

University of Wollongong

Building Monitoring and Control Systems Design Standards
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3. BUILDING MONITORING AND CONTROL SYSTEMS

The building monitoring and control system (BMCS) shall provide monitoring and control of building and environmental services as required for the project. The BMCS systems currently in use by UOW are the Siemens Apogee Insight and the Johnson Controls Metasys. All hardware, software and field devices shall be capable of full integration into one or other of these systems.

The BMCS shall conform to the current requirements of the University of Wollongong network and communications infrastructure as provided and maintained by the UoW Information Technology Services.

3.1 OVERVIEW

This design standard outlines the functional, installation and technical requirements for a new or modified building monitoring and control system.

The designer shall use these standards as the basis for the system design, however it is incumbent upon the designer to ensure that the design satisfies site specific operational, logistical and performance requirements and meets UOW's monitoring and control objectives for the site.

The BMCS is to incorporate operational strategies that provide effective and energy efficient performance of the equipment specified to be controlled and or monitored.

Where the designer considers that alternate equipment is preferred to the equipment specified in the design standard, the designer will advise the UoW Project Manager of the functional, performance or cost benefit that will be achieved through the use of the alternate equipment type.

The system shall have a distributed architecture. Data processing and storage and message handling shall be performed at the system field processing units (FPU) and other intelligent field devices.

Each FPU shall operate independently and execute its own control algorithms, alarm management routines, and data processing routines. The system shall be modular and shall permit expansion of both capacity and functionality through the addition of FPUs onto the primary control network.

The system database shall reside within the FPUs. This database shall be populated with the hardware and virtual points and their respective attributes. The system database shall also be able to retain historical data.

All devices shall be configurable from the system operator terminals and from portable PC based field operator terminals.

At the time of practical completion, the installed BMCS firmware and software versions will be the latest available.



3.2 DESIGN PROCESS

This section overviews the design process. The process shall be followed to achieve UOW's desired outcomes.

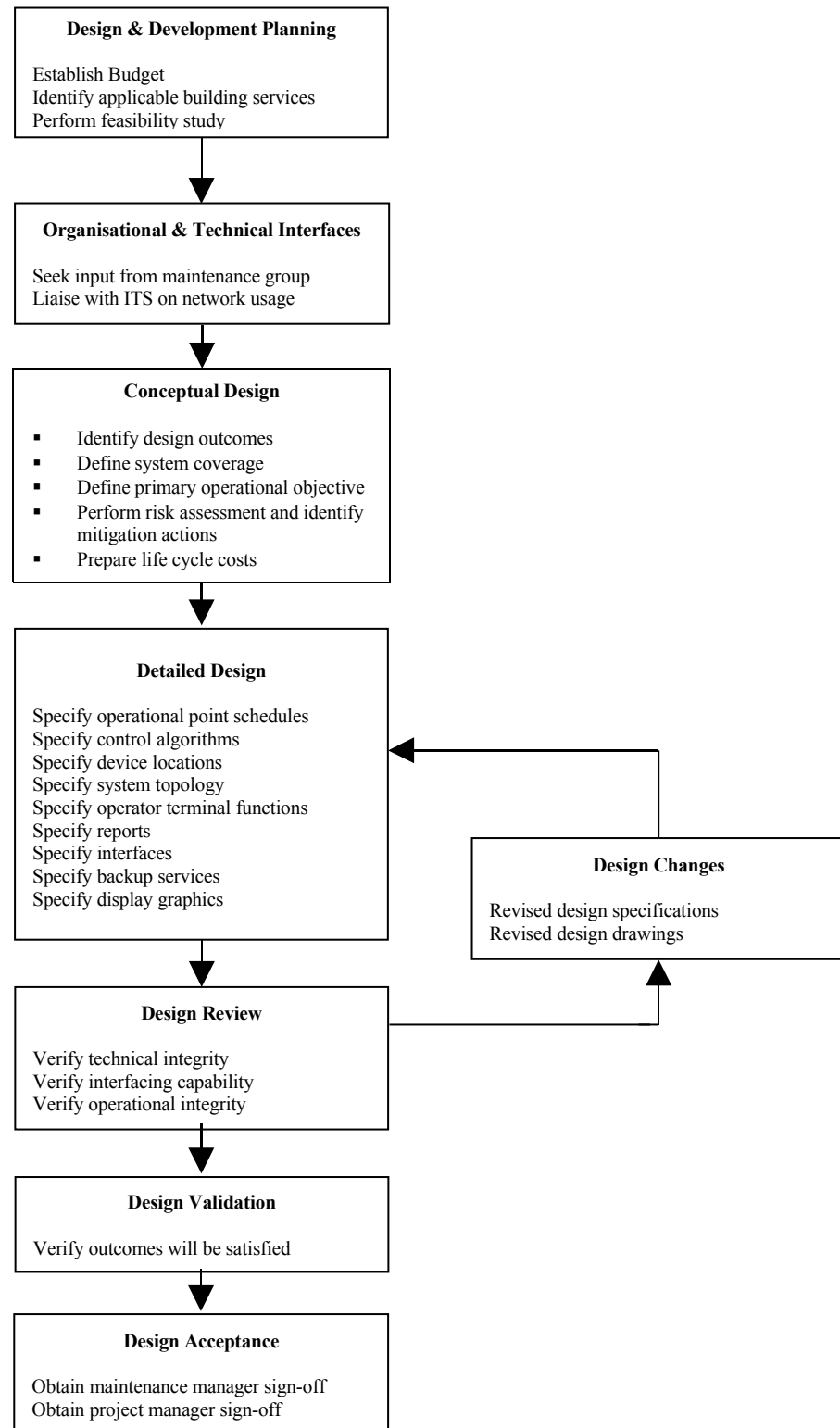


Figure 3.1 - Process Flow



3.3 FUNCTIONAL REQUIREMENTS

The BMCS shall be configured with programs to control the following systems as applicable:

3.3.1 Air Handling Systems

3.3.1.1 Air Handling Units - Plant Operation.

The starting and stopping of the air handling units shall be controlled by a program which checks time and holiday schedules, after-hours operation, optimum start, optimum stop and night purge routines to determine plant run times.

3.3.1.2 Optimum Start Routine

The optimum start/stop time algorithm shall calculate the lead time necessary to provide space conditions from the commencement up to the termination of the scheduled occupancy.

When an optimum start routine is on, conditions shall be referenced to determine if the desired space temperature has been achieved. The routine shall be turned off if occupancy time has commenced or if the desired temperature has been achieved. The optimum start routine will contain the following sub-routines:

3.3.1.2.1 Pre-Heat

The BMCS shall control the pre-heat cycle. This cycle shall not be initiated if after-hours mode is operating.

The pre-heat cycle shall be enabled if the outside air temperature is lower than the external set point programmed temperature and sensors within the zones served by the unit are below the programmed internal set point temperature by a set amount.

This operation shall be time schedule dependent and shall begin prior to scheduled occupancy times.

Once terminated or if not executed the pre-heat cycle shall be disabled for that day. The pre-heat shall not be initiated if the heating equipment is "out of service" (OOS) or in alarm.

3.3.1.2.2 Pre-Cool

The BMCS shall control a pre-cool cycle. This cycle shall not be initiated if after-hours mode is operating.



The pre-cool cycle for the conditioners shall be enabled if outside air temperature is greater than the designated setpoint. This will be time schedule dependent and shall be scheduled to begin prior to normal building occupancy.

Once terminated or if not executed the pre-cool cycle shall be disabled for that day.

3.3.1.2.3 Night Purge

The night purge routine shall provide cooling of the building with outside air during the night.

Night Purge shall not operate if the plant is working in after-hours mode and shall not operate on non-working days.

3.3.1.3 Air Handling Fans

The fans shall only start if building occupancy, pre-heat, pre-cool, night purge, heat recovery or after-hours mode is turned on.

If pre-heat or pre-cool has been operating and terminates prior to building occupancy time, the fans shall not stop (to be followed a short time later by restarting for occupancy) but shall continue to run through to the building occupancy period.

On start up, variable volume fans shall be energised at minimum air flow to prevent damage to equipment by excessive pressure.

