# 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 |
| | | | |

# 23.0 BUILDING MANAGEMENT SYSTEM

## 23.1 INTENT OF THE JAMES COOK UNVERSITY DESIGN GUIDELINES

James Cook University was established to pursue and encourage study and research, especially in subjects of importance to the people of the tropics. James Cook University is Queensland's second oldest university and through its research, graduates and industry links, is a major driver of economic growth and social change in northern Queensland.

Staff and students of JCU use its unique locations to conduct nationally significant and internationally-recognised research in areas such as marine sciences, biodiversity, tropical ecology and environments, global warming, tourism and in tropical medicine and public health care in underserved populations. Its network of specialist centres, institutes and research stations span a wide geographic area from marine islands to the outback and the students come from many backgrounds, promoting a rich cultural and experiential diversity on campus.

These design guidelines have been developed to ensure that projects delivered by JCU comply with the University's vision, are appropriate for the unique tropical environments and incorporate the lessons learnt from previous projects. The Deputy Director – Planning and Development is responsible to ensure these Design Guidelines achieve the best design outcomes for JCU.

## 23.2 COMPLIANCE AND APPROVALS

### 23.2.1 Compliance Requirements

All design and works are to comply with the latest versions of all Australian National, Queensland State, legislation and standards, as well as local council/authority requirements.

All other sections of these Guidelines are to be read for completeness as this document has been developed as a section of a suite of documents.

Where there is a discrepancy between requirements, legislation and regulation to take precedent over these Guidelines.

### 23.2.2 Non-Conformance Approvals

All project team members (for example Consultants, D&C Contractors, Principal Consultants, Internal/External project managers, subcontractors etc.) are responsible for delivering the project in accordance with the project brief, these guidelines, user group information and other contractual documents.

Where there are sound engineering reasons to deviate from these documents, a written non-conformance request is to be submitted to the Deputy Director – Planning and Development via the JCU Project Manager.

This could apply when the project involve aspects, scope, technologies, locations or other applications that are not specifically briefed or covered by the Design Guidelines, the non-conformance request will include clear information on:

- Technical Aspect that is not covered
- A range of options to address the issue
- Time and costs implications for each option
- Effect of the aspect on the design and on other trades
- Effects on users, maintenance, access, life of plant, energy efficiency, cost
- Effects on future re-allocation of the space / system etc.

- Recommended solution to the issue

A Non-Conformance register is to be maintained by the Consultant and the details of each request plus the outcome are to be recorded.

#### 23.2.3 Design Approvals

Irrespective of directions received from JCU, the Consultant remains fully responsible for the design solution developed.

All designs done for and on behalf of JCU require RPEQ certification, unless approved by the Manager, Infrastructure Services via the JCU Project Manager.

Form 15 Design Certification is to be obtained.

#### 23.2.4 NCC Version to Apply

Confirm with JCU's Project Manager which version of NCC (Building Codes of Australia) that is applicable to the works.

#### 23.2.5 Site Infrastructure Connection Approvals

The Manager, Infrastructure Services shall approve all connections to the existing Building Management System (BMS). A single request for approval to connect to each system is to be sent to the Manager, Infrastructure Services, at least 3 working days before the connection is required. This document shall contain the following information;

From the RPEQ Design Engineer:

- Certificate of Design Compliance for related Hydraulic, Mechanical and Electrical Systems

From the commission team:

- All Services Commissioning Plans
- Certificate of Installation Compliance for related Hydraulic, Mechanical and Electrical Systems
- Statement that installation and meters are in compliance with the JCU Design Guidelines
- Quality, pressure and other appropriate test result for services
- System commissioning test results

## 23.3 DESIGN PROCESS REQUIREMENTS

#### 23.3.1 Roles and Responsibilities

The University does not wish to be separated from the design process, regardless of whether the project is traditionally delivered, delivered through Managing Contractor, D&C contractor or other.

##### 23.3.1.1 Traditional Delivery

Where traditional delivery is chosen, the framework may be through a Principal Consultant (such as an Architect or Project Manager), or direct to JCU.

The Principal Consultant is to arrange workshops with the JCU Deputy Director – Planning and Development, Manager, Infrastructure Services, Manager, Asset Strategy and Maintenance and other technical staff as directed by these managers from initiation of schematic design.

23.3.1.2 Managing Contractor Framework

Arrange workshops and information issues throughout the design process with the JCU Deputy Director – Planning and Development, Manager, Infrastructure Services, Manager, Asset Strategy and Maintenance and other technical staff as directed by these managers (through the Managing Contractor and JCU's Project Manager).

23.3.1.3 Communication Arrangements

All communication with JCU is to be via the JCU Project Manager. Minutes of any design review meetings etc. are to be provided to all participants via the JCU Project Manager.

### 23.3.2 Interfaces with Other Disciplines

Ensure that all works necessary for the complete installation and successful operation are advised to other consultants and specified as interface with other engineering disciplines, professions or specialists.

Ensure that information required to accurately design the services is obtained from other consultants as required.

### 23.3.3 Schematic Design (SD) Report / Design Review

The Schematic Design (SD) report will give a high level understanding to University of the requirements for the project.

23.3.3.1 Report Content

- The drawing numbers and revisions the SD report is based upon e.g. Architectural, As Installed drawings, Landscape, Survey, Civil etc.
- A detailed list of the hydraulic scope of works for the project
- A detailed list of the applicable standards, regulations and local authority requirements that the project has to conform to
- Where existing plant is being utilised, whether this plant is being used, replaced, refurbished etc. with indication of associated issues and costs.
- A high level description of the method of servicing the various spaces in the project
- List of Ecological Sustainable Development (ESD) opportunities
- Non-Conformance Register listing any deviations from Legislation, Standards, Codes, Guidelines or Project Brief.
- List of Assumptions, Boundaries (battery limits or tie-in points) and Specific Exclusions
- Proposed Drawing Register and Deliverables List
- Functional specification for basis of BMS
- Detail the labelling and identification requirements for the project
- Where option analysis was included, a recommendation on the option to take forward with supporting information/decision criteria.
- Outcomes and recommendations for safety in design, and design risk assessment workshops.
- List of proposed design development activities/milestone schedule and deliverables

23.3.3.2 Submission Format

This information is to be submitted to the JCU Project Manager as an A4 colour PDF file with A3 drawing attachments, in hard and electronic format. The Consultant may be requested to deliver a presentation (in person or via VC) to JCU stakeholders and decision makers.

#### 23.3.3.3 Design Review

Submit SD drawings / report and non-conformance register to JCU's Project Manager in full size hard copies (1) and on CD for a full design review in accordance with the project schedule, allow a minimum of 2 weeks for design review.

Inform the JCU's Project Manager as soon as possible if the drawings are going to be delayed for any reason.

Following receipt of the design review comments from JCU, respond formally with

- Acknowledgement that changes will be actioned, and
- List any areas where the design review comments require additional discussion and proposed manner of resolution.

### 23.3.4 **Developed Design / Universities' Review Report Requirements**

The DD report will provide more detail on the design for the accepted option and design approaches.

#### 23.3.4.1 Report Content

- Full return brief for the BMS services
- The drawing numbers and revisions the DD report is based upon e.g. Architectural, As Installed drawings, Landscape, Survey, Civil etc.
- Provide detailed information of all site services, their re-use, refurbishment, relocation or removal
- Detailed functional specification
- In each case options investigated, reasons or supporting information for design choices,
- ESD Opportunities Register
- Updated Non-Conformance Register listing any deviations from codes, standards, legislation, guidelines or project brief.
- Updated Assumptions, Boundaries (battery limits or tie-in points) and Specific Exclusions
- Final Equipment List with sizes/specifications
- Drawing Register and Deliverables list
- Detail the labelling and identification requirements for the project
- All IFC drawings and design calculations
- Updated and finalised Investment Decision Report including Cost (Capex and Opex) and Schedule estimates, Lifecycle costs and indicating any areas of risk to the project delivery.
- Updated outcomes and recommendations for safety in design, and design risk assessment workshops.
- Finalised recommendations for preventative maintenance and list of critical spares on proposed equipment.
- Risk Matrix for design methodology (i.e. n+1 redundancy systems)
- Areas of risk to the project during construction and commissioning
- List of construction activities/milestone schedule and deliverables, including construction and commissioning hold point/inspection/witness/approvals.

23.3.4.2 Submission Format

This information is to be submitted to the JCU Project Manager as an A4 colour PDF file with A3 drawing attachments, in hard and electronic format. The Consultant may be requested to deliver a presentation (in person or via VC) to JCU stakeholders and decision makers.

