Building Control Systems

Practical Guidance Note

Universities and Colleges Climate Commitment for Scotland

Who is this for?

This EAUC Guidance Note is provided to help energy managers and other facilities staff identify and address problems in building control systems. This should help you to reduce energy consumption as well as keeping your building comfortable.

What does it cover?

Controls for heating, ventilation, air conditioning and lighting can come in many forms. Systems can range from very simple stand-alone controls through to sophisticated Building Management Systems (BMS).

The way they are set up and operate can have a huge influence on how much energy a building consumes and how comfortable it is to users. These systems can quickly fall into disrepair and it is often the case that there is room for improvement.

Some of the problems with controls can be quite easy to spot; others can be picked up with a little prior knowledge. This guide aims to give you some hints and tips for your buildings.

What to remember

This is not a detailed guide to building controls (there are lots of good publications available to help give you a better understanding of these).

However, with this guidance and the help of colleagues in your institution (e.g. building users, other estates and maintenance staff) you should be able to identify and address some of the basic problems you encounter.

For other problems you might need to look for external help, potentially in the form of a maintenance contractor or controls engineer. In some cases an external specialist or controls engineer might be required before a problem can be solved. Sometimes the repair or replacement of a system might be required but often problems can be addressed at no or low cost.

Some aspects of control are particularly important for colleges; effective time control of HVAC in teaching and other spaces can make a huge difference to the overall energy consumption. Unlike other building types the use of each space will change substantially through the year so to get it right requires effort to refine time controls. Colleges by their nature include spaces with dense, transient occupancy (e.g. lecture theatres). This can require energy intensive equipment and where this equipment is not well controlled there can be large increases in energy consumption and cost.

Most of the energy used in colleges relates to space heating but other users such as lighting, ventilation and air conditioning also make substantial contributions to overall cost.

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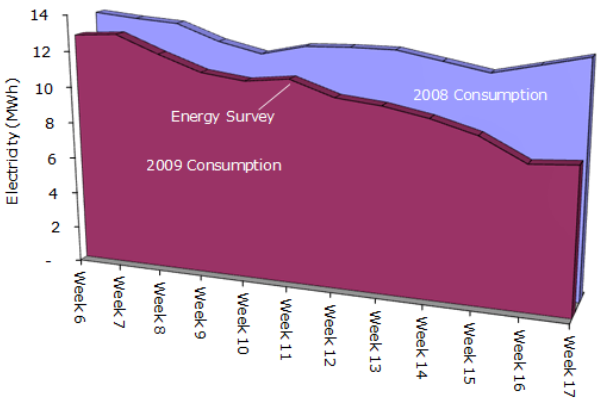
What can I do?

1. Get to know your building

The more you understand about your buildings and the systems that deliver heating, cooling and ventilation, the better chance you will have to address any problems with controls.

Take some time to discuss the systems and changes to your building with staff. Identify the major items of plant and see what Operation and Maintenance material is available.

Sometimes a walk through plant rooms and along service routes can help your understanding of how a building works. Get to know how control varies from zone to zone in your building.



2. Get to grips with your energy data

What a control system should be doing is often very different from what it does once problems develop. Often it is easy to see the actions of the controls expressed in the energy data – this is particularly the case where you have detailed half hourly or AMR (automated meter reading) data but even simple monthly data can be useful.

Consider undertaking a degree day analysis of your fossil fuel data. Does the profile of energy use change the way you would expect between seasons?

If you have sub-metering and AMR you might be able to view more detailed energy profiles to see when equipment is activating. Check whether this matches your understanding of when your HVAC systems should operate.

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3. Get on Schedule

Time control for your plant might be provided by very simple stand-alone controllers or it might be integral to a BMS. Either way it is worth regularly reviewing whether the controls schedule actually matches the way the building is used.

Check that buildings or areas of a building are not being heated when they do not have to be. Check that holiday schedules are utilised.

Scheduling can be particularly important for colleges. The use of spaces can vary significantly from day to day. It is important that there is good communication between staff and the estates team to ensure that the control system correctly reflects the actual use of the building.

4. Care and attention

BMS systems can do wonders for a building's energy consumption and comfort. But what is often forgotten is that the more complex the system the more care and attention it will need in the years to come.

If you have no current maintenance allowance for your controls or if maintenance is purely reactive then it is likely that problems will develop. An annual controls health check is a sensible option.

If you are specifying new systems try to get a clear indication of the potential costs for maintenance.

5. Set the temperature

It can be difficult to maintain a happy balance in terms of temperature control in a space, especially where there are underlying problems with the heating or air conditioning system you are considering. However, optimising the temperature across all of your occupied spaces can make a big difference to your annual fuel bill.

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There are a range of recognised temperature ranges (specified by CIBSE (Chartered Institution of Building Services Engineers) for most types of functional spaces. Try to adhere to them, and where this is a problem find out why – it can often be that problems with system manifest themselves as complaints about comfort.

Find out about the temperature control features of your system – for example air conditioning will often come with flexible temperature deadbands to allow energy use to be minimised.

6. HAND controls and their misuse

One of the most common mishaps in building controls is the use (or more precisely the overuse) of the HAND control setting in plant rooms.

The HAND setting allows automatic controls to be overridden and causes equipment to operate continuously, even out of hours.

This is often necessary for maintenance purposes but the problem is that equipment is often left on HAND long after the maintenance in question is complete.

Have a walk through your plant rooms and if any equipment is set to HAND rather than AUTO, establish why. Equipment is often set this way when there are wider problems with the automatic controls.