3.3.1.4 Zone Temperature Selection

In normal operation the air handling units shall be controlled by a selectable option of either the highest or the average of the thermostats located in the respective operating zones.

All temperature sensors within the occupied zone(s) shall be available for use in the selected calculation and the options of highest or average shall be selectable by the operator.

The system will allow for any specific sensor to be excluded from highest/average calculations if its reading is faulty.

3.3.1.9 BMCS Controlled Terminal Air Volume

The mode of operation of BMCS controlled terminal air volume shall be set according to the mode of operation of the air handling unit.



If a fire alarm is active, all fans, zone dampers and terminal devices shall be set to the states and positions required by the applicable fire/smoke control strategies. Where this is accomplished by hard-wired control the BMCS shall mimic these control signals.

During occupied operation zone dampers and terminal volume devices shall vary the flow rate of conditioned air as required to best maintain space temperatures.

3.3.1.10 Air Handling Units - Temperature Control

The BMCS is to utilise outside air cycles for cooling whenever the conditions are suitable. This mode is designated as "Economy Cycle" (EC).

The BMCS will include the provision of outside air and return air temperature and humidity sensors to allow the calculation of outside air and return air enthalpies.

The EC shall be enabled if outside air temperature/enthalpy is less than the return air temperature/enthalpy and the air handling unit is operating in a cooling mode.

The EC shall be disabled if outside air temperature/enthalpy is above the programmed set point or the associated air handling unit switches to heating mode.

To avoid possible oscillation of the EC cycle, the routine shall include an adjustable timer and/or differential, to ensure that the condition is stable and not transient prior to implementation of the cycle.

Where applicable to the cooling plant type and beneficial to energy consumption or space temperature control the space temperature calculation will be used to reset the air handling unit supply air temperature setpoint.

The operation of the unit's chiller shall be enabled or disabled according to programmed values of a unit cooling call which will be derived from either chilled water valve position or DX cooling demand from the occupied space.

Mode setpoint deadbands shall be incorporated into all control strategies to ensure that the plant operation utilises the allowable tolerances specified for the controlled variable.

3.3.1.11 After-Hours Operation

After-hours operation shall be initiated manually, by local push-buttons, or programmed to occur automatically by time schedule as required by the building design brief. Where push-buttons are used, a green indicating light will be installed adjacent, to display the system operating state.



The automatic program shall permit operation of the plant and initiate control of a respective floor, level or zone depending on the specified zoning and capability of the plant.

3.3.1.12 Ventilation and Exhaust Fans

Ventilation fans shall be started and stopped by the BMCS in accordance with independent time schedules and interlocked with other systems as appropriate. Fan status should be monitored by the BMCS.

3.3.1.13 Air Filter Operation

Unless lesser or additional requirements are specified, the BMCS shall monitor a differential pressure switch configured to sense across each filter bank.

3.3.1.14 Fire Mode Operation

The BMCS shall monitor the activation or deactivation of fire mode within the areas served. This fire mode of operation shall be indicated on the operator terminals as a high priority alert.

3.3.2 Cooling Plant

The cooling plant comprises chillers, split systems, water or air cooled package units etc.

3.3.2.1 Chiller Operation

The BMCS shall monitor the following parameters as applicable:

- a. Cooling calls.
- b. Chillers, Chilled Water Pump and Condenser Water Pumps statuses.
- c. Chiller/heat pump faults/alarms.
- d. Chiller load.
- e. Chiller Chilled Water entering and leaving temperatures.
- f. Condenser water entering and leaving temperatures.
- g. System supply differential pressure
- h. Out of service (OOS) condition.
- i. Energy consumption



The BMCS or, if required by the chiller/heat pump manufacturer the chiller/heat pump shall control the following as applicable:

- a. Chiller/Heat pump enables.
- b. Pump enables.
- c. Bypass Valves
- d. Staging and Sequencing.
- e. Load limiting.
- f. Restarting after power failure
- g. Out of Service (OOS)

Provisions should be available for all equipment to be run from local manual switches should the BMCS be out of service.