23.3.4.3 Supporting Documentation

- Controls functional
- Mechanical Specification

23.3.4.4 Design Review

Submit DD drawings / report and non-conformance register to JCU's Project Manager in full size hard copies (1) and on CD for a full design review in accordance with the project schedule, allow a minimum of 2 weeks for design review.

Inform the JCU's Project Manager as soon as possible if the drawings are going to be delayed for any reason.

Following receipt of the design review comments from JCU, respond formally with

- Acknowledgement that changes will be actioned, and
- List any areas where the design review comments require additional discussion and proposed manner of resolution.

23.3.5 **Contract Documents Requirements**

23.3.5.1 Specification Requirements

A concise, project specific specification shall be produced that

- Clearly identifies the scope of works
- Clearly identifies the project nature
- Clearly identifies Interfaces with other disciplines
- Calls into effect the requirements of codes, standards, legislation etc.
- Calls into effect the requirements of these guidelines
- Does not contain excessive or spurious references to unrelated projects or unrequired works.
- Includes all performance requirements
- Includes schedules of all equipment requirements, capacities etc.
- Requires relevant price breakup information from the contractor
- Requires contractor confirmation of equipment, scope, documentation etc.
- Calls up required service, maintenance details etc. in an acceptable Operating and Maintenance Manual format complete with preventative maintenance schedules.

23.3.5.2 Drawing and Documentation requirements

Both Issued for Tender (IFT) and Issued for Construction (IFC) drawing and documentation will be required.

Drawings shall conform to section 34. Ensure:

- Use JCU Title block and include JCU Drawing Number (obtain from JCU Drawing register)
- All fonts and colours to be legible at A3 print colour or black and white
- Use Australian English throughout all documents

- Clearly identifies the scope of works
- Are clear and legible and easily read
- Provide sections, elevations and the like to indicate heights, etc. Generally a minimum of two sections shall be provided for any project to enable the contractor to determine the work heights, co-ordination etc.
- Provide details for specific items such as pumps, hot water systems, meter assemblies, trade waste pre-treatment devices etc.
- Details on connections to all infrastructure
- Maximum 1:500 existing site services drawings
- Maximum 1:500 proposed site services drawings
- Single line diagrams
- Commissioning and testing plans and protocols including notification of any outages

23.3.5.3 Number of Copies

Unless briefed / agreed otherwise, the contract documents shall be provided in electronic (.pdf and native (.dwg)) format and in hard copy as follows:

- Three full sized hardcopies of all drawings
- Three bound copies of specifications in A4

23.3.6 **Handover Requirements**

23.3.6.1 Requirements for Commissioning

Testing and commissioning of all hydraulic, mechanical and electrical systems shall be witnessed and signed off by an independent testing authority not associated with the contractors and made available for use in BMS in.

The commissioning and calibration shall include all associated metering.

23.3.6.2 Witnessing

Following commissioning, undertake witness inspections of the operation of all associated metering, and rectify any defects identified, recommission and re-inspect prior to handover.

23.3.6.3 Records to be provided

Within 3 weeks of Practical completion provide

- All commissioning data as finalised
- Defects lists signed out and complete

23.3.6.4 Defects Liability

The Defects Liability period shall be a minimum of 12 months from the date of Practical completion or acceptance of the systems by the Manager, Infrastructure Services or Manager, Asset Strategy and Maintenance. Longer periods of warranty for key/critical equipment may be required. This should be reviewed in consultation with the Manager, Infrastructure Services and Manager, Asset Strategy and Maintenance on a project specific basis.

During this period the contractor must attend to and rectify all faults, defects etc. at their cost including all parts, labour, commissioning and associated costs. Should an item repeatedly fail during this period, JCU may require warranty in relation to that item to apply from the date of latest repair / replacement.

23.3.6.5 Maintenance Requirements

All construction/ installation contracts shall allow for the performance of regular preventive maintenance of the works during the period of the defects liability period inclusive of all consumables.

Such maintenance shall be in accordance with the manufacturer's instructions and the requirements of AS 1851, Work Health and Safety Act and Regulations, Standards or other applicable regulations, legislation, or codes of practice.

~~S~~afety systems shall be maintained and recorded as a minimum to relevant requirements (e.g. AS1851).

23.3.6.6 Operating and Maintenance Manuals

Operating and maintenance manuals must be issued as Preliminary prior to Practical Completion. Any amendments must be made and manuals issued within three weeks of Practical completion. Manuals must include as a minimum:

- Concise English description of the installation as a whole
- Concise English description of the each system
- Concise English description of the Operation of systems
- Equipment list for all BMS equipment and systems
- Supplier / Support list for all hydraulic equipment
- Manufacturer's Literature for all equipment
- List of recommended critical spares
- List of Contractors and Subcontractors
- List of As-Constructed drawings
- All related services drawings
- All finalised commissioning data
- Form 16
- Recommended Service and Maintenance procedures
- Service and Maintenance Schedule
- Fault finding and reporting procedures
- Emergency Contacts
- All test results as finalised
- Defects lists signed out and complete, and all warranties
- Updated planned and preventative maintenance schedules and design calculations

Provide THREE hard copies of all manuals and "As Constructed" drawings plus electronic (.pdf and native (.dwg)) copies of all documents and drawings.

Consultants shall provide a statement that maintenance manuals and as constructed drawings are correct to the best of their knowledge.

## 23.4 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 room shall be labelled including chilled water sensors and chilled water valves. Chilled Water Supply temp to building is to be labelled (T1). Chilled Water Return temp from building is to be labelled (T2).

Where duty /standby plant is installed, automatic changeover shall occur during the morning, at staggered times and days for different plant. Automatic changeover after hours shall be avoided so that there is someone on hand to attend to any issues that may occur during changeover.

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

### 23.4.1 Design for project and future

A holistic approach shall be taken to any new or refurbishment design and the effect on the existing campus services and buildings shall be well understood.

All designs must consider how the project specific requirements and any additional areas served by systems serving the project areas will impact on the existing services, possible future fitouts / reworking of the project area, and future expansion such as master plan items, items advised etc.

Additional controller space shall be provided 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

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

### 23.4.2 Design for Tropical Areas

JCU's campuses are located in a tropical environment. Particular care is required to ensure necessary measures are taken to prevent the formation of condensate on external or internal surfaces such as air conditioning units, pipework, ductwork, registers, ceilings, walls, windows etc. The design and specification shall address monitoring and controlling spaces, and must specifically deter the growth of mould.

### 23.4.3 Design for Cyclone Prone Areas

JCU's campuses are located in a cyclone prone environment. Particular care is required to ensure necessary measures are taken to ensure that all plant, equipment etc. (particularly external plant) is securely fixed, of suitably rated cyclone area construction and constructed in a manner to withstand such events.

### 23.4.4 Corrosion Prevention and Protection

JCU's campuses are generally located in coastal areas. The prevention of corrosion must be considered in the design.

Elements such as switchboards, control panels shall be installed inside buildings where possible. They shall be stainless steel where exposed to weather. All external sensors or control devices shall be provided with sun / weather covers. Identify additional service recommendations to mitigate or minimise corrosion where the particulars of the installation may produce corrosion in the installation.

### 23.4.5 Equipment Quality and Support

All equipment and components shall have a proven track record of operation in Queensland and be of high quality and reliability, readily available, with a Queensland based agent for service / spare parts, with sufficient stock of spares to support JCU's operation.

Critical Spares requirements shall be listed in Operating and Maintenance Manuals.

### 23.4.6 Design for Maintenance

Ongoing service and maintenance must be facilitated in the installation. Measures at least will provide minimum service access spaces, easily workable arrangements, clear unencumbered walkways of minimum 1200mm.

In all cases mandatory clear access for electrical switchboards and the like is to be provided.

### 23.4.7 Safety in Design

Safety in design must be incorporated into the design of all new plant, buildings etc. In addition to legislated and briefed requirements, work closely with JCU Project Manager and keep the Deputy Director – Planning and Development, Manager, Infrastructure Services and Manager, Asset Strategy and Maintenance fully informed of installation, service and maintenance and access requirements.

Particular care must be taken to ensure that safe installation and service is inherent in the design. Generally any requirement for the use of Personal Protective Equipment (PPE) or protective measures (fall restraint systems etc.) should be avoided by design.

### 23.4.8 AQIS / OGTR / Authorities

Where AQIS / OGTR / Federal Drug Administration or other requirements apply, the designer must fully address these requirements, and provide all information to allow JCU to inform these bodies and pass certification.

### 23.4.9 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).

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.

### 23.4.10 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 Sigma (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 Deputy Director – Planning and Development.

All BMS controllers must be supplied with access to the JCU BMS network via an adjacent data outlet. 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).

### 23.4.11 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 which will be operated on emergency generator power.

### 23.4.12 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.

### 23.4.13 Experienced Technicians

All technicians that work on the JCU BMS shall be known to Estate Office Maintenance Manager, retain required licenced for the works carried out and shall have a minimum of 5 years' experience in programming.

