# HVAC&R Nation

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## Feature

**The A to Z of controls and instruments**

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# CONTROLS — FROM A TO Z

*Used to monitor system performance, maintain conditions, ensure comfort and improve energy efficiency – as well as various other functions – controls and instrumentation are an integral part of today's state-of-the-art HVAC&R industry. HVAC&R Nation runs you through everything you need to know.*

## A Analytics

Increasingly, real and instantaneous data from multiple system sources is informing how systems are operated and controlled. Known as data analytics, this is having a direct bearing on HVAC system performance, energy consumption, fault finding and maintenance scheduling.

## B Building Management Systems (BMS)

Building management systems (BMS) provide control and interface with a building's various stand-alone controlled systems such as mechanical services and HVAC systems.

As the tool through which a building operates, the performance and operation of the BMS has a direct bearing on building energy consumption as well as occupant comfort. And where poorly designed, commissioned or maintained controls are found – typically a poor performing building exists around it.

## C Calibration

Regular calibration of instrumentation, including sensors, is paramount to accurate controls.

For instance, carbon monoxide (CO) sensors found in environments such as carparks are normally of the electro-chemical type and require regular six to 12-month calibration to ensure they operate accurately.

To this end, Andre Jonker, general manager at Dwyer Instruments SE Asia Pacific, suggests buying a sensor that is easy to recalibrate.

"Look for one that has a display that can be plugged into the unit to easily check the measured value locally at the unit," Jonker says. "This will make calibration of the sensor in the field simpler when calibration gas is attached to the sensor."

## D Data

The key tool for BMS optimisation is data.

"It's not possible to optimise a system where there is no information on what the controls in the field are doing, and it is hard to optimise where there is no record of what they are meant to be doing," says Paul Bannister, F.AIRAH, director of innovation and sustainability at Energy Action.

But Bannister says that data by itself is not enough.

"It needs some degree of analysis to turn it into information that can be acted upon by the building manager, the tuning specialist or the controls company. And this is true of both BMS and metering systems."

## F Facility manager

Get to know the facility manager looking after the building. All buildings have their own intricacies, and most facility managers know their buildings inside and out. The same can be said for the controls engineers – assuming they have been engaged post-construction.

## H Habits

Breaking convention and the habit of "that's the way we normally control it" can produce exceptional results when looking to improve system performance through controls.

In some buildings, it is not unusual to see an immediate energy consumption reduction of up to 30 per cent as a result of simple control intervention.

## I Instrumentation

For those tradies working with HVAC&R systems and controls on a daily basis, owning good instrumentation is paramount.

According to Andre Jonker, general manager at Dwyer Instruments SE Asia Pacific, the cost of ownership should be as important a consideration as the initial capital outlay when purchasing instruments.

"Be aware of cheap products that will cost far more to maintain over time," Jonker says.

## I Internet of Things (IoT)

The Internet of Things is defined as the internetworking of billions of devices via the internet, so that they are able to communicate, share data and ultimately influence each other. Think of the Internet of Things as the enabler of big data, or the enormous amount of information being produced from controls and instruments. Analysis of this can reveal trends, patterns, faults, and associations.

## K Know your limits

When it comes to controls, it is important to know your skill limits.

Rather than adjust set-points and parameters to try and resolve a specific issue – which can have a knock-on effect somewhere else in the system – know when it's time to call in a controls expert to assist.

# FUNDAMENTAL OPTIMISATION ISSUES

**NDY's Jonathan Clarke, M.AIRAH, runs us through four fundamental control optimisation issues that are commonly encountered in buildings.**

### 1. Set-points out of design and not achievable

Set-points that have been adjusted beyond design can drive the system to operate at 100 per cent. This does not typically achieve any additional cooling or heating, but does waste substantial amounts of energy.

Always consider the application before making the adjustment. For example, trying to control humidity in an auditorium to 40 per cent RH will require excessive amounts of cooling, and is probably not achievable. A simple adjustment upwards by 10 per cent can deliver significant results.

### 2. Control bands too tight

In many cases, we have found unstable control with systems constantly hunting between heating and cooling – particularly where the process can influence the results in a fast cycle.

For example, supply-air temperature control has a short cycle time between opening the control valves, and affecting the supply-air temperature. With tight control bands, this will cause the system to hunt.

### 3. Poor VAV control biased to air volume

The intent of the VAV system design is to reduce fan power. However, we find that most of the supply-air temperature reset strategies allow the supply-air temperature to rise in conjunction with the average load conditions in the space.

