Bendigo Health Care Group
Bendigo Hospital Campus

Building Control Systems Optimisation

Quick Fact File

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Project/Design Engineer - Wally Evans

Cost - $50,000

Topics

- Facility description
- Existing controls technology
- Changes implemented
- Reason for and description of changes
- Savings potential
- Life cycle costs
- Implementation and post implementation experience

Facility Description

The Bendigo Health Care Group has two main sites utilising a vast variety of air conditioning equipment comprising:

- In excess of 50 Air Handler Units (AHU's), many Fan Coil Units (FCU's) and various packaged systems. Systems vary from reheat systems to dual coil zones,
- Systems contrast from very old (30+ yrs) to new installations,
- Mixture of air cooled and water cooled refrigeration units.

Bendigo has fairly hot summers with temperatures often in excess of 40°C and many frosty starts with temperatures often less than -3°C.

In general the major plant (fans, valves, ductwork, etc.) is of high quality manufacture and in good repair. The Building Automation System (BAS) has installation deficiencies, the biggest being one main communications link servicing all control computers on each site.

This case study is an excellent example of the optimisation of a typical BAS installation. This health facility is not unique in the problems presented. Taking a system wide approach has allowed efficiencies to be created that are not possible with systems that have developed in an ad-hoc manner typical of most hospitals.

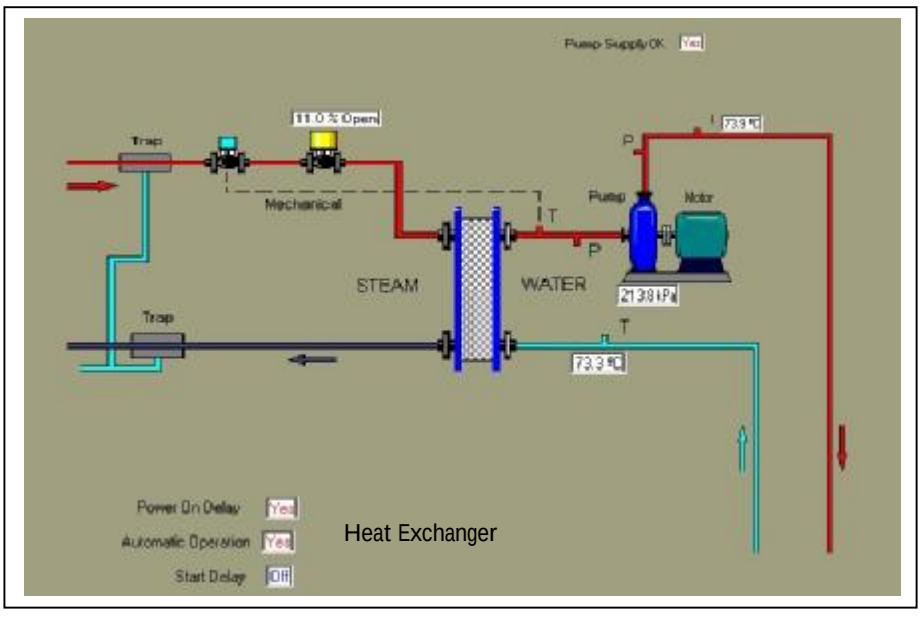
Existing Technology

Existing control systems range from stand alone single unit mechanical controllers to centralised electronic control (Sphere Systems Facility BAS equipment). About 40% of air conditioning and less of major plant was connected to the BAS. Some plant operated correctly and efficiently, but the major equipment such as chillers were not performing efficiently or reliably.

The BAS system uses an RS485 electrical protocol. The communications medium is shared between BAS controllers and automatic door controllers using another Sphere product.

The messaging protocol has recently been changed to User Datagram Protocol (UDP). Each site was a complete standalone system each with its own computer, communication controller, ring main and set of programs and display drawings.

A major hurdle of the project was an almost total of lack documentation related to the installed control systems.



Heat Exchanger

Reason for changes

Changes to the control systems are being made as a result of the poor performance of the air conditioning and plant control systems. A great deal of the plant was not connected to the BAS system resulting in a lack of plant monitoring and central control. The result was plant not operating correctly, efficiently or to a global operating strategy. In one of the operating theatre suites five of the 15 valve motors were not operational.