## 23.5 BMS CAIRNS CAMPUS

### 23.5.1 General

The system shall be a micro-computer based (Tridium AX) 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 AX, VykonPro, LonWorks, Niagara, ASD, Sedona, tcom, oBix and ndio.

In buildings with essential power, all BMS controllers are to be provided with power via a filtered UPS with minimum 72 hour capacity 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 eg Invensys well-mounted temperature sensors TS-5721-853.

### 23.5.2 Colour Codes

Red; over temperature, fault

Blue; under temperature

### 23.5.3 **Active Graphics 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.

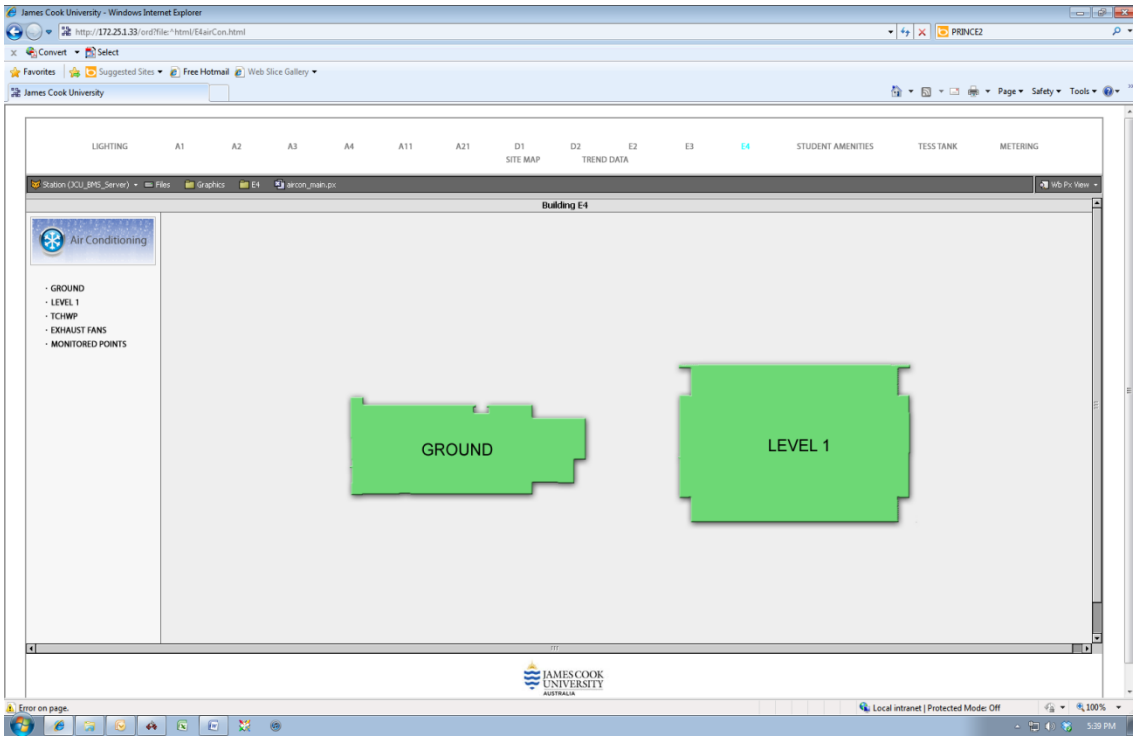
These graphics are to have selectable active links for all control points for AHU and VAV.

As a minimum the graphics shall provide the following

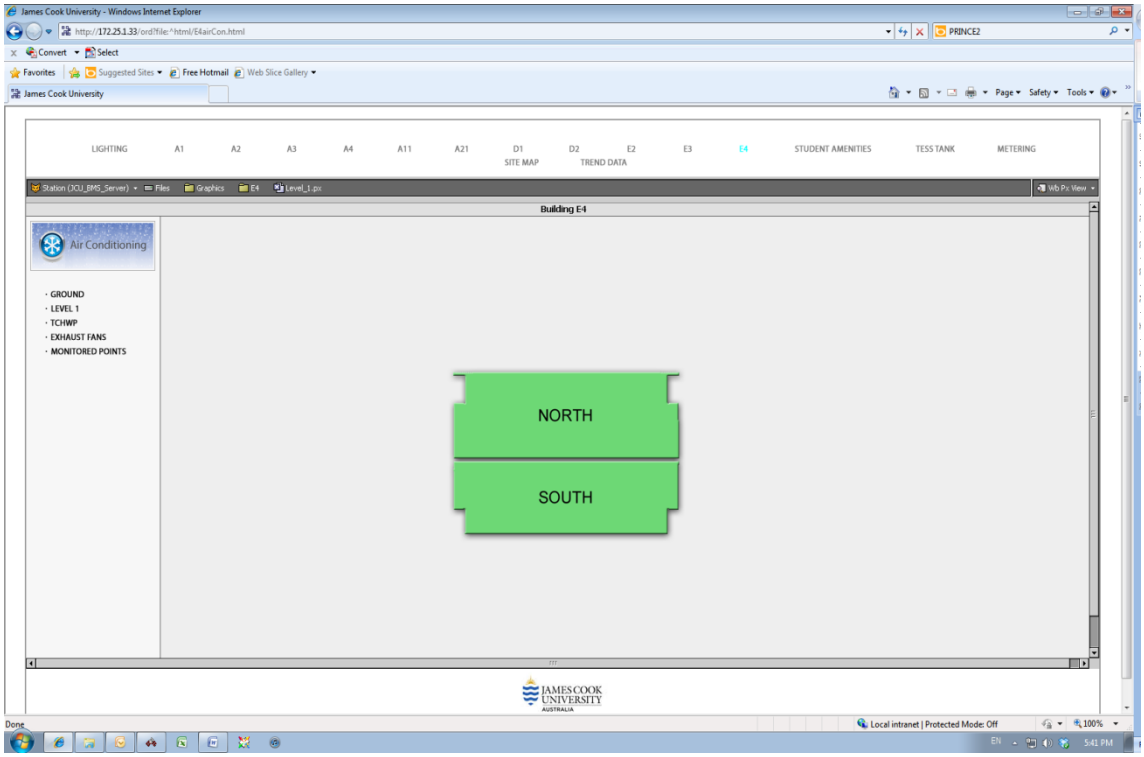
- Building and floor plans showing the locations of the plantrooms and other control and monitored points e.g. AHUs, VAVs, cold rooms, sensors, control panels (Cairns Graphic 3)
- A graphic for each plantroom showing the equipment installed, its operational status (on off), and whether there are any 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 table, with selectable links, for all AHU and VAV showing, (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)

