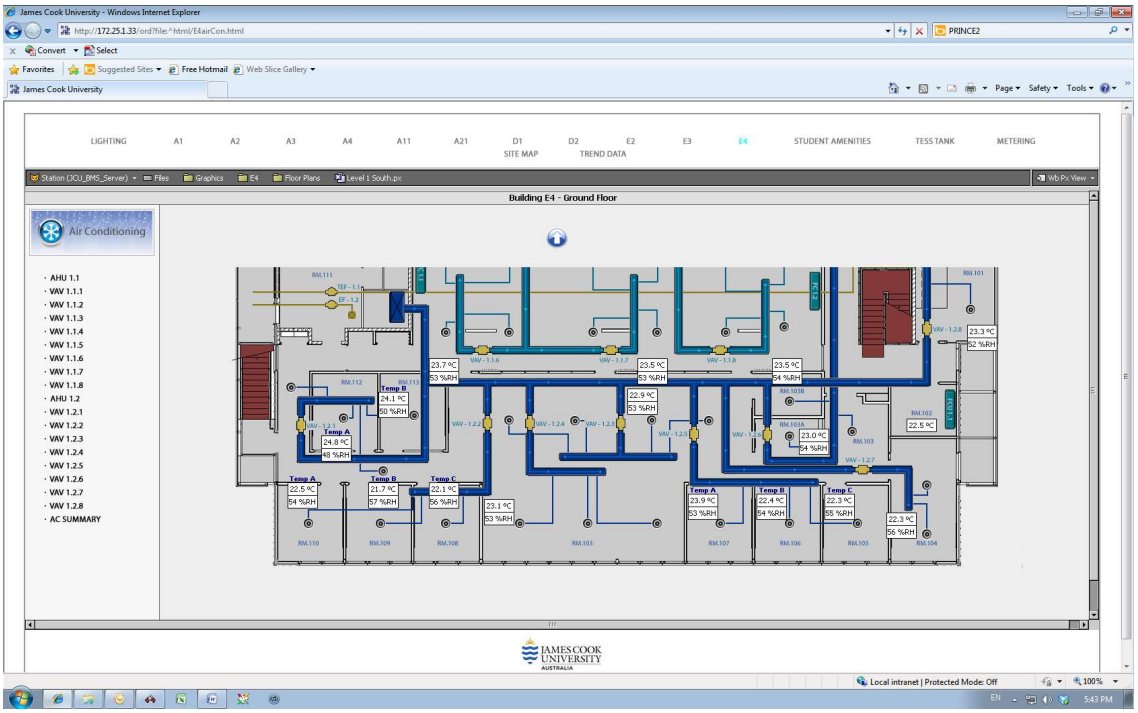
23.3.4 Active Graphic Examples



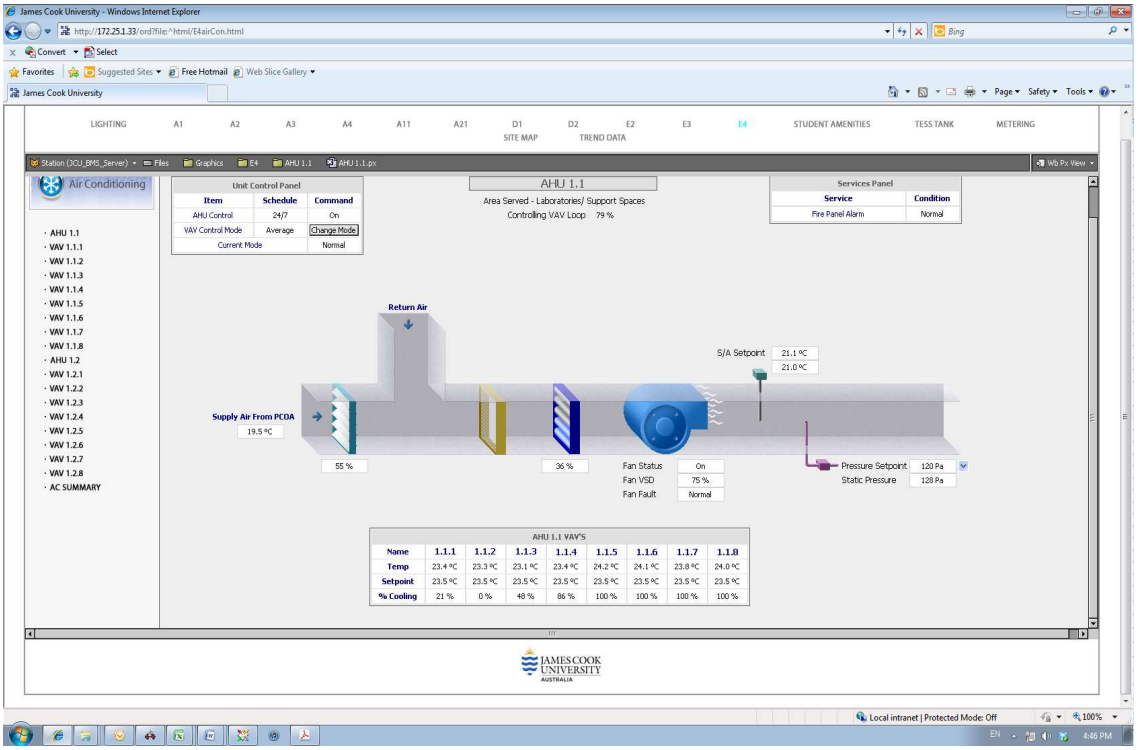
Cairns Graphic 1



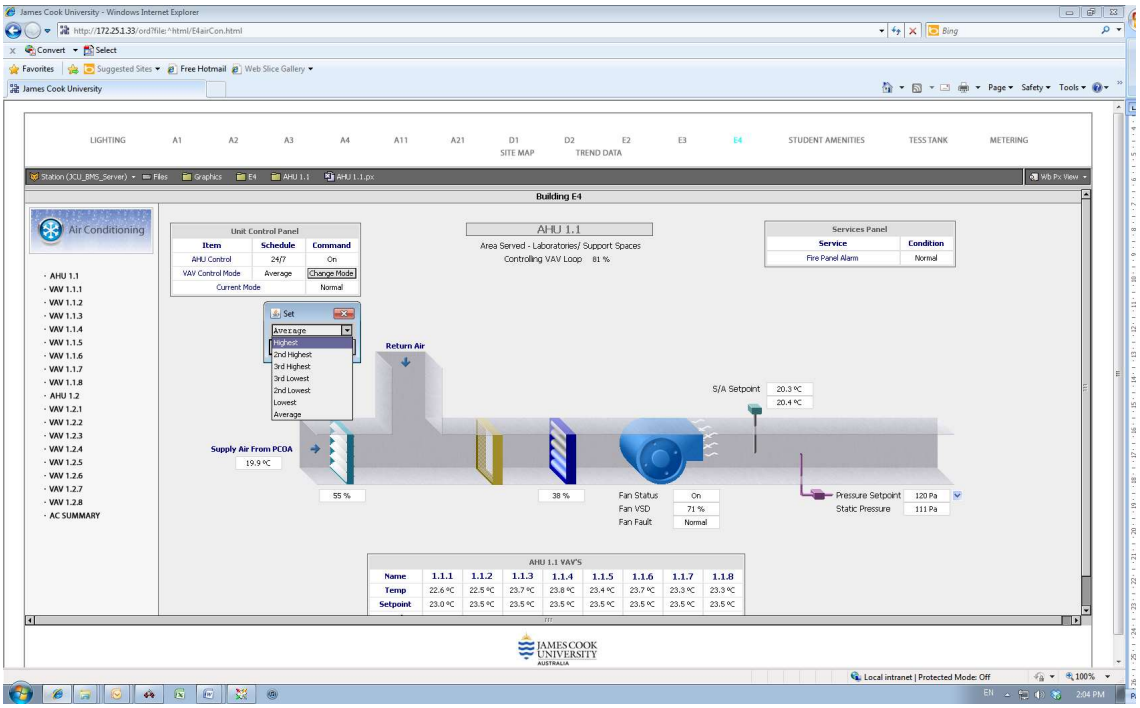
Cairns Graphic 2



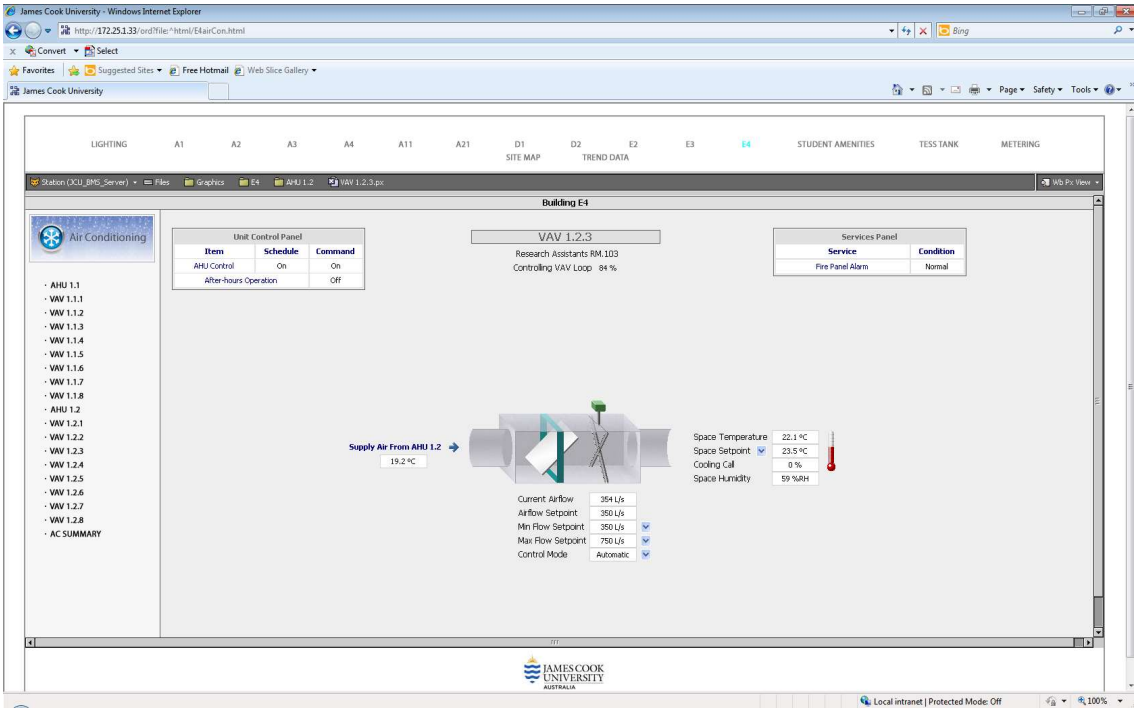
Cairns Graphic 3



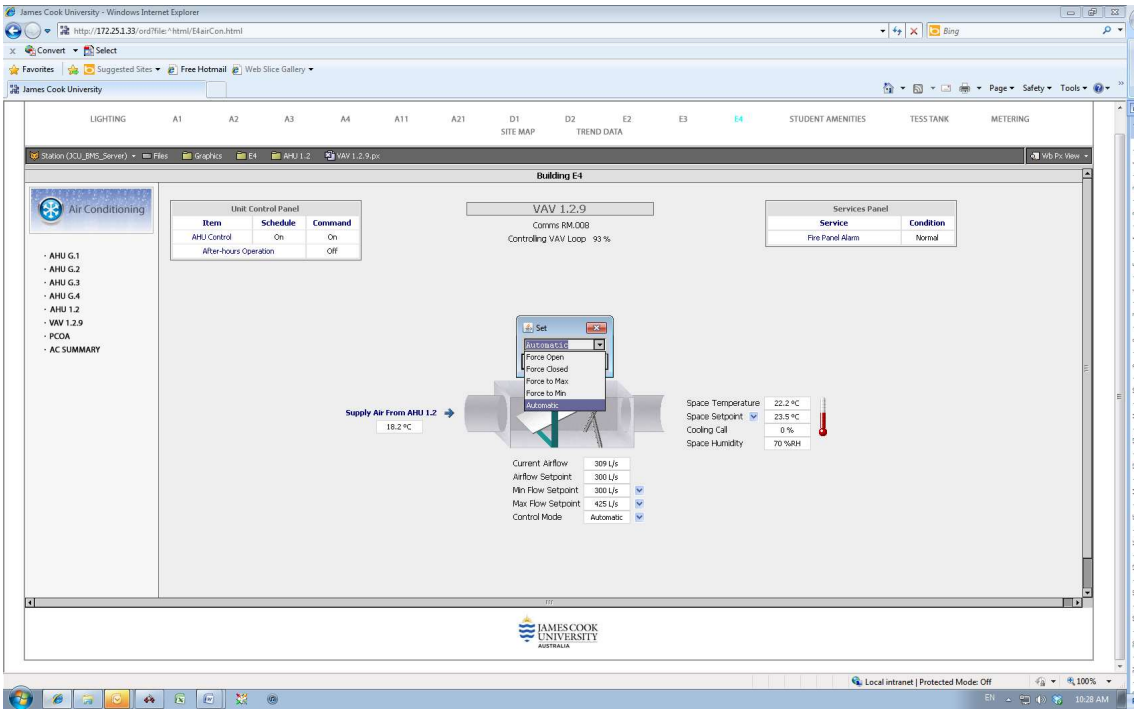
Cairns Graphic 4



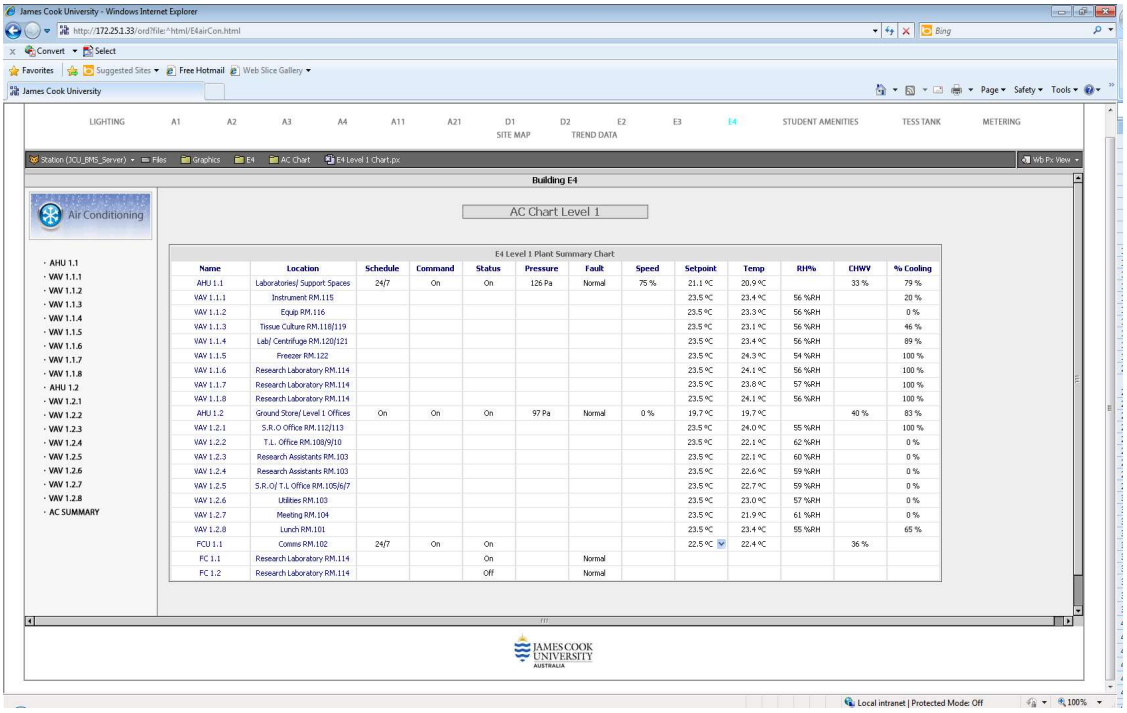
Cairns Graphic 5



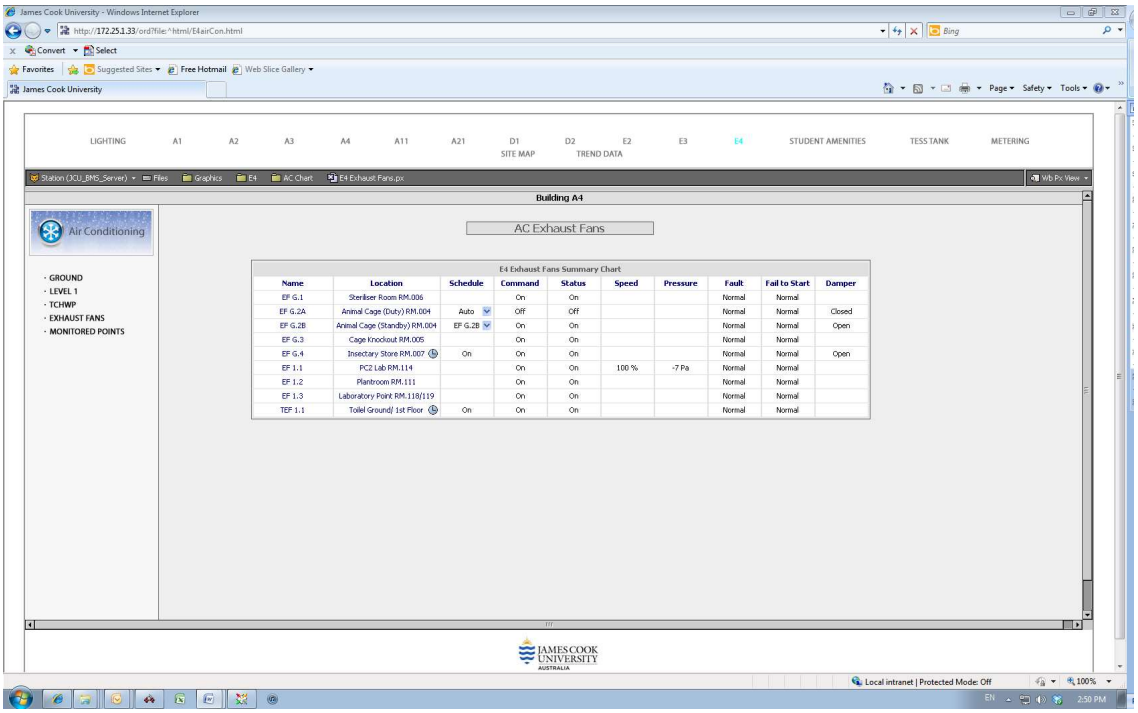
Cairns Graphic 6



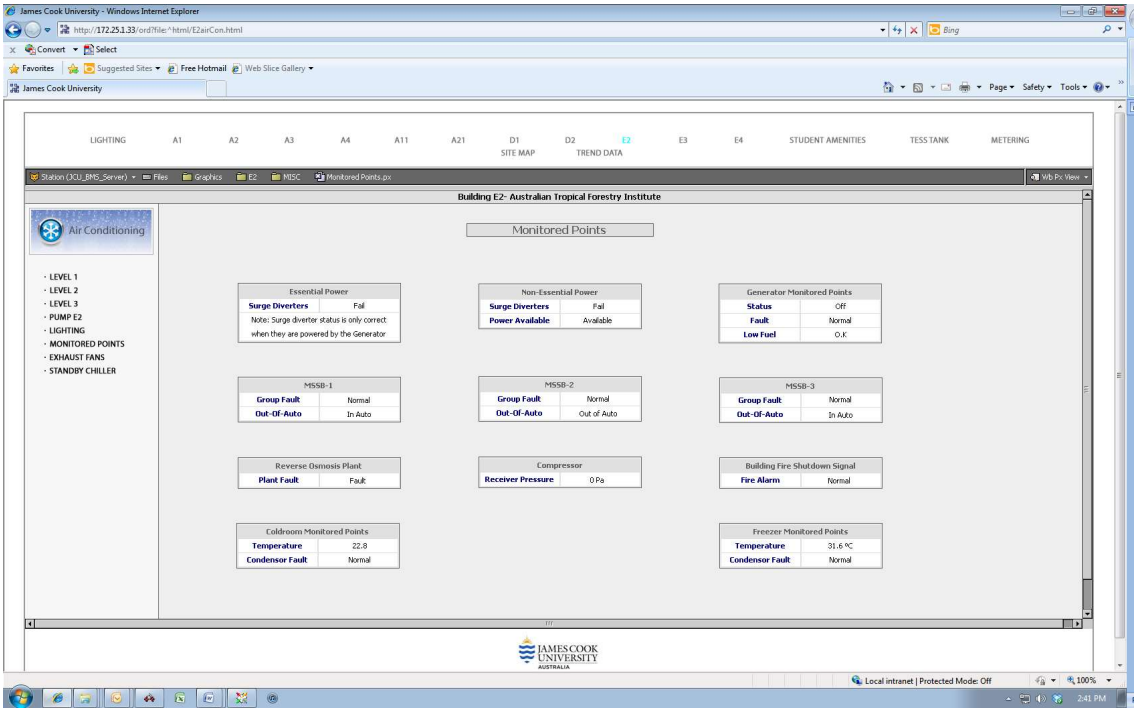
Cairns Graphic 7