7. Simultaneous Heating and Cooling

In buildings with separate heating and air conditioning systems, there is always the risk that one system will try to heat whilst the other cools. This results in a waste of energy in both systems as they essentially compete with one another to control the space temperature.

Look out for areas where air conditioning has been added as an afterthought – this is potentially where simultaneous heating and cooling is most likely to occur

Look to develop controls which ensure that heating systems cannotactivate at the same time as cooling systems, and vice versa.

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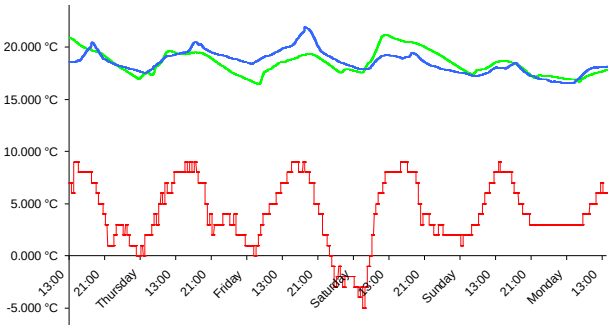
8. Passing Valves and Dampers

Often a control system will incorporate a number of control valves to control the release of heat (or cooling) at local equipment like air handling units. In air based systems similar control is achieved by automated dampers.

These valves and dampers can often fail leading to the release of heat (or cooling) where it is not wanted. This can lead to uncomfortable space temperatures and in some cases unintentional heating will have to be dealt with later by a cooling system, much like the simultaneous heating and cooling scenario noted above.

Check heat emitters after valves, if they are at temperature when you would expect them to be off the valve may be passing heated fluid. Often it is possible to see passing valves remotely on a BMS. The valve will appear to be at 0% open position but the space or air stream considered will still be increasing in temperature.



9. Temperature Profiles

If you have a BMS, you will often be able to plot charts of the individual space temperature profile. This can be a very useful feature.

A good exercise is to to periodically look at the temperature profile of spaces out of hours. You may find that spaces are being temperature controlled when ideally they should not be. Look for spaces maintaining or increasing in temperature long after the heating system should stop operating.

This can be caused by underlying problems in the way the control system is set up, for example overly high fabric and frost protection set points.

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10. Variable Speed Control

Many fan and pump systems now feature inverters or variable speed control. This can be retrofitted to older systems too. If properly used, the savings in electrical power and temperature control can be substantial.

However, variable speed control is often not used to its full potential. Look for ventilation fans that are continually operating at 100% even when it appears the use of the spaces served varies. There may be better control solutions for these spaces.

Look out for artificial restrictions in air and water movement systems (e.g. half turned valves) used to comission the system. The variable speed control should be able to control the flow rate without the added energy loss of these restrictions.

11. Sequence Control

Large centralised boiler plant needs to be properly sequenced to minimise the number of boilers firing. This reduces the standing losses from the boiler casing but also reduces the amount of heat lost as each boiler purges heated air at the start of each firing sequence.

If you have a number of boilers feeding the same system then it is likely that some level of boiler sequencing will be required.

Take some time to watch your boilers in operation – do they continually fire for short periods and change between boilers? If so, there may be the opportunity to improve the sequencing control.

Often this feature is included in the overall BMS and can be easily improved with the input of a controls engineer. It is common for this to be caused by poor setting of individual boiler temperature stats.

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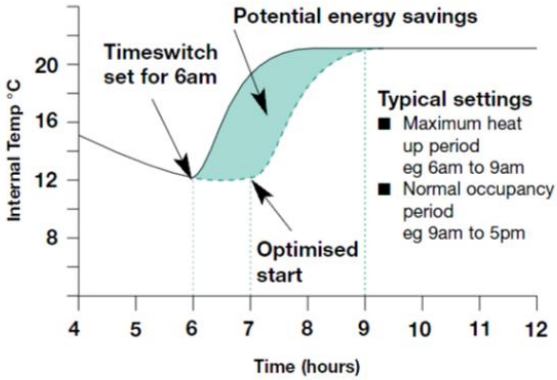
12. Optimum Start

Optimum start should be a feature of most modern building heating controls. It works by comparing the internal and external temperatures and determines how long it should take to heat up a building to occupancy temperature. The algorithms that control this function learn over time, so you may find that over the first year of use the system over or under compensates on occasion.

Despite this feature many users still feel that *they* should make their own judgement about when the heating system needs to come on. This doubling up of heat up periods can lead to the heating systems being activated very early in the morning and the wasteful consumption of energy.

Check to see if your system includes optimum start as nearly all BMS systems will, but many stand-alone controllers will too. Check the system start times, generally these should be the occupancy times – the system will make its own allowance for a warm up period



Other useful links

- Further & higher education sector overview (CTV020/CTV060)
- Building controls (CTV032)
- Degree days
- Building Management System Procurement Guide

Summary and Top 5 Tips for Colleges

At least some of the tips above should be relevant to you, but what you find most useful will depend on the type of building you operate, its age and the condition of the associated controls.

The following might be the best places to start:

- Get to know your system and your energy data – taking the time to become familiar with your controls, your HVAC and the related energy data will pay dividends
- Time control and scheduling – keeping track of your building schedule and changing time control to suit can make a big difference in your energy consumption
- Simultaneous heating and cooling – remember this can occur in occupied spaces but also in the air handling systems serving your spaces, the latter can often go unnoticed
- Optimum Start – it is often the case that people overestimate heat up periods
- Passing valves – especially in older air handling systems this can be a common problem.

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