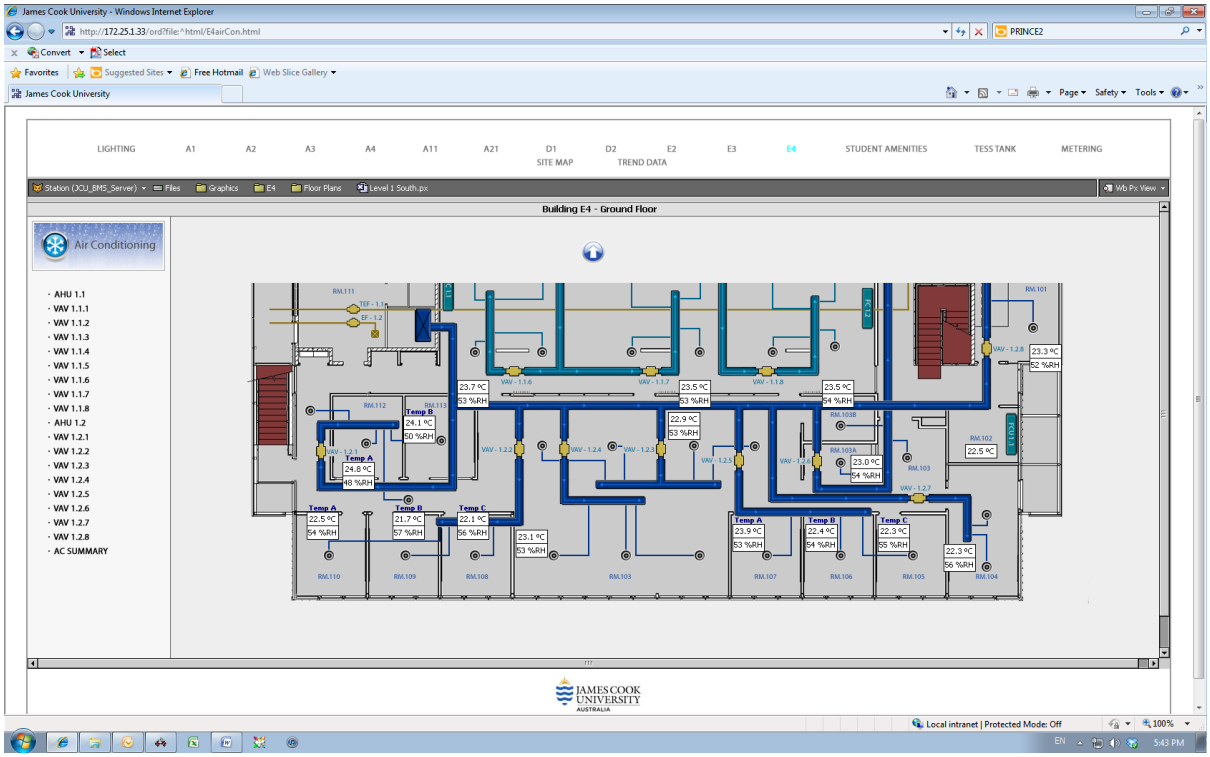
### 23.5.4 **Active Graphic Examples**



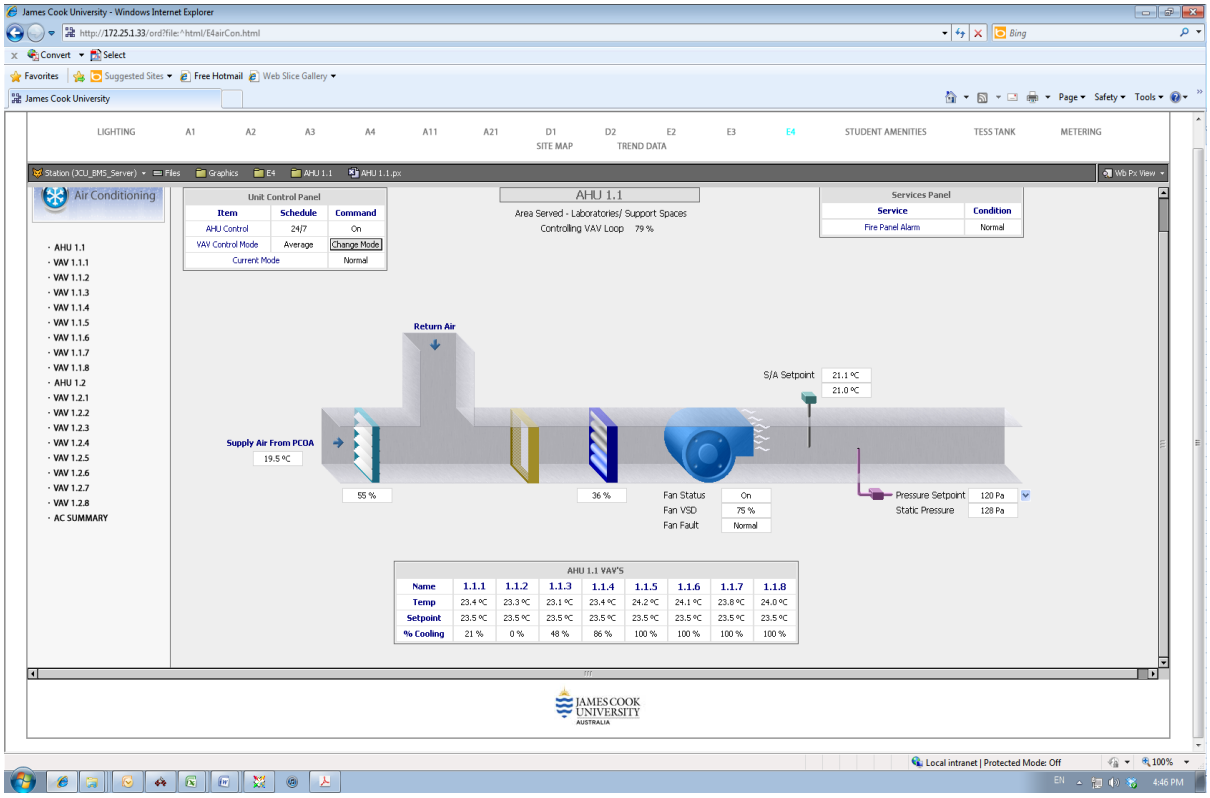

Cairns Graphic 1



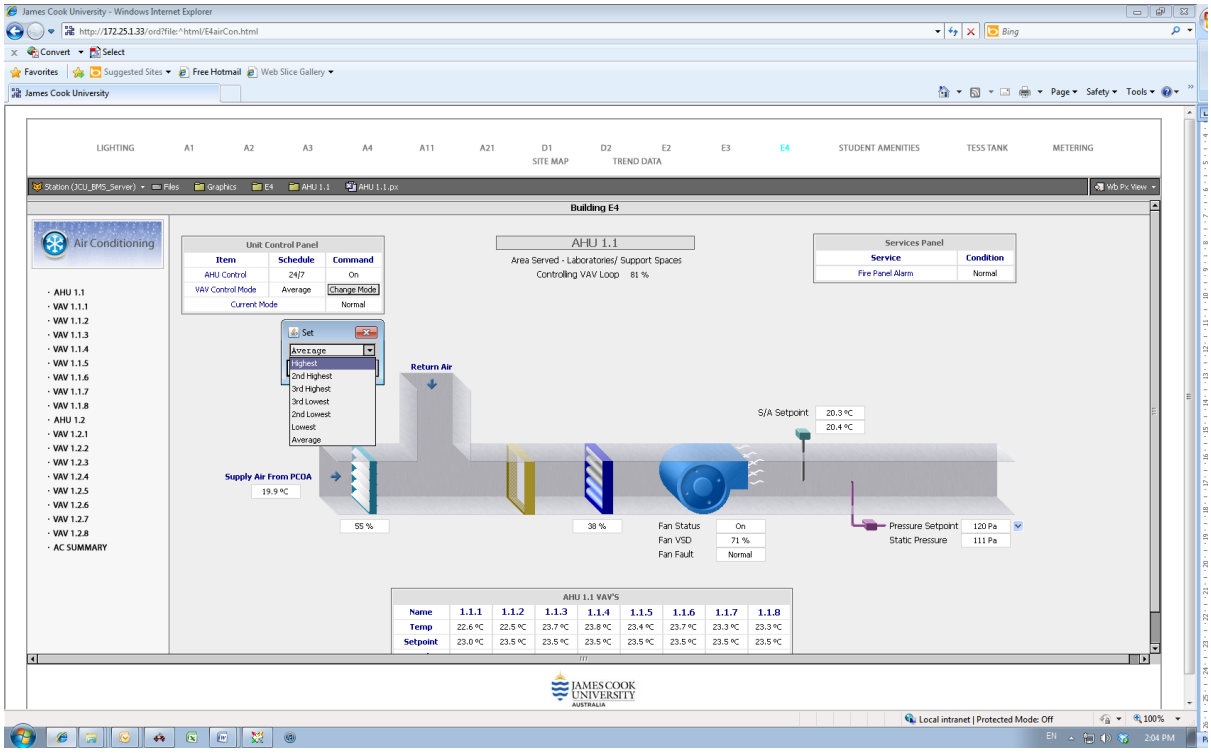

Cairns Graphic 2



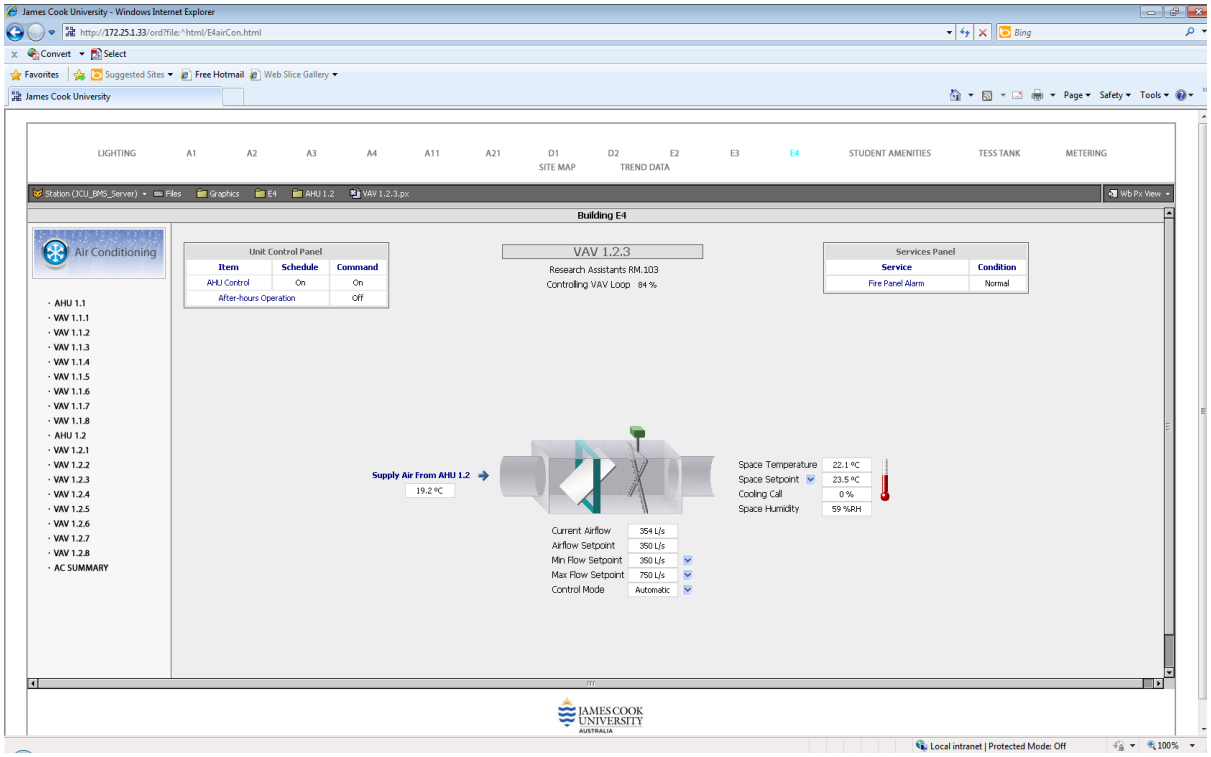