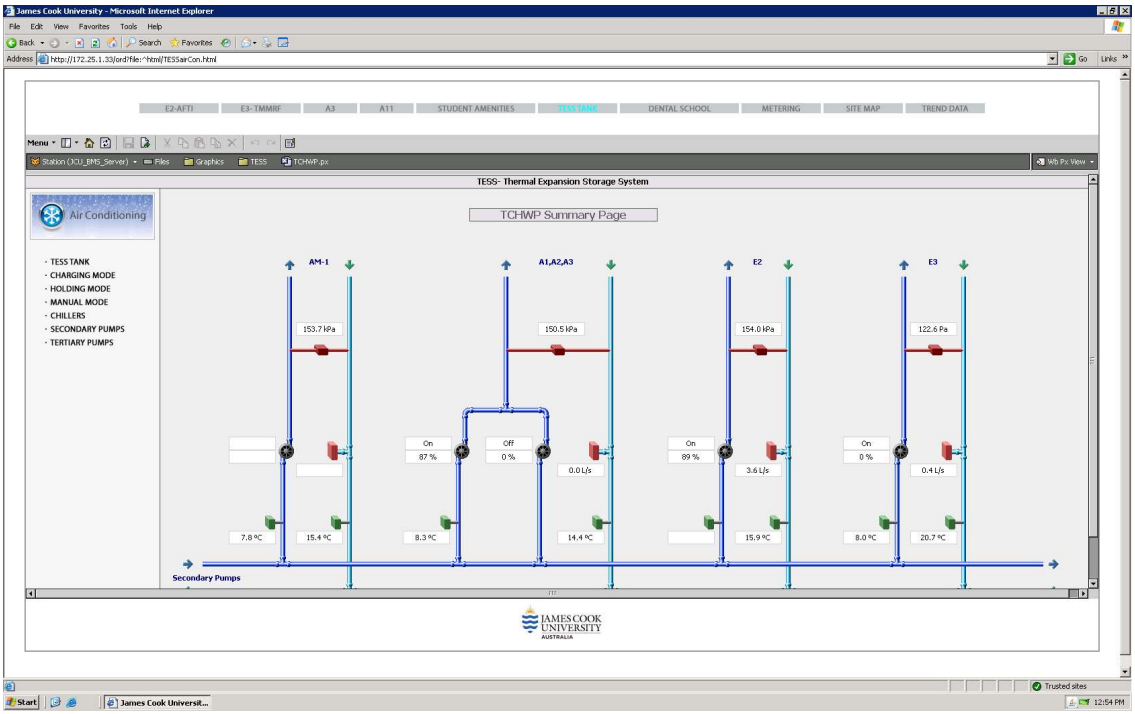
Cairns Graphic 8



Cairns Graphic 9



Cairns Graphic 10



Cairns Graphic 11

23.4 BMS Townsville Campus

23.4.1 General

The system shall be a micro-computer based (Schneider EcoStruxure) with stand-alone remote Automation Servers communicating directly with the field sensors and actuators and a central monitoring and control station (Enterprise Server).

Use the latest JCU template available on request from the JCU Project Manager.

23.4.2 Active Graphic Standards