3.3.2.2 Chiller Systems (Normal Operation)

Chiller systems shall be enabled and will run whenever a cooling demand signal is received from an associated air handling unit. BMCS chiller control sequences shall include for Duty/Standby, Lead/Lag and fault change-over as applicable. The BMCS should instigate an automatic system restart after interruptions such as power failure or fire trip reset.

3.3.2.3 Critical Cooling Areas

The BMCS shall utilise dedicated sensors to monitor the temperatures within areas having with a critical temperature requirement. Temperature thresholds shall be configured to generate warning and alarm notifications on the BMCS when reached.

3.3.3 Cooling Tower and Condenser Water Systems

Where the heat rejection plant comprises cooling towers and associated equipment.

The BMCS shall monitor:

- a. Condenser water pump and cooling tower fan statuses
- b. Condenser water entering and leaving temperatures.
- c. Water treatment equipment faults



- d. Level alarms-high and low for all cooling towers.

The BMCS or chiller/heat pump equipment shall control:

- a. Condenser water pump and cooling tower fan enables and speeds as applicable.
- b. Staging and sequencing of pumps.
- c. Leaving temperature control and sequencing of fans and their speeds as required.
- d. Motorised cooling tower isolating and by- pass valves.

3.3.4 Heating Systems

The heating systems comprises electric duct heaters or electric or gas boilers.

The BMCS shall monitor the following:

- a. Temperature of all duct heated zones.
- b. Entering and leaving water temperatures.
- c. Equipment statuses.
- d. Equipment faults.

The BMCS shall control the heater enables. Incorporating duty/standby, lead/lag and fault change-over as applicable.

3.3.5 Lighting System

Where specified, the BMCS shall control lighting systems comprising external, security and selected internal and external lighting. The control will be by time schedule, PE cell, PIR detection and/or after hours switch as required.

The BMCS shall monitor:

- a. After-hours lighting switches.
- b. Occupancy detectors.
- c. Photo-electric cells.



The BMCS shall control lighting contactors (via auto-off manual switches), generally provided within the lighting distribution boards.

3.3.6 Stormwater, Rainwater, Recycled Water and Sewerage Pumps Sets:

The BMCS shall monitor the following:

- a. High level alarms
- b. Pump fault.

3.3.7 Fire Indicator Panel Monitoring

The BMCS shall monitor the following:

- a. Fire alarms
- b. System faults

Where the mechanical-electrical configuration allows, the BMCS should be configured for an operator ability to reset the mechanical panel fire trips.

3.3.8 Lift Monitoring

The BMCS shall monitor the following:

- a. Lift faults
- b. Emergency Stop/Fire Service

3.3.9 Standard Systems Interfacing

Where the BMCS interconnects to other building services such as fire services, electronic monitoring and access control systems or automatic lighting systems, an interface shall be provided that achieves specified functionality, performance and reliability.

Low level interfaces shall comprise of a set of voltage free electrical contacts controlled by the service providing the necessary signal.

High level interfaces shall be provided using a standard protocol and an established software product that is fully compatible with the BMCS and the service to be interfaced.



System to be Interfaced	Interface Type	Interface Responsibility
Fire	Low level	Fire Or Mechanical Contractor
Lift	Low level/high level	Lift Contractor
Lighting	Low level Control	BMCS Contractor
Electronic Monitoring and Access Control	Low level/high level	EMAC Contractor

Table 3.1 - System Interfaces

3.3.10 Other Systems Interfacing

Where required by the client brief, the BMCS shall monitor and or control other incorporated services. Typical services in this category are:

- a. Laboratory gasses.
- b. Fume cupboards.
- c. Rainwater systems
- d. Irrigation systems
- e. Grey water systems.
- f. Domestic hot and cold water systems.
- g. Laboratory cooling water systems.
- h. Non-Potable Water Systems.
- i. Specialist laboratory equipment.
- j. Cool rooms and freezers.
- k. Generators.

3.3.11 Alarm notifications.

Where required by the client brief, the BMCS shall monitor system and point alarms, designated by the client as critical. The BMCS shall pass a notification of activated critical alarms to the Information Technology Services messaging service for broadcast to nominated email addresses or, by SMS, to nominated phone services.