Cairns Graphic 3




Cairns Graphic 4




Cairns Graphic 5

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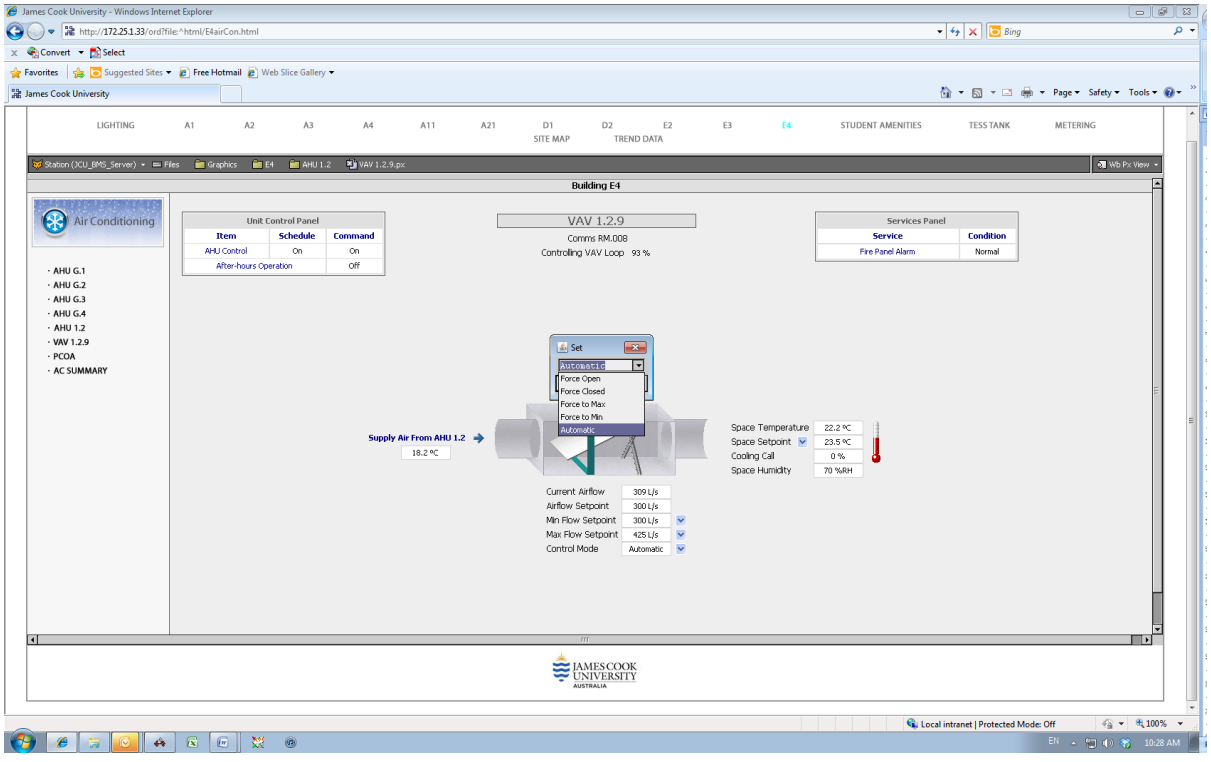
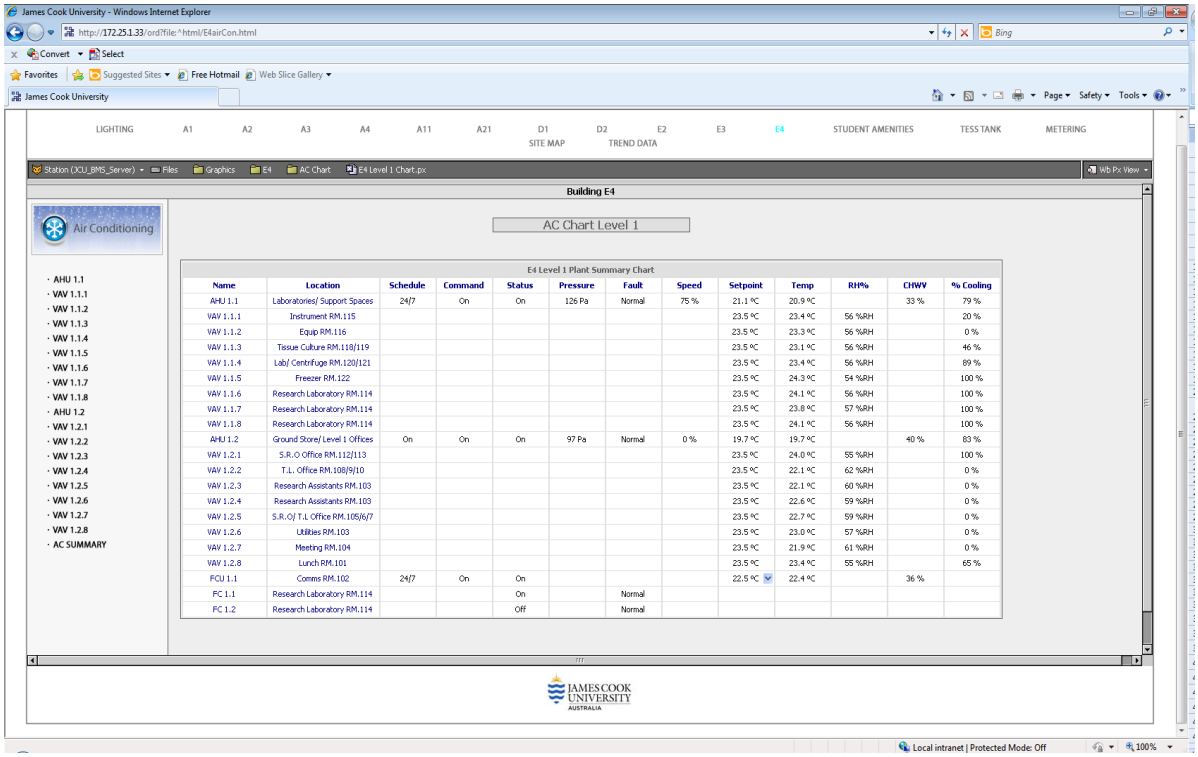
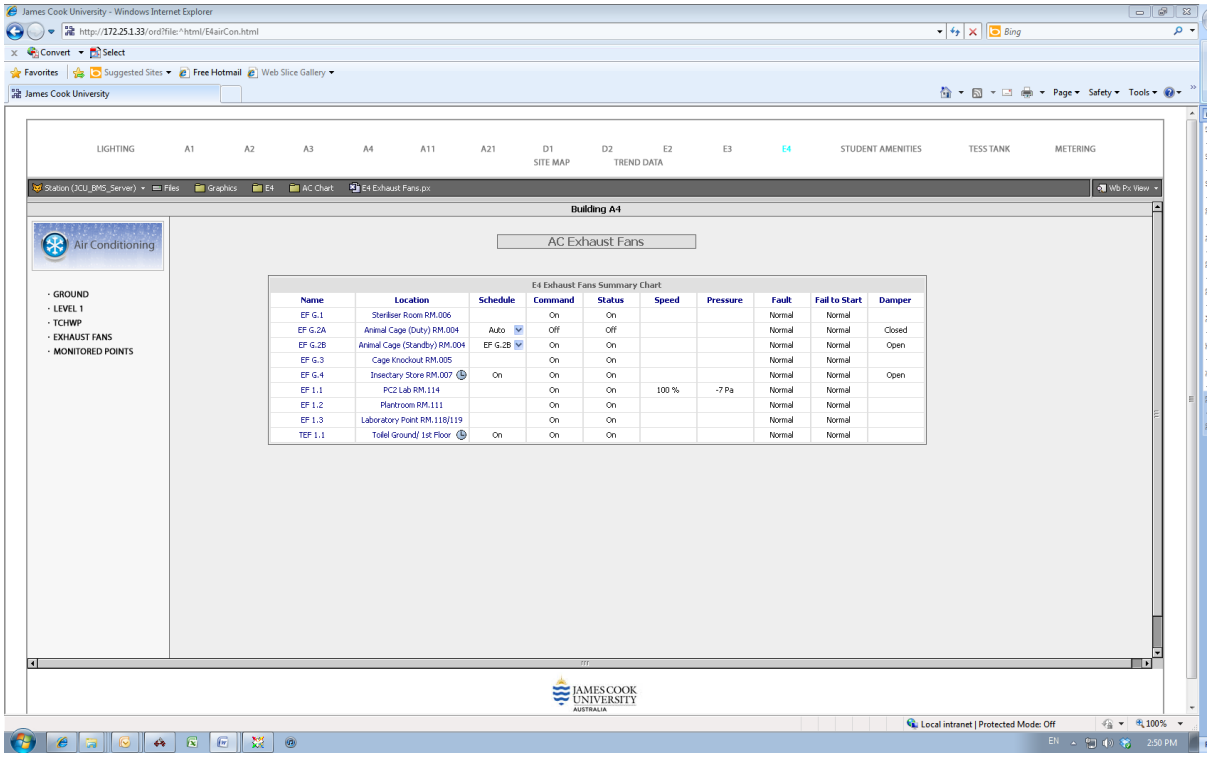


