

## Commissioning HVAC systems: Quick, cost-effective energy efficiency



The proper commissioning of HVAC systems represents one of the quickest and most cost-effective opportunities to increase energy efficiency. How to grasp these opportunities is explained by **LASATH LECAMWASAM** of GHD Canberra.

Facilities managers are increasingly under pressure to focus on reducing energy costs and to improve building performance ratings. New commercial offices are typically designed to achieve high Green Star and NABERS ratings and proper commissioning is essential to deliver this performance. In addition, the vast majority of office spaces are older buildings, many of which are operating inefficiently and would benefit significantly from recommissioning or retro-commissioning.

HVAC systems typically consume the highest proportion of energy in office buildings, which can be as high as 80 percent of base building consumption. Commissioning represents one of the quickest and most cost-effective opportunities to increase energy efficiency because typically 20 to 40 percent of energy in older buildings is wasted. Even in well-managed buildings, there is scope to improve energy efficiency by 10 percent through commissioning and implementing energy smart control strategies. Information from the US indicates that a payback period from retro-commissioning existing buildings is typically less than one year. No equivalent information is available in Australia; however, if a building has a fairly modern controls system that can be reprogrammed with energy smart features, the HVAC equipment is less than 20 years old and the NABERS performance is fewer than two to three stars, then similar results should be achievable.

Benefits from good commissioning include reduced energy costs, higher NABERS ratings, better indoor air quality, improved occupant comfort and safety, lower maintenance costs due to enhanced reliability and longer life expectancy of plant. Collectively, these benefits increase the asset value of buildings. Commissioning of HVAC systems and controls is an area that has often been perceived in the past as

being 'too difficult' or has delivered poor outcomes. This is due to a lack of awareness of its cost-effectiveness, poor design, inadequate specifications and engaging unskilled commissioning technicians offering the lowest price. This has resulted in safety issues, energy wastage and poor performance. The HVAC industry is now becoming more aware of the importance of good commissioning for the delivery of energy efficiency and optimal performance.

Facilities managers have an important role to play in accelerating changes that ensure new buildings are commissioned thoroughly and older buildings are recommissioned or retro-commissioned to improve energy efficiency. An awareness of what constitutes proper commissioning and the implementation of processes that will deliver a good outcome is important.

Proper commissioning requires a good specification (or commissioning brief), planning, coordination across different trades and the allocation of sufficient time. It is important to engage skilled commissioning technicians who are familiar with current technology and commissioning standards and have access to good instrumentation.

### **WHAT IS COMMISSIONING?**

Commissioning is a quality assurance process for setting up equipment to work safely, efficiently and in accordance with the manufacturer's recommendations while meeting the building's performance objectives specified by the services design engineers. Proper commissioning covers a range of activities by multidiscipline trades, including tasks such as installation checks, pressure tests, proving of safety and functional controls, and setting up of flow rates for fluids such as water, air and refrigerant.

HVAC systems typically have water and air distribution networks consisting of pipes and ducts respectively. For systems to work efficiently, the setting up of the design flow rates for water and air through key equipment and the distribution network across the building is important during the commissioning process. This is referred to as 'balancing' the system. Unless systems are properly balanced, water and air flow will occur through paths of least resistance and this could lead to occupant discomfort due to either a lack of or excessive heating or cooling. Poor balancing can also cause energy wastage, noise and plant failure.

### **WHEN TO RECOMMISSION**

Recommissioning or retuning is carried out on older buildings that have been in operation for a number of years. Recommissioning essentially restores the system operating parameters to the original design intent, which should be available in the operating and maintenance manuals. Recommissioning should rectify issues that have occurred over the years and have an adverse effect on HVAC system performance and efficiency. These typically include:

- system changes caused during fitouts due to poor trade practices – these include squashed or extended flexible ducts (increase of system resistance), ductwork with open ends (air leakage), partitions erected that affect air distribution to rooms, location of office equipment that affect temperature sensors (hence poor control), alteration of regulating valves and damper positions (hence system resistance)

- system changes caused due to a change of occupancy; for example, the conversion of office areas to meeting rooms, significant changes to occupant density and office equipment and excessive afterhours use of HVAC by some tenancies
- wasteful operational practices such as ad hoc adjustments to control setpoints and plant set to operate manually (rather than automatically) by staff and maintenance contractors as 'quick fixes' to complaints, resulting in issues such as simultaneous heating and cooling, which are very wasteful
- deterioration of equipment such as sensors drifting out of calibration, faulty field items such as leaky dampers, valves and malfunctioning actuators, and
- inadequate maintenance; for example, blocked strainers, dirty air filters, fouled heat exchangers or leaking ducts and pipes.