3.4 STANDARDS

The BMCS design, configuration and operation shall comply with the latest versions of all relevant codes and standards in force at the time of tender. Where the designer considers a standard to be inappropriate to the circumstances, the designer shall advise the University of Wollongong project manager and seek direction.



3.5 MINIMUM PERFORMANCE STANDARDS

The following minimum performance standards shall be achieved to ensure efficient operation of the building monitoring and control system:

Functions	Worst Case Response (seconds)
Operator initiated point status change	5
Environmental initiated point status change	5
GUI update to point status change	6
GUI update to an alarm condition	6
Display graphic and associated point information	5
Database upload (mass storage to FPU)	100
Database download (FPU to mass storage)	100

Table 3.3 - Minimum Performance Standards



3.6 INSTALLATION GUIDELINES

3.6.1 System Topology

The system shall comprise a network of field processing units (FPUs) to which all field monitoring and control devices shall be connected. Operators' terminal(s) where specified shall be connected via the primary campus network.

3.6.2 Electrical Cabling

Electrical cabling shall be sized to meet the maximum demand of the proposed equipment and the potential additional equipment likely to be connected to the final sub-circuit.

Electrical cabling shall be installed such that stress does not occur to any part of the cable or to the connected equipment. Cables shall be securely supported and protected from mechanical damage.

All cabling installed between equipment or devices shall consist of one continuous length of cable. Cabling shall be concealed wherever possible in ceiling spaces, wall cavities, risers and the like.

Prior to the connection of equipment, cabling shall be tested for continuity, polarity and disturbance.

3.6.3 Communication Cabling

The type and size of communication cabling shall be selected to achieve optimum system performance. Where a different type of cabling for the primary control bus and secondary control bus produces optimum performance, the different cable types will only be used where compatibility is assured and manufacturer recommendations are satisfied.

Communication cabling shall be installed such that stress does not occur to any part of the cable or to the connected equipment. Cables shall be securely supported and protected from mechanical damage.

All cabling installed between equipment or devices shall consist of one continuous length of cable. Cabling shall be concealed wherever possible in ceiling spaces, wall cavities, risers and of the like.



3.6.4 Field Devices

Field devices shall be provided with mounting brackets, protective covers, connections, leads and all other items necessary for proper operation. They shall each have a range, accuracy and speed of response suitable for the application and shall be suitable for the environment in which they are installed. Field devices shall be mechanically secured to protect against operational damage and ensure stability for continuous use.

Electrical terminations shall be permanent and insulated to protect against faults. Communication cable terminations shall be permanent and protected from interference.

Where possible, field devices shall be recessed and all external devices shall be weather resistant.

3.6.4.1 Temperature Sensors

Sensors shall be thermally insulated from the surfaces on which they are mounted so that they sense the true fluid temperature.

Room sensors shall be mounted on an insulated plate in the inside face of perimeter columns or walls not exposed to sunlight. Outdoor air temperature sensors are to be of robust build suitable for outdoor conditions.

Duct sensors shall be of a type and position such that their readings accurately reflect the mixed temperature of the air within the duct.. Where they measure cooling/heating coil temperatures, they shall cover each coil module and effectively average the temperature across its cross sectional area. All duct temperature sensors are to be supported properly so no part of the sensing element touches the duct/plenum wall. The element external housing shall be located clear of all insulation.

Immersion sensors shall be easily removable and shall be mounted so that condensation does not run into the sensor head.

3.6.4.2 Humidity Sensors

Humidity sensors shall be low maintenance and immune to moisture saturation.

3.6.4.3 Pressure Sensors

All duct installed pressure sensors shall be accessible. Differential pressure sensors for chiller bypass control shall be industrial grade instruments.



Sensors shall be protected against over pressure to a minimum of three times the rated input.

Pressure sensors shall be capable of handling the maximum expected system pressure and with span covering the pressure range to be measured.

3.6.5 Field Processing Units

The FPU shall be installed in designated service areas where adequate access and ventilation is available. The location shall maintain separation from other building services such as electrical and fire systems.

The FPU cabinets shall be mechanically secured and cable entries shall be insulated to protect against cable damage.