In practice, the air volume increases in parallel with the supply-air temperature that satisfies the space conditions, but uses additional fan power. We have successfully implemented optimised VAV strategies using an existing BMS with zone voting techniques to maximise the efficiency whilst maintaining conditions.

### 4. Demand calculations using P+I loops

Use proportional control only for zone temperature control. Implementing the "I" term into the control loop allows the demand to increase to 100 per cent regardless of how close to set-point the conditions are, and this falsifies the actual demand level causing plant to operate at higher levels than necessary.

Above all, think about the application and the effect that one control process can have on another. Don't cut and paste from previous projects – buildings are typically unique and require specific control logic to match the design.

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## L Look first

Even the smartest control strategy cannot overcome seized dampers and sensors out of calibration. So before anything else, look to see that the controls have been tested, installed, commissioned and tuned properly.

David Stidolph, controls engineer at Arup, says the most significant improvements can normally be gained by getting the basics right – economy cycle, supply-air temperature reset, pump and fan pressure control, and terminal unit control.

"We often see brand new buildings falling well short of their potential and expectations because corners have been cut in the controls delivery process," he says. "Controls can only perceive the world through the sensors, so if the sensors are wrong the controls will be wrong too."

## M Machine learning

The evolution of machine learning is changing how the HVAC&R industry monitors equipment performance by allowing controls systems to automatically monitor and recognise system performance degradation and automatically capture faults and their root cause.

Machine learning is behind one of the big changes in HVAC&R maintenance – the move from the traditional schedule-based maintenance to predictive maintenance.


The Edge, Amsterdam

## O Over-riding points

Become familiar with the control strategy in place, otherwise simple actions like over-riding points that force equipment to turn on can create problems downstream.

For example, over-riding the cooling call of chilled water plant might solve the immediate problem of a warm zone, but then compromise energy targets such as NABERS Energy. So don't make changes without understanding the system, and if you need to override a point, make a note in the system as to why the change has been made and what corrective action is required.

## P Protocols

Protocols are the accepted rules and standards that allow communication and data to be shared between system components. Devices and systems that use a particular protocol can communicate easily with each other, but not necessarily with other protocols.

In Australia, the ASHRAE open-source BACnet protocol is the most common, and can be found in new building and retrofit specifications.

Other protocols you may come across include LonWorks, KNX, DALI, Clipsal C-Bus, Modbus, M-Bus and ZigBee.

## R Rubbish in. Rubbish out.

Even the best controls systems are based on software that can be configured in a multitude of ways. And as with any software-based technology, it is only as good as the programmer and testing regime behind it.

That's why on-the-ground, intimate knowledge plays a vital role in optimising performance. After all, if you put rubbish in, you'll get rubbish out.

"The greatest tool anyone can have is knowledge based upon experience – understanding how a building operates and identifying the tipping point between energy efficiency and occupant comfort," says Jonathan Clarke, M.AIRAH, associate director and controls group manager for NDY.

## S Strategies

One of the most important things HVAC&R tradies need to understand are the control strategies being implemented in the system.

The shift towards operational efficiency and energy optimisation has resulted in more complex control strategies being implemented that don't always make sense without understanding the bigger picture.

## T The Edge, Amsterdam

Smart buildings integrate and automate all building services, learn and understand occupant patterns, and provide optimum environmental conditions by balancing energy use and comfort.

Basic vendor training can be valuable.

Amsterdam's The Edge building is a good, working example of this seamless integration. It includes Power over Ethernet (PoE) lighting, façade and rooftop solar photovoltaic (PV) panels, rainwater harvesting and geothermal heating systems, which all work together to deliver the world's smartest building.

## U User access

Restricting user access to reflect each user's own level of training or competency will avoid many of the common issues that come from various stakeholders making changes to controls.

## V Vendor training

If you are in regular contact with a control system that you are unfamiliar with, approach the controls vendor for training. Basic user training will give you the skills to ensure you are not creating issues, as well as give you the ability to perform fault diagnosis and trouble shooting.

## W Web-based

Almost all systems in use today are web-based, and provide visibility to the user from anywhere that an internet connection is available.

Being online also allows for remote alarming via SMS or email, including acknowledgement and escalation, out-of-condition alarms and automated energy and performance reporting via email.

## Z Zero emissions

Effective controls strategies are at the heart of high-performance buildings aiming for net-zero emissions. ■

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