The need for recommissioning can be identified through a fall in energy performance, occupant complaints of discomfort or interrogation and trending on the building management system (BMS). Recommissioning should be periodically carried out in buildings typically every five years. Calibration of sensors that operate key functions such as the economy cycle, chiller and boiler sequencing, air-handling unit static pressure and carbon dioxide monitoring should be carried out more often, typically every 12 months, as routine maintenance.

Facilities managers must also put in place measures to prevent poor fitout practices affecting the performance of HVAC systems. Interrogating and fine-tuning the BMS is also an important element of recommissioning, which typically is very cost-effective since it involves programming changes only. The loss of a NABERS rating can have major commercial and reputational consequences and could take 12 months to recover. Facilities managers should ensure that the energy performance is continually tracked and key performance indicators (KPIs) are set on the BMS that provide warnings of a loss of efficiency and the need for recommissioning.

## **RETRO-COMMISSIONING**

Retro-commissioning goes beyond recommissioning with a view to enhancing some of the original system operating parameters. Retro-commissioning typically involves making major changes to BMS control strategies as well as air and water flow rates. Typically, retro-commissioning is beneficial in the following circumstances:

- where the building use, operation or the building fabric has undergone a significant change
- where the original BMS, which had very limited functionality (perhaps it was a pneumatic system), has been replaced with a more modern system, but 'energy smart' controls strategies were not included; for example, optimum start and stop, economy cycle, night purge, critical zone reset, chilled water reset, heating water reset, condenser water reset and cooling tower wet bulb tracking – and dynamic set points for fan and pump speed controls have not been programmed
- in older buildings typically designed prior to the '70s when energy costs were not high, system design parameters such as air and water flow rates are likely to be conservative and not conducive to energy efficiency; for example, constant flow systems and dual duct systems with set temperatures for hot deck and cold deck – retro-commissioning is an opportunity to reassess the air and water flows and to implement variable flow control strategies that save energy
- where equipment such as chillers have been replaced with modern variable speed machines that have the capacity for introducing new control strategies that significantly improve part load performance – similarly, the replacement of conventional boilers with high efficiency condensing type boilers requires alternative control strategies for optimal performance, and
- where major changes have been carried out to the air or water systems; for example, conversion of a constant volume reheat or dual duct system to a modified VAV (variable air volume) system, conversion of constant volume chilled water and heating water systems to variable flow.

When recommissioning and retro-commissioning, it is important to obtain the original commissioning documentation and functional descriptions for controls to be able to determine what changes need to be made. Where no existing information is available from operating and maintenance manuals, it is important to seek specialist advice and to ascertain the key system parameters, including air and water flow rates, to which a system is to be commissioned.

*Further information:*

*References 1 and 2 provide general information on commissioning and benefits. References 3 to 6 are internationally accepted guides for those tasked with commissioning HVAC systems and should be appropriately referenced in commissioning specifications.*

- 1. Guide to Best Practice Maintenance and Operation of HVAC Systems for Energy Efficiency. Department of Climate Change and Energy Efficiency. Free download from [ee.ret.gov.au/energy-efficiency](http://ee.ret.gov.au/energy-efficiency)*
- 2. A Retro-commissioning Guide for Building Owners. US Environmental Protection Agency/PECI. Free download from [www.peci.org](http://www.peci.org)*
- 3. AIRAH DA 27 Building Commissioning. The Australian Institute of Refrigeration Air Conditioning and Heating. [www.airah.org.au](http://www.airah.org.au)*
- 4. CIBSE Commissioning Codes: Air Distribution, Boilers, Controls, Commissioning Management, Refrigeration and Water. Chartered Institution of Building Services UK. [www.cibse.org](http://www.cibse.org)*
- 5. ASHRAE Commissioning Guidelines 0 and 1. American Society for Heating Refrigerating and Air Conditioning Engineers. [www.ashrae.org](http://www.ashrae.org)*
- 6. BSRIA Commissioning Guides. Building Services Research and Information Association UK. [www.bsria.co.uk](http://www.bsria.co.uk)*

*Lasath Lecamwasam is the principal engineer, building services at GHD Canberra. Lecamwasam is a chartered professional engineer with 25 years of experience in building services design and maintenance management in England, Scotland, New Zealand and Australia. He was the lead author of the Guide to Best Practice Maintenance and Operation of HVAC Systems for Energy Efficiency published by the Department of Climate Change and Energy Efficiency and one of his projects – 4 Mort Street – won the Best HVAC and Refrigeration Upgrade AIRAH 2012 Award for Excellence.*