Electrical terminations shall be permanent and insulated to protect against faults. Communication cable terminations shall be permanent and protected from interference.

3.6.6 Operator Terminal

The operator terminal CPU, LCD screen and other peripheral devices shall be provided as free issue by the University of Wollongong. The BMCS supplier shall nominate any necessary specifications for this equipment and shall load and configure all of the required applications.

3.6.7 Software Development

The application software comprises the graphical user interface (GUI) which will contain programming and configuration, security, alarming, trending, reporting and command modules. The application software shall be installed on an appropriate server/workstation which is to be housed and maintained by the University of Wollongong IT services department. Operational access to the BMCS application is to be available to nominated client workstations via the UoW intranet.

Floor plans showing sensor locations and readings shall be provided, along with detailed system schematics. The Contractor shall generate the following system graphics screens (as applicable) as a minimum:

- Chilled Water Systems.
- Heating Water Systems.
- Refrigeration Systems.
- Condenser Water Systems.
- Heating Water Systems



- Air Handling Systems
- Other Controlled or Monitored Building service systems
- Navigation pages as required for efficient movement between system displays.

All graphics screens shall be interactive and display a comprehensive view of the current operation of the system depicted. The operator must be able to modify set points, valve positions and the like from the screen. Any point whose value has been manually altered must be enunciated on the screen as being in manual mode. Pseudo points may be displayed on the screen, but it must be clearly obvious to the operator that the points do not affect the position or condition of the actual field point.

The Contractor shall liaise with the Engineer prior to generating the graphics screens. Where possible, the operator, responsible for the system, shall also be involved in the generation of the graphics screens. Graphic screens should follow the look and format of existing screens on the University of Wollongong BMCS systems.

Allowance shall be made for the generation of ten additional graphics screens during the warranty period.

The Contractor shall make allowance to train the operator in the generation of graphics screens.

Monitoring and control shall be available to the operator from both graphical and text screens. Each digital input, digital output, analogue input and analogue output shall be accessible and logical groups shall be established for ease of monitoring and programming functions.

3.6.8 Program of Works:

Provide a time schedule for the implementation of the works and resources for approvals as the initial development stage of the control system.

Incorporate as part of the program, dates for:

- Submission of points schedule for approval.
- Submission of descriptive software logic for approval.
- Testing of software programs before installation on site.
- Development of graphics list and associated system graphics for approval, submitted in coloured hard copy.
- Submission of commissioning records indicating:
 - Point integrity into system checked.
 - Point calibration checked.
 - Damper and valve actuator checked for correct operation.
 - Set points and time delays noted and checked.



- Power supply failure and protection checked.
- Verification of final system operation to specification requirements by checking and testing of I/O points and testing of software logic and its reaction as specified under clause Controls Systems – Commissioning, Training and Maintenance.
- Submission of request by the controls system supplier for practical completion of the system.

3.6.9 Labelling

FPU's and other major system components shall be clearly labelled using black lettering on white background self adhesive permanent engraved labels, attached to a suitable fixed part of the equipment.

Equipment labels shall identify the equipment in accordance with UOW's asset register convention.



3.7 EQUIPMENT

All BMCS equipment shall be of a quality and accuracy suitable for the satisfactory monitoring and/or control of the designated systems. The designer shall ensure that all components are supplied with a minimum warranty of twelve months from practical completion. Technical data and/or samples of all equipment shall be provided for approval prior to purchase.



3.8 WARRANTY

The designer shall ensure that all components are supplied with the following minimum warranty periods:

System/Equipment	Warranty Period
Field Devices	12 Months
Field Processing Units	12 Months
Operator Terminal	12 Months
Application Software	12 Months
Cabling & Communications Equipment	12 Months

Table 3.8 - Warranty Periods



3.9 LIFE CYCLE COSTING

The designer shall prepare life cycle costing as part of the conceptual system design. A ten-year period of financial interest shall be used as the basis of the life cycle analysis. In the case of a building monitoring and control system these costs will include:

- a. Initial cost of system equipment
- b. Installation costs
- c. Maintenance costs
- d. Software support and regular upgrades
- e. Licenses and statutory costs
- f. Cost of third party support for interfaces