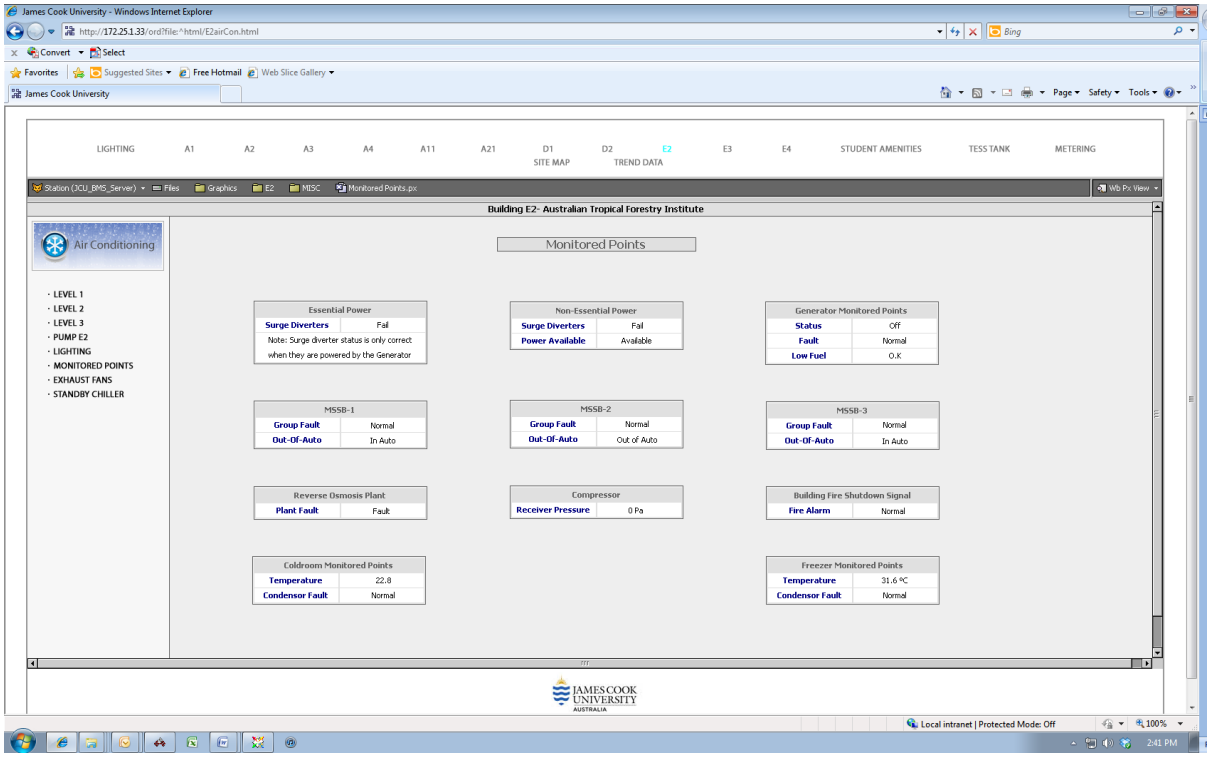

Cairns Graphic 7



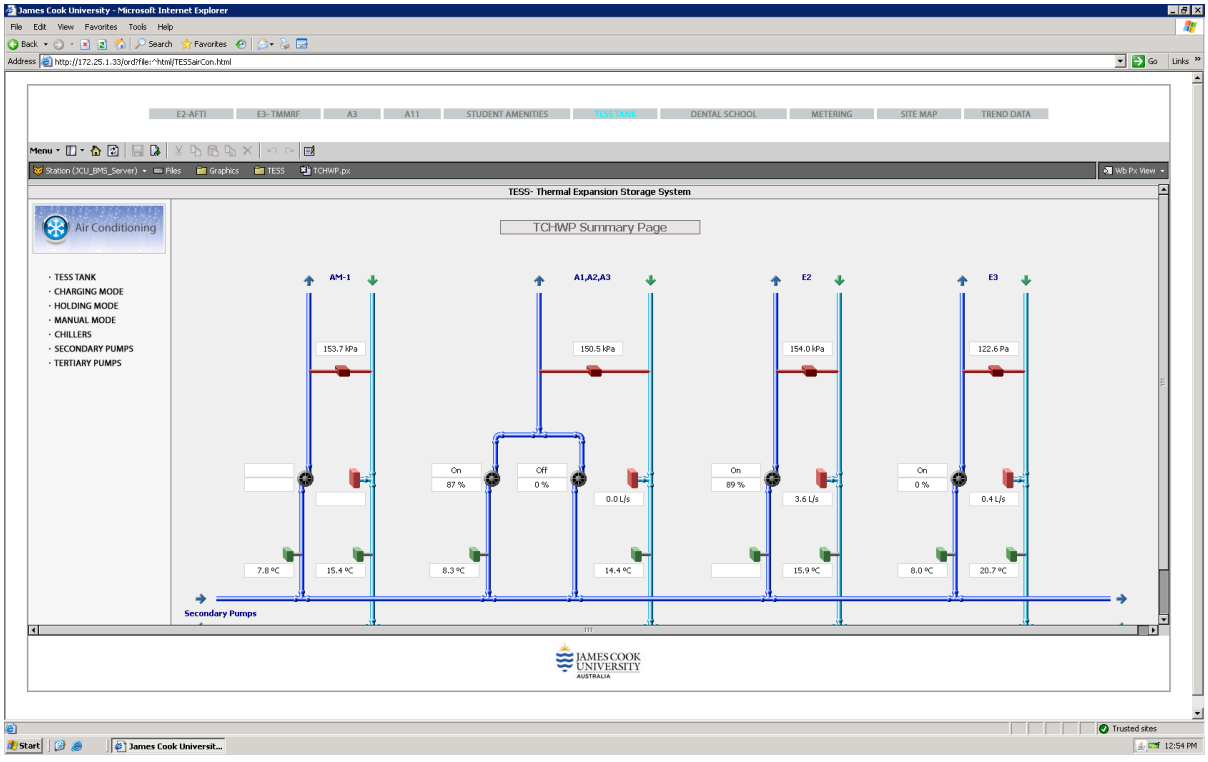

Cairns Graphic 8




Cairns Graphic 9




Cairns Graphic 10




Cairns Graphic 11

## 23.5.5 Typical Control methodologies

### 23.5.5.1 Outside Air Pre-Conditioning Units

**Fan Start**

Pre-conditioner will run when any connected AHU is commanded to start. Once started, the pre-conditioner will run until all connected AHUs have stopped.

**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 $T_d$ from the formula:

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

Where: $T_d$ : 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 $T_d$ SP of 13°C.

The supply air temperature set point for the PCU is derived using a low signal select from its associated AHUs chilled water valve positions to maintain a minimum chilled water valve position of 10%. As the lowest valve position deviates from 10% to 100%, the supply air temperature set point will be reset from 12.0°C to 24.0°C.

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.

**Static Pressure Control**
The variable speed drive on the supply fan is controlled by a pressure transducer located in the supply air duct. The fan VSD is controlled via proportional plus integral control loop with a user adjustable set point of initially 5 Pa via the pre-conditioner graphic.

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

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

### 23.5.5.2 Constant Volume AHUs

**Fan Start**

- Each unit is to be time scheduled, adjustable from the AHU graphics page, initially set to 0730-1800hrs (global site timeclock schedule to be used).
- On receipt of fan status, via a duct mounted air-pressure switch, control is enabled. On loss of status, all controls are disabled.
- Afterhours air conditioning is to be activated by 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.

**Temperature Control**

- A wall mounted temperature sensor reads room temperature with the BMS calculating the supply air temperature.

- 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 or average space temperature. These control modes are to be selectable from the AHU graphics page.
- For AHUs connected to pre-conditioners, an unoccupied temperature set back of 25°c is to be used.

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

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

#### 23.5.5.3 Variable Air Volume AHUs

**Fan Start**

- Each unit is time scheduled, adjustable via the AHU graphic, initially set to 0730-1800hrs (global site timeclock schedule to be used).
- On receipt of fan status (via a duct mounted air-pressure switch) control is enabled. On loss of fan status all controls are disabled.
- When the supply air fan is called for, by either the schedule or after hours button, the variable speed drive is given a start signal and initially ramp to its programmed minimum output frequency. On receipt of a fan status, control is enabled. If fan status is lost all controls are disabled.
- 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.
- If one zone is called for after-hours use, only that zone shall operate in normal mode. The remaining boxes shall remain at their minimum air quantity and not have authority over the high select routine.

**Temperature Control**

- The AHU chilled water valve is controlled by a supply air temperature sensor via proportional plus integral control. This set-point is calculated using an algorithm to maintain space conditions depending on the VAV mode selected on the graphics. The modes available are:
  - Highest- Select;- the highest cooling call of the VAV's served from this AHU
  - Average- Select;- the average cooling call of the VAV's served from this AHU excluding any VAV's with a cooling call of zero.
    If the maximum cooling demand is 0%, the supply air set-point is 21°C. If the maximum cooling demand is 100%, the supply air set-point is 12°C.

- Each VAV modulates through proportional control to maintain a user adjustable set-point via the VAV graphic by calculating a required airflow measured, in litres per second, to obtain the required space conditions. This flow set-point is calculated within the limits set for each particular VAV box minimum and maximum flows and is adjustable via the VAV graphic.
- For AHUs connected to pre-conditioners, an unoccupied temperature set back of 25°c is to be used.

**Static Pressure Control**

The VSD output is modulated via proportional plus integral control algorithm based on the input of a duct-mounted pressure transducer to maintain a predetermined static duct pressure set-point. The duct pressure set point is user adjustable via the AHU graphic.

**VAV Control**

- VAVs are to modulates through proportional control to maintain a user adjustable set-point via the VAV graphic by calculating a required airflow measured in litres per second to obtain the required space conditions.
- The airflow set-point is calculated within the limits set for each particular VAV box minimum and maximum flows and is adjustable via the VAV graphic.
- VAVs are to be controllable via their graphics page for;-
    - automatic
    - minimum airflow
    - maximum airflow
    - force open
    - force closed

**Plant monitoring:**

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

- zone temperatures
- zone VAV air quantity
- return air temperature
- supply air pressure
- CO2 level, if used
- outside air VAV quantity
- AHU fault
- fan status
- fire alarm
- supply air temperature
- CHW valve signal

23.5.5.4 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.
- Duty and standby pump sequencing is to be user selectable via the TCHW pump graphic.
- The variable speed drive of the duty pump is controlled by a differential pressure transducer located in the AHU plantroom. The VSD is controlled via proportional plus integral control with a user adjustable set point on the pump graphic.

- Hours run of the pump are logged and displayed on the graphics.
- If a chilled water bypass valve in used, it is to open when the system differential pressure is such that the TCHW pump is at its minimum speed but the pressure is still greater than set-point, and is to reduce pump head.

#### 23.5.5.5 $CO_2$ Control

A duct mounted CO2 sensor is located in the AHU return air duct. If the CO2 level rises above set-point, initially 800ppm, the outside air quantity is modulated from minimum outside air quantity to maximum air quantity when the CO2 level is 200ppm above set-point.

## 23.6 BMS TOWNSVILLE CAMPUS

### 23.6.1 General

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

### 23.6.2 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.

All active graphics shall be prepared for display at 1680x1050 resolution, page size 15x8.

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 located on the template graphic "template.swc"

- 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. (Font: "Arial Black", Regular, Maroon, size 4). Use 3 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)
  - All inactive names should be maroon in colour as per JCU specs
  - Place names above objects where possible (e.g. VAV above temps) and keep centred.
  - Mark location of VAVs on duct
  - Temperature symbols: wall mount Blue fill, ceiling mount Orange fill
  - Supply a link to VAV page in bottom banner
  - AHU legend not necessary, name at beginning of duct run only
  - 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: chain(400))
- All alarm points to flash in alarm
- All alarm points displayed in graphic to be set to critical priority (5).
- Point Short Text (Sigma) to follow JCU BMS standard (below).
- Graphics Sensor symbol ID command lines to include primary short text (Sigma)

### 23.6.3 **Colour Codes**

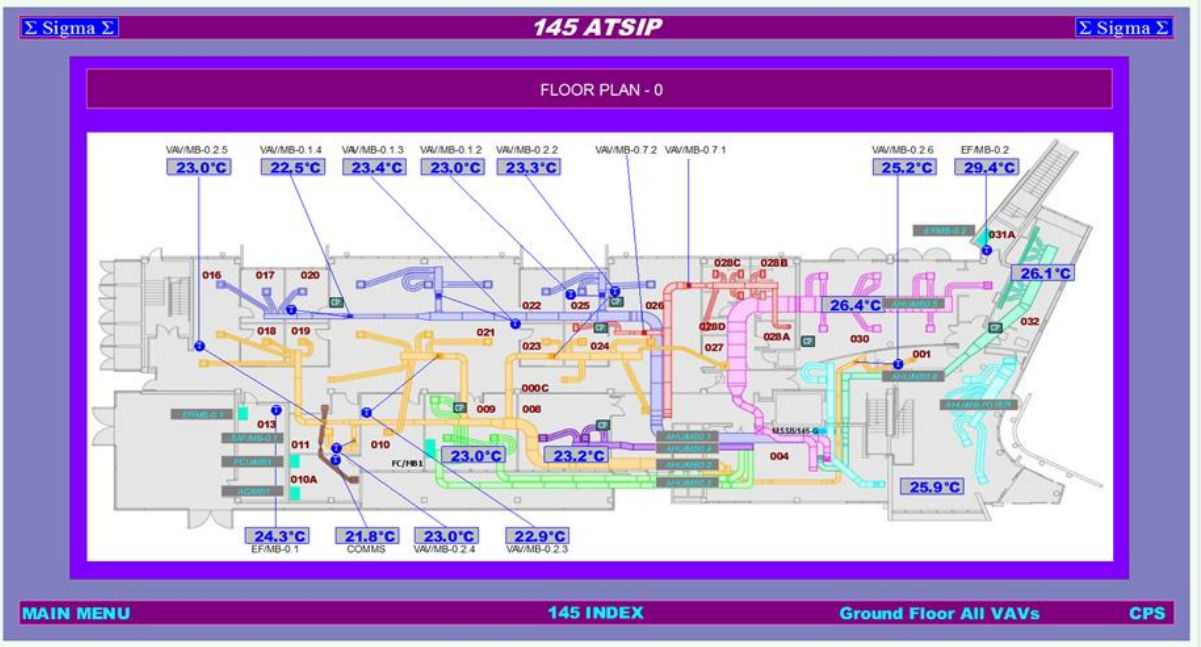
| | |
|---|---|
| Mauve: Page background Paper colour | Blue: Temperatures |
| Aqua: Link | Yellow: Position/Value |
| Red: Heat | Lime: Pressure, $CO_2$ and Flow |
| White: Status | Maroon: Names |
| Purple: Humidity | Black: Setpoint |

### 23.6.4 Default Primary Short Texts

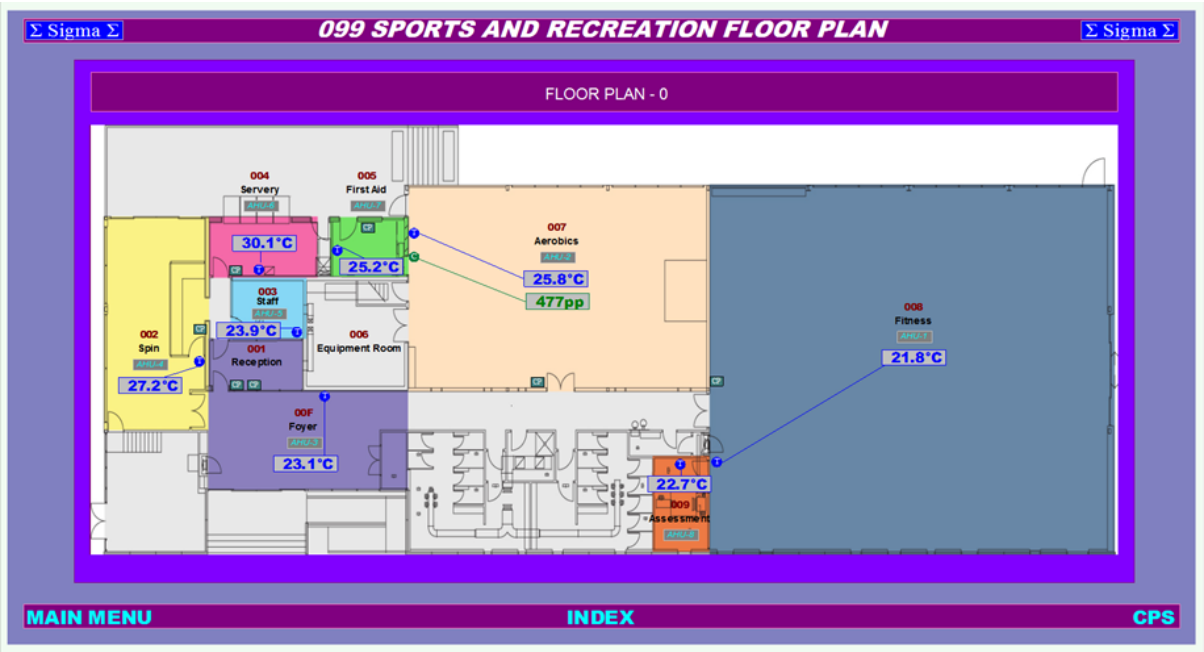
| | |
|---|---|
| 1: | “Off” |
| 2: | “On” |
| 3: | “Stop” |
| 4: | “Start” |
| 5: | “Failed” |
| 6: | “Normal” |
| 7: | “Open” |
| 8: | “Closed” |
| 18: | <Fire>” |
| 22: | “Running” |

| | |
|---|---|
| 92: | “%” |
| 101: | Temperature “°C” |
| 104: | Relative Humidity “%” |
| 110: | Pressure “kPa” |
| 122: | “kW” |
| 152: | “kWr” |
| 208: | “<Fault>” |
| 209: | Pressure “Pa” |
| 321 | “Stopped” |

### 23.6.5 Active Graphic Examples




Townsville Graphic 1 Floor Plan with VAV




Townsville Graphic 2 Floor Plan without VAV

### 23.6.6 Typical Control methodologies

#### 23.6.6.1 Outside Air Pre-Conditioning Units

**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 $T_d$ from the formula:

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

Where: $T_d$ : 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 $T_d$ SP of 13°C.

The supply air temperature set point for the PCU is derived using a low signal select from its associated AHUs chilled water valve positions to maintain a minimum chilled water valve position of 10%. As the lowest valve position deviates from 10% to 100%, the supply air temperature set point will be reset from 12.0°C to 24.0°C.

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.

23.6.6.2 Constant Volume AHU Serving Offices Space

**Unit start/stop**
The supply fan has been configured to run whenever the associated Time Schedule or After Hours Mode is on. All schedules have been initially set to start at 07:00 and stop at 17:30 daily from Monday to Friday. Time Schedules must be referenced to global demand management time schedules as required.

Activation of a local push button outside of the normal operating hours as determined by an applicable Time Schedule will initiate the After Hours Mode. An after-hours run time set point has been initially set to 1 hour.

Plants should have optimum start as per the site demand management plan.

**Fan Speed Control**
Fan runs on constant speed.

**Temperature Control**
The BMS will use proportional control only to modulate the chilled water valve to maintain temperature set point of 23 °C.

23.6.6.3 Constant Volume AHU Serving Lecture Theatre/Meeting Room

**Unit start/stop**
The supply fan has been configured to run whenever the associated Time Schedule or After Hours Mode is on. All schedules have been initially set to start at 07:00 and stop at 17:30 daily from Monday to Friday. Time Schedules must be referenced to global demand management time schedules as required.

Activation of a local push button outside of the normal operating hours as determined by an applicable Time Schedule will initiate the After Hours Mode. An after-hours run time set point has been initially set to 1 hour.

Plants should have optimum start as per the site demand management plan.

**Fan Speed Control**
Fan runs on constant speed.

**Temperature Control**
Setback mode:
Providing no local push button call is active, when the Time Schedule is on the air handling unit will be activated in Setback Mode. On activation of Setback Mode the BMS will select the unoccupied cooling set point of 27 C as the active temperature set points, the green neon light will be off.

Occupied mode:
Occupied mode is initiated by activating the push button when the unit is already running in Setback Mode (normal hours of operation). An occupancy run time set point has been provided, and initially set to 1 hour.

The BMS will select the occupied set point (OCC SP) of 23 C as the active temperature set point, the green neon light will be on.

After Hours mode:

Activation of the local push button outside of the normal operating hours will initiate the After Hours Mode. Upon activation of After Hours Mode, a run time set point has been provided, and initially set to 1 hour. The BMS will select the occupied set point of 23 C as the active temperature set point, the green neon light will be on.

23.6.6.4 Variable Volume AHU with VAVs' Serving Office Spaces

**Unit start/stop**

The supply fan has been configured to run whenever the associated Time Schedule or After Hours Mode is on. All schedules have been initially set to start at 07:00 and stop at 17:30 daily from Monday to Friday. Time Schedules must be referenced to global demand management time schedules as required.
Activation of a local push button outside of the normal operating hours as determined by an applicable Time Schedule will initiate the After Hours Mode. An afterhours run time set point has been initially set to 1 hour.
Plants should have optimum start as per the site demand management plan.

VAVs will be shut when the unit is not running.

**Fan Speed Control**

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

**Temperature Control**

Control of the chilled water valve is in response to supply air temperature.

The BMS measures the outside air temperature at building 310 (point 119|7).

- If the outside air temperature is below 19.0°C for more than 20 minutes. The supply air temperature set point for the AHU is derived using an average signal select from its associated VAV box cooling loads. As the average VAV box load deviates from 0% to 100%, the supply air temperature set point will be reset from 24.0°C to 12.0°C.
- If the outside air temperature is above 19.0°C for more than 20 minutes. The supply air temperature set point for the AHU is derived using a high signal select from its associated VAV box cooling loads. As the highest VAV box load deviates from 0% to 100%, the supply air temperature set point will be reset from 24.0°C to 12.0°C.

The BMS will use proportional plus integral (PI) control over the supply air temperature.

23.6.6.5 Tertiary Chilled Water System Control

**Pump start/stop**

The BMS monitors the local *Cooling Call* from each air handling. On receipt of a cooling call from any of the air-handling units being served the program will enable the duty pump.

The duty and standby pump will be rotated on a weekly basis or if there is a fault with the duty pump. The BMS monitors a local control switch for each pump. Basically if the switch is on the pump will be available to run, and if it is off it will not be available.

**Pump speed control**
The BMS will vary the pump speed of the duty pump to maintain a constant differential pressure set point as monitored from the differential pressure transducer located across the flow and return chilled water lines in the ground floor pant room.

Differential pressure set point to be determined during commissioning.

Field pressure sensor set-point for pump control shall be reset to maintain the demand AHU control valve at 90% open up to the upper limit set-point (current set-point).

**Energy monitoring**
A Siemens Mag-Flow meter and Siemens energy calculator should be installed within the chilled water supply to each building providing flow rate to the BMS and energy consumption to the EMS respectively. The following points should be provided.

- Buildings supply temperature to the BMS.
- Buildings return temperature to the BMS.
- Buildings flow rate in to the BMS.
- Building energy consumption to the EMS

23.6.6.6 Miscellaneous

- The BMS monitors 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
- 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 –not required on the BMS, required on the EMS (please refer to the EMS specification for further details)
- High Level Interface (HLI) to VSDs – is not required on the BMS, except for building 310 where HLI to VSD is required.
- Lift control/monitoring – not 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 Electric ATV61 or Danfoss VLT