Unreliable communications between nodes of the control system (processors and central controller) meant that at the start of the project the system would not run for more than 10 minutes without rebooting. Control signal levels were typically less than half of the minimum voltage required by the relevant RS485 standard. Failure of one component would bring the whole communication system down.

A number of control loops had never worked and control was by reaction to phone calls from the tenants, resulting in manually opening the chilled water valve a bit more. BHCG needed to take ownership of the system to enable a global strategic approach and to ensure that there was a development of expertise within the in-house trade group. BHCG Engineering trade staff had little computer or electronic expertise and many of the faults were directly traced to poor electronic management and knowledge.

Control algorithms problems have resulted from poor consultant advice, inappropriate system installation, lack of commissioning, poor in-house knowledge of the system and ineffective testing. There are many examples of these but two typical cases were: (i) demand for heating from one building resulted in a call to start the chiller in the next building, (ii) cooling in one operating theatre was controlled from the thermostats in the recovery area and vice versa!

Unreliable and dysfunctional alarm system.

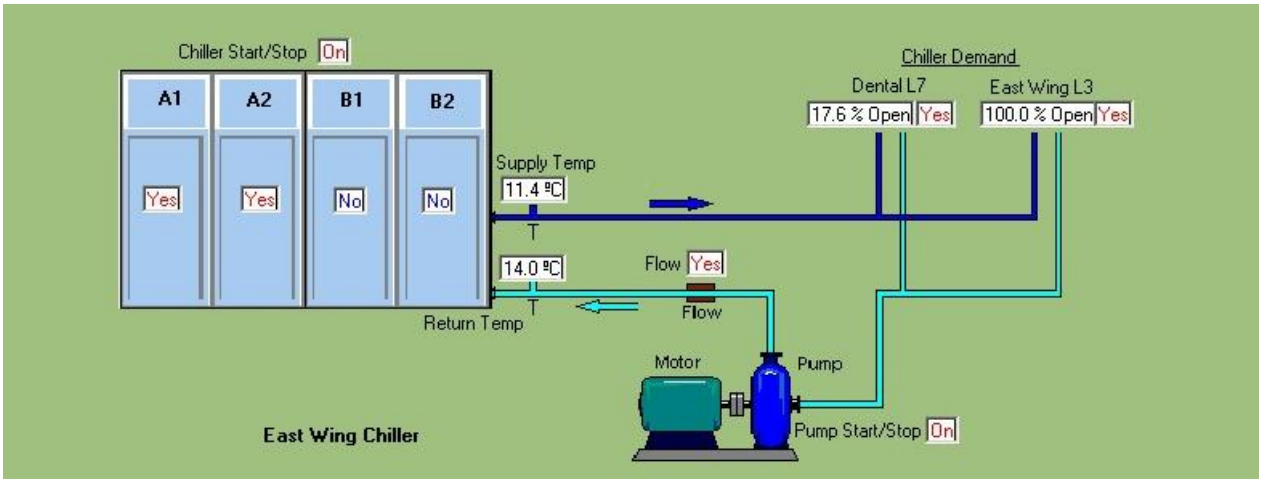
Most development of the BAS has been piecemeal with each item of plant considered as a separate entity without reference to the complete picture. The “I’ve finished the new building – where do I connect these two wires to make it work” syndrome prevailed.

Each control system had a different layout, different method of connection, different drawing and different terminology – all without operator and maintenance documentation and personnel training.

Changes Under Implementation

The major changes to the system can generally be described as:

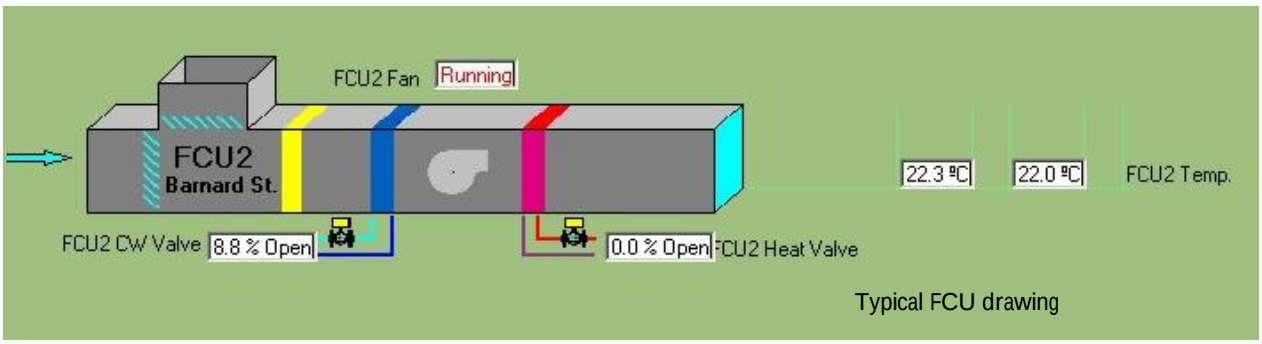
- Use of a global approach to the operation of the systems with consideration of interactions between various parts, that is, design of the system as a whole.
- Aiming for centralised control so that monitoring and changes of all BHCG plant on all sites can be made from the one location.
- Redesign of controller centralised communication system to improve reliability, improve scope of information and increase the control capacity.
- Proper commissioning and testing of control plant.
- Development of a program of regular maintenance testing.
- Redesign of control algorithms to make systems more reliable, user friendly, patient friendly and efficient.
- Standardisation and simplification of control algorithms.
- Reduction in the operating hours of high energy consumption equipment.
- Development of a set of standardised alarms which improve patient comfort and reduce the likelihood of calling in the wrong trade to repair a fault.
- Documentation of information relating to control strategies, implementations and interconnections used on BHCG plant.
- Development of a handbook for each major piece of equipment.
- Development of a set of standard control strategies and control drawings to ensure that future contractors install controls that meet BHCG requirements



Description of Changes

Changes in general can be summarised as:

- Installation of a proper ring main communications system with controllers attached radially to the ring main in groups of three to six. A complete communications failure now puts about 10% of the controllers out of communication.
- Updated about 70% of the controllers to the current technology.
- Designed controller implementation so that all signals needed originate and terminate at the same controller.
- Considered each control situation, ascertain how the equipment is meant to work and design and implement simple, prudent control algorithms.
- Developed a set of standard signalling conditions to manage signalling between controllers such as when a controller needs a chiller turned on.
- Commissioned each system by testing each transducer to ascertain correct operation. Developed standard procedures and documentation.
- Develop software to search the BAS database and document existing control strategy.
- Develop standards to manage future contractor installations to ensure that BHCG strategies are continued and under the control of BHCG.
- Implementation of a meaningful, accurate and reliable alarm system which can discriminate appropriate failures such as AHU belt failure.
- Document each control strategy.
- All of the changes have been carried out by our own in-house trained staff.
- Train staff to continue these strategies.



Typical FCU drawing

Implementation and post implementation experience

In the areas that have been improved (about 50%) the following results have been noted:

- Temperatures controlled to within 0.5 ^{o}C on most systems.
- Electricity costs reduced. Will look into quantifying this.
- Communications systems reliable and well above specified minimum signal levels
- Air flow improved.
- Typical air conditioning related calls significantly reduced, eg. In medical and surgical wards from several per day to one or two per year.
- Engineering staff working on this project are very keen and pleased with the result.
- Contractors generally receive the standardisation in a positive way.
- We now have excellent expertise and ownership of our air conditioning systems.
- We still have much to do.
- The bonus is that the systems now operate efficiently, consequently patients and staff have a greatly improved environment.

Economic Evaluation

An initial investment of $50,000 was made on hardware, mainly new controllers and wiring. It is estimated that $20,000-$30,000 in electricity was saved in first few months when incorrect cooling and heating calls were rectified. These savings do not include plant maintenance costs which will be reduced due to lower plant running hours or labour as all work was conducted by in-house staff.

Recurrent savings in the order of $50,000- $60,000 per annum are being realised, giving a simple payback of less than one year

Further savings are anticipated when the project enters the next phase of optimising plant operation. This phase will focus on control strategies such as the shut down unoccupied areas, improved chiller controls and install lighting controls. The savings potential from this stage are high as for example in one building alone two chillers cost approx $100 per hour to run.