Supply Active Graphics for all plant equipment to the current JCU standard including colour coding, alarms and adjustment points.

Supply floor plan Active Graphics, including temperatures and links to AHU graphics with room numbers.

These graphics are to have selectable active links for all control points for AHU and VAV.

As a minimum the graphics shall provide the following

- All graphic slides to use the latest graphic schemes using building 142 The Science Place as a template (including duct/VAV layers)
- Building and floor plans showing the locations of the plantrooms and other control and monitored points e.g. AHUs, VAVs, cold rooms, sensors, control panels
    - Use room numbers only, not names or building numbers. Use three digits: ground-001, first-101, second-201 etc.
    - Locate room numbers in centre of room where possible and keep level with other room numbers
    - Room zones to be clearly identified with colour. Ducts can be coloured grey to make less busy and allow for more zone colours (constant flow, not VAV)
    - Place names above objects where possible (e.g. VAV above temps) and keep centred.
    - Duct/VAV layers shall be selectable on each floor plan graphic
    - Temperature symbols: wall mount Blue fill, ceiling mount Orange fill
    - It is important to keep the graphic tidy and professional
- A graphic for all AHUs, FCUs and VAVs if applicable
    - the area/room supplied by the unit
    - space temperature
    - temperature set points
    - supply air temperature from the unit, downstream of any heaters
    - off coil temperature
    - chilled water coil percentage open
    - fan status
    - for AHU's supplying VAV's, additionally
        i. a table, with active links, to each VAV supplied showing the VAV's set point, space temperature, minimum and maximum airflows, airflow set point, active airflow and damper position
        ii. fan speed
        iii. duct pressure set point
        iv. duct pressure
        v. fan/VSD fault
        vi. fan status
- Keep to existing index format e.g. (CHW system on top, floor plan second, miscellaneous last)

