

# CIBSE JOURNAL



#Build2Perform

June 2020

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SAFE REOCCUