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Mitsubishi Electric Guide to Controls for Energy Efficient Cooling, Heating and Ventilation

Information Guide 48

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Mitsubishi Electric Guide to Controls for Energy Efficient Cooling, Heating and Ventilation

This is an independent guide produced by Mitsubishi Electric to enhance the knowledge of its customers and provide a view of the key issues facing our industry today.

This guide accompanies a series of seminars, all of which are CPD certified.

Contents

Good control - the heart of energy efficiency and comfort

Building controls are vital to the energy efficient operation of building services equipment, and buildings as a whole.

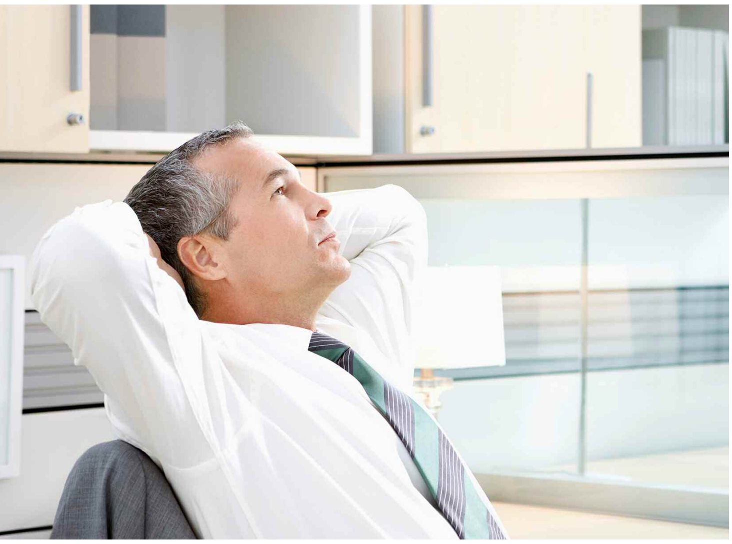
The Carbon Trust*[1] states:

> "Poor control of heating, ventilation, cooling and lighting is responsible for excessive consumption in many buildings"

According to CIBSE*[2], controls and control systems provide a number of important functions in commercial buildings:

- Create and maintain a comfortable indoor environment
- Prevent systems from being on when not required
- Prevent simultaneous heating and cooling of the same space
- Keep HVAC plant operating safely and efficiently
- Reduce energy consumption and running costs
- Provide feedback that can be used for monitoring system performance and planned maintenance requirements.

Any system within a building will therefore perform more effectively and efficiently when it is correctly controlled. Systems include heating, cooling and ventilation as well as lighting and alarms. Controls on air conditioning systems, for example, will optimise performance and minimise running costs. For every degree that the system deviates from the required temperature, energy costs can rise 5%. Good control will keep the system to the required temperature (or within a desired temperature band) thereby saving energy and also optimising running times, hence reducing wear on the equipment.



A building-wide integrated system of controls, known as a building energy management system (BEMS) is an increasingly important tool for today's facility managers. Not only does a BEMS keep systems running effectively and efficiently, it can also monitor performance and provide vital feedback on building energy use.

Knowing how a building is performing in terms of energy use is important because there is a growing emphasis in legislation and through incentives on having accurate data. For instance, the Carbon Reduction Commitment (CRC) Energy Efficiency Scheme requires accurate tracking of energy use. Also, there are many voluntary schemes in the property market which are being used by property owners and managers to benchmark their portfolio's performance against an industry average. There can be little doubt that Energy Performance Certificates (EPCs) are having an impact on the financial performance of buildings, with low-rated and energy-inefficient commercial buildings attracting lower rents than those which can be shown to be energy efficient.

The increasing sophistication of controls can also be seen in the building services equipment. Forward-thinking manufacturers are ensuring that their equipment is supplied with built-in controls that not only aid energy efficiency but also long-term maintenance. For instance, machine-to-machine controllers can send email messages to the maintenance team which communicate faults in particular parts.

Advances in technology mean that smart kit can utilise cloud computing to bring sophisticated controls and energy management within the reach of smaller projects.

For example a new launch from Mitsubishi Electric, known as MELCloud, collects data from its air conditioning and Ecodan heating systems and can offer users online access to the information for fault-finding and scheduling. Data is held centrally by Mitsubishi Electric.

Intelligent controls such as this mean that servicing engineers can then arrive at a site with the correct equipment to solve a fault - rather than having to make an initial visit to ascertain the problem. This kind of intelligent or 'smart' equipment is therefore saving on down-time and the costs of upkeep.

1. Carbon Trust Technology Overview (CTV032): "Building controls: realising savings through use of controls". Also see: Carbon Trust: "How to implement a building energy management system."
2. CIBSE Knowledge Series KS04, Understanding Controls. Also see: CIBSE GUIDE H - Building Control Systems.

Building controls in Part L 2010

Building controls are covered in Part L of the Building Regulations.

The regulations state that **"fixed building services shall have effective controls"** and that control strategies should be organised **"such that priority is given to the least carbon-intensive (energy source)."**

Section 4 of Part L 2010 makes the most extensive mention of how building controls should be used to minimise energy use in a building. Section 4:34 states that systems should be provided with appropriate controls to enable the achievement of reasonable standards of energy efficiency in use.

In normal circumstances, this section states that the following features would be appropriate for heating, ventilation and air conditioning system controls:

1. The systems should be subdivided into separate control zones to correspond to each area of the building that has a significantly different solar exposure, or pattern or type of use.
2. Each separate control zone should be capable of independent timing and temperature control and, where appropriate, ventilation and air recirculation rate.
3. The provision of the service should respond to the requirements of the space it serves. If both heating and cooling are provided, they should be controlled so as not to operate simultaneously.
4. Central plant should operate only as and when the zone systems require it. The default condition should be off.

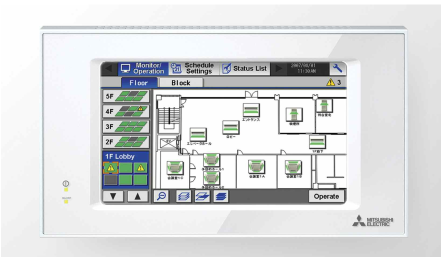
Building controls - basic strategies

Controls vary in complexity from a simple light switch to building-wide automated systems. In modern buildings, manual controls like light switches are sometimes enhanced with automated technology.

For example, a time-clock to set the hours when the light should be on. This can be overridden by occupants, but will help to ensure that the light switches off automatically during times when that room is not usually occupied. It is also possible to add a motion detector or PIR sensor to the lighting - so that the lights will switch on automatically when occupants enter the space. Other sensors include CO_2 sensors which will automatically detect the occupancy level and change the ventilation rates accordingly. Control technologies, like IT for business, are becoming increasingly accessible, with more functionality available at a highly cost-effective price. Room controllers with integrated PIRs are now available which mean that it is very easy to set up a control strategy from a touchscreen on the wall. For example, users can decide to switch on cooling or heating when someone enters the room and turn it off when they leave. It seems simple, but it is very common for energy to be wasted because occupants leave a meeting room without switching off cooling or heating.

An important concept when thinking about building controls is the 'control loop'. At a simple level, the control loop is the process for measuring and adjusting the requirements of a piece of the system (for example a heater or fan).

In a closed control loop, a temperature sensor in a room will detect heat from the radiator and adjust its performance according to its settings. An open loop might link the radiator to an outside sensor which adjusts performance according to the outdoor temperatures. In this case, the heat output from the radiator is not felt by the outdoor sensor. It is possible to combine control loops. An outdoor sensor can be linked to the indoor control loop in order to lower the room temperature requirements (known as 'setpoints') as the outdoor temperature rises. It is also possible to control heating and cooling in a single closed loop, known as 'sequence control'. *See page 8 for an example of combined loop controls*. The advantage of this sequence control approach is that it enables a seamless move from cooling to heating modes. It is advisable to include a 'dead band' of temperature where neither system operates between certain temperatures. It is with these more complex control loops that energy efficiency and comfort can be enhanced because the building can react to outside conditions automatically, and it can 'rest' at certain conditions so heating and cooling equipment is not operating constantly. This is known as providing a 'dead band'.



Modern building controls are about far more than simply operating building services equipment. A growing emphasis on energy efficiency in buildings means that controls can also now be used to monitor and measure what energy is being used by the different systems.

A system which not only switches equipment on and off, but also monitors and changes the performance of systems, is known as a building energy management system (BEMS). A BEMS offers a number of building-wide functions that can form the basis of an energy efficiency strategy for building managers. Optimisation is one of these functions, and it means that the exact requirements for system operation are calculated and actioned automatically. Examples of optimisation are start/stop optimisation for primary plant and optimised use of fresh air.

Time scheduling is another BEMS function that offers building-wide switching and holiday control programmes, as well as local plant and system time control. For example in a university building, time scheduling can ensure that system operations in some buildings are minimised in the holiday periods. It is also possible to shift setpoints at certain times, for example when a building will be largely unoccupied. Duty cycling is another way to minimise operation of a system in off-peak periods. For example the BEMS can ensure that a fan operates only ten minutes in every twenty when a building is at lower occupation levels.

One of the benefits of controls is that, like IT equipment, their price relative to their functionality, is falling. So energy-saving control strategies are within reach even of smaller building or refurbishment projects. In air conditioning, for example, functions such as 'auto-off' can set the auto mode for a predetermined period of time before reverting back to fan-only to save energy. This means that the air conditioning can be set to turn on at 8am, run for two hours, then switch to fan-only mode.

Melcotel - combined loops for the hotel sector

In an ideal world, occupants would understand building controls and use them appropriately. However, hotel guests occupy a room for a few nights at most, so the controls must automatically return the system to its most energy efficient automatically. But this must be balanced against the need for occupant comfort.

The Melcotel control from Mitsubishi Electric does this with a number of control strategies:

- It offers an automatic switch off of heating and cooling in each hotel room after a pre-set amount of time
- It switches to off at night time
- When the unit is switched off, the hotel interface monitors the bedroom temperature and the unit will switch back on if it is too low or too high. Set back values can be changed seasonally
- When the hotel room windows open, the system is automatically switched off
- When the unit is switched on, the settings are re-set to, for example, 21°C. These presets can be different for each hotel room if required

Energy Measurement, Control and Reporting

Today's building control technology can be applied at a whole-building level to create smart, efficient solutions to cooling, heating and ventilation.

By using a combination of internal and external sensors, timers and other elements, a building energy management system (BEMS) can keep the internal conditions in a comfortable range of temperatures, in a highly energy efficient way.

It is possible to design buildings which are entirely passive in their approach to ventilation, relying on natural ventilation to provide fresh air and cooling to the occupants. However, this is not always a practical approach for example in urban centres where external air may not be suitable, or when retrofitting existing buildings which are not designed for a natural approach.

However, a mixed mode approach, which utilises the advantages of air conditioning with intelligent building control, can offer an energy efficient approach that uses the benefits of both methods.

The controls play a very important part in ensuring that a mixed mode strategy works, as CIBSE*[3] states:

> "The control concept is a particularly key part of mixed mode design to ensure the effective integration of fabric and engineering systems"

3. CIBSE AM23 Mixed Mode Ventilation (Application Manual 13).

Fundamentally, a mixed mode building will utilise fresh air and natural ventilation where possible, but as internal temperatures rise, the controls will switch to use of mechanical ventilation, perhaps with air conditioning. The mixed mode approach requires careful design and consideration of occupant requirements.

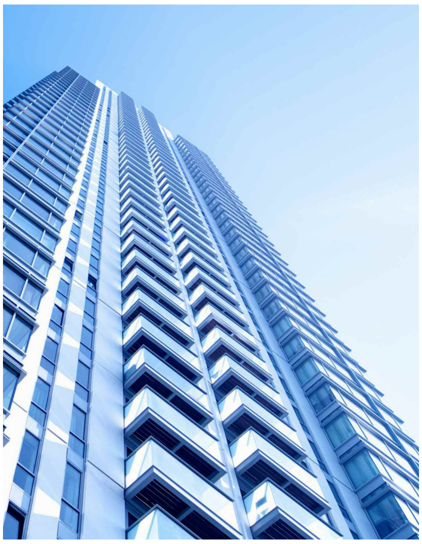
CIBSE outlines a number of advantages for occupants of this approach:

- Tuneable buildings with a longer life; greater adaptability of space and services
- Better occupant satisfaction by offering the benefits of openable windows, assisted by mechanical engineering
- Buildings that are easier to manage, with generally smaller HVAC systems
- Lower energy use and CO_2 emissions
- Lower capital costs

Another benefit of mixed-mode systems is that they allow for night cooling. By flushing hot air out of the building when it is unoccupied, the requirements for cooling in occupied hours. One of the most important aspects of building controls is that they not only manage the energy use of the building day-to-day, but can also provide an invaluable source of information on how the building is performing in the long term.

Monitoring and collection of data on energy use are becoming more important as legislation from Government is driving building owners and managers to have a better understanding of energy use. Reporting through systems such as Energy Performance Certificates (EPCs) and the Carbon Reduction Commitment are already in place. With the new drive to managing energy demand, it is likely that further monitoring will become a requirement.

However, energy monitoring does not necessarily require a full-scale building energy management system (BEMS). The latest control technologies can offer energy monitoring and logging data as standard so that building managers can easily track the energy use of their air conditioning equipment, for example.



It is now possible to monitor the energy use of up to fifty indoor units, gathering data on their energy use and comparing like-for-like. It is also possible to set target energy use for each month, so that the system will warn when energy use is approaching this limit. With online access to this data, it is easy for users to spot where a particular area of their building is using excess energy - and to act on that information.

Building controls offer many benefits, and increasingly sophisticated functionality is now being brought into the reach of even small projects. As energy costs to businesses rise, and Government looks to incentivise demand control, it makes sense to consider greater use of intelligent kit that can help to track and manage energy use in buildings.

Energy saving strategies

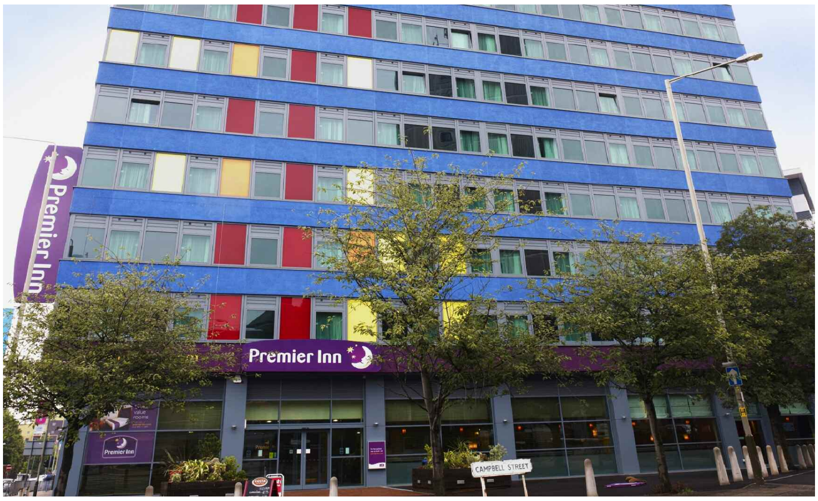
Effective use of the controls on an HVAC system can reduce energy consumption, running costs and improve occupant comfort.

- Make sure you have the right level of control for your building size and type
- Make the most of user manuals to understand what features your controller has, and use them to gain better control of the HVAC system
- Set time controls to turn off at nights, weekends and bank holidays - whenever the building is unoccupied
- Someone should have responsibility for monitoring HVAC control systems to avoid incorrect use
- Thermostats should be positioned correctly - avoiding direct sunlight, or being placed above heat-generating equipment such as photocopiers
- Avoid operating heating and cooling simultaneously
- Avoid opening windows while heating a room
- Reduce the thermostat point temperature whenever possible (for example in meeting rooms that are often unoccupied)
- Lower the set point in winter, as occupants benefit from the difference to outside temperature. Raise the set point higher in summer

Case Study: Premier Inn

The Premier Inn Hotel, Leicester has 135 bedrooms and occupies the first 9 floors of a 20 floor building. The hotel is located in the heart of the city close to the main railway station.

Premier Inn installed a Mitsubishi Electric high efficiency heat recovery VRF (variable refrigerant flow) air conditioning system to provide heating and cooling to the 135 bedrooms as well as the bar, restaurant and back offices. They wanted to use this site to test the Melcotel™ control interface and determine if they could reduce energy consumption, thus CO_2 emissions and running costs. Based on the test results Premier Inn would decide whether or not to install Melcotel interfaces into more of their hotels. A Mini M2M interface was also installed to monitor the energy consumption and the Melcotel settings.



> This resulted in a 30% decrease in average monthly system running costs and CO_2 emissions.

The monitoring and analysis of the data for this report clearly showed that the Melcotel controls interface enabled Premier Inn Leicester to benefit from reduced energy consumption and therefore reduced system running costs and CO_2 emissions. This allowed them to provide a comfortable internal environment for their customers, in a highly efficient, cost effective and environmentally friendly manner.

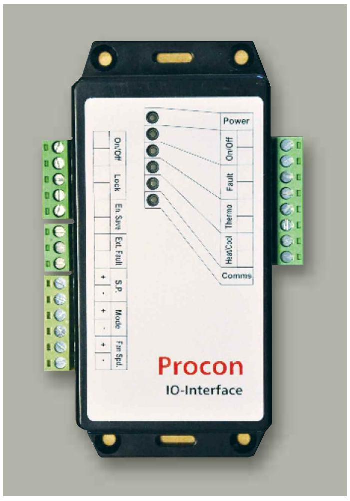
With clear and successful results, Melcotel is now part of the national Premier Inn controls specification. Premier Inn are now investigating their other hotel sites where this system can be utilised.

M2M Monitoring

Case Study: Costa Coffee

Costa Coffee have been using Mitsubishi Electric air conditioning for many years and were one of the first companies to make use of the IO Interface.

Due to the fact that the shops have a very limited number of indoor units, the control system needs to be kept within budget, however the air conditioning must still be able to run as efficiently as possible. When Mitsubishi Electric launched the new IO Interface in May 2009, Costa Coffee undertook a trial to measure how effective the IO Interface's energy saving functions were.



The trial was mainly using the 'Dual Setpoint' energy saving feature whereby the air conditioning operates in heating mode up to 19ºC and cooling mode down to 23ºC for instance. In between the air conditioning is running to a strict minimum (fan only) thus allowing the compressor to switch off and save energy. The results were very impressive. Across the whole year the IO Interface was responsible for a 20% reduction in energy use, with customers and staff still very happy with the coffee shop environment.

When Costa Coffee arrange for an IO Interface to be installed into one of their shops as part of an already scheduled maintenance visit, the IO Interface payback period is less than 2 months, making it an impressive addition to the Costa Coffee controls portfolio.

> Great comfort, great saving and a payback period of less than 2 months!

If you missed the CPD seminar on Controls you can call your Mitsubishi Electric Regional sales office to arrange an in-house presentation of this information.

If you would like to receive invitations to future CPD events, please email **livingenvironmentalsystems@meuk.mee.com**

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