- A graphic/table summarising the exhaust and ventilation fans
- A graphic/table summarising any other miscellaneous monitored points in the building
- A representation of the tertiary pumps
- All pages to have link to CPS (Critical Point Summary)

23.4.3 Graphic Examples

Figure 1 - Townsville Floor Plan with VAV

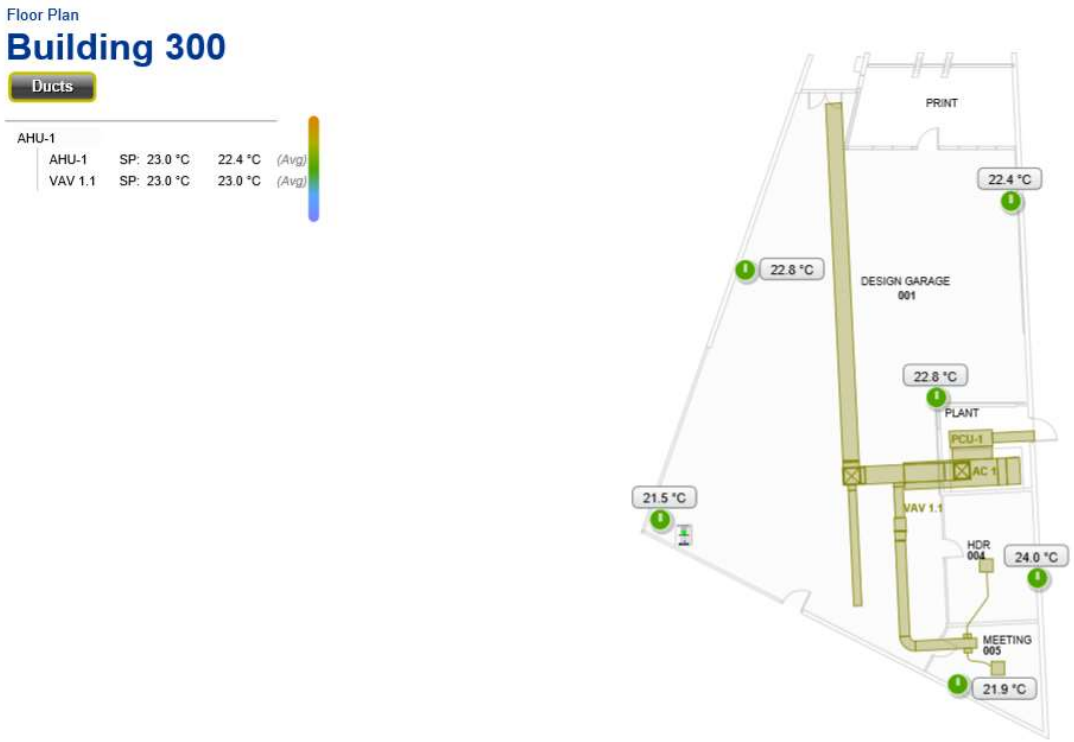


Figure 2 - Townsville Floor Plan without VAV

23.5 Typical Control methodologies

23.5.1 Outside Air Pre-Conditioning Units

Provide detailed plain English for all control strategies to ensure the preconditioners complete the design intent.

Unit start/stop
Unit will be commanded to run if any of the associated air handling units is running.
Unit will be commanded to stop when all associated air handling units are not running.

Fan Speed Control
Fan speed will be varied via its variable speed drive to maintain a constant supply air velocity (or pressure). The supply air velocity (or Pressure) set point to be determined during commissioning.

Chilled Water Valve Control
A temperature and humidity sensor must be installed in the supply air duct of the pre-conditioner after any cooling coil and heat exchanger. Dew point is calculated by the BMS. The chilled water valve is controlled to maintain a constant leaving air dew point of 13°C (Initial Setting).

The BMS calculates the room dew point Td from the formula:

$$Td = T-[(100-RH)/5]$$

Where: Td : Dew point temperature °C, T: Supply Air temperature °C, RH: Supply Air Relative Humidity (%).

The BMS will use proportional control to maintain the dew point setpoint Td SP of 13°C (Initial Setting) which can be manually adjusted via a drop down on the units graphic. The graphic for the PCU is to display the calculated dew point

The supply air temperature set point will be reset from 12.0°C to 24.0°C with a manually adjustable minimum.

Control of the chilled water valve will be in response to the lowest signal select between the Dew Point Control signal and the S/A Temp Control signal.

Plant monitoring:
Monitored, recorded and displayed information on the BMS graphic is to include but not restricted to;-

- fan status
- fire alarm
- outside air temperature
- outside humidity
- supply air temperature
- supply air humidity
- supply air dewpoint
- supply air static pressure
- CHW valve signal

23.5.2 Constant Volume AHUs

Each unit is to have an adjustable time scheduled regardless of if they are designed run schedule. If they are intended to run continuously, this shall be noted on the graphic for the unit.

After hours air conditioning is to be activated by an after-hours button, which enables Aatwo hour run time. A green indicator lamp is to show that the AHU is activated. A second press of the after-hours button will terminate after hours mode. If the after-hours mode is left to run its two hour run time, the indicator lamp will flash for the last five minutes of this period, to indicate that the unit is about to turn off.

Temperature Control

A wall mounted temperature/humidity sensor required (Vaisala HMW93).

The chilled water valve is be modulated to maintain conditions in the space via proportional plus integral control algorithm to the user adjustable set-point from the AHU graphics page

For AHU's with multiple temperature sensors the BMS is to calculate the supply air temperature from the highest, average space temperature (excluding zeros). These control modes are to be selectable from the AHU graphics page.

For AHUs connected to pre-conditioners, an unoccupied temperature set back of 27°C is to be used.

Humidity Control

All AHU's that supply entry foyers and office areas shall have humidity monitoring.

Plant monitoring:

Monitored, recorded and displayed information on the BMS graphic is to include but not restricted to;-

- zone temperatures (Vaisala HMW93)
- return air temperature (Vaisala HMD83D)
- CO2 level, if used
- fresh air make-up VAV quantity
- AHU fault
- fan status
- fire alarm
- supply air temperature
- CHW valve signal
- fan

23.5.3 Variable Air Volume AHUs

Fan Start

Each unit is time scheduled.

Each VAV zone has an after-hours button, which enables two hours run time. A green indicator lamp is to show that the AHU is activated. A second press of the after-hours button will terminate after hours mode. If the after-hours mode is left to run its two hour run time, the indicator lamp will flash for the last five minutes of this period, to indicate that the unit is about to turn off.

VAV Control

VAVs are to be controllable via their graphics page for;-

- Automatic
- minimum airflow
- maximum airflow
-

- force open
- force closed

23.5.4 Tertiary Chilled Water Pumps

A cooling call will be initiated after ten minutes when any chilled water valve opens to 50%. The cooling call is terminated when all chilled water valves close below 10%. On receipt of cooling call, the duty pump is initiated.

The pump duty/ standby is rotated monthly. On failure of a duty pump, the standby pump is enabled and an alarm raised.

The variable speed drive of the duty pump is controlled by a differential pressure transducer located in the AHU plantroom.

Hours run of the pump are logged and displayed on the graphics.

23.5.5 CO_2 Control

A duct mounted CO_2 sensor is located in the AHU return air duct. If the CO_2 level rises above set-point, initially 800ppm, the outside air quantity is modulated from minimum outside air quantity to maximum air quantity when the CO_2 level is 200ppm above set-point.

23.5.6 Miscellaneous

The BMS shall monitor the MSSB Fire Alarm shutdown status at each MSSB. Fire mode operation is hardwired and independent of the BMS. Upon receipt of a fire alarm (hardwire relay in MSSB) the BMS will mimic the hardwired control.

Commercial (not domestic) Fridge/Freezer/Cold rooms temperature and alarms need to be monitored by the BMS and alarms routed to security alarms.

Economy mode – is not required unless it can be proved it will work in tropical climate.

Seasonable temperature set points – are not required but will be integrated with the demand management controls

High Level Interface (HLI) to energy meters –is required on the BMS, and required on the EMS (please refer to the EMS specification for further details)

Lift monitoring – is required on the BMS

Hydraulic system control/monitoring – not required on the BMS.

Lighting system control/monitoring – not required on the BMS (C-BUS as specified)

Medical gas alarms – not required on the BMS (unless local alarm output required)

Variable Speed Drives to be Schneider or Danfoss

Temperature/Humidity sensors to be Vaisala HMD83D for duct mount and HMW93 for wall mount. Where additional data is required such as dew point use Vaisala HMW96 BACnet HLI sensors

For non 24/7 plant, time schedules shall have optimiser control and be interfaced with the campus holiday schedule

For the Cairns Campus, all external building and street lighting is to be connected to the BMS and shall be controlled by the campus PE cell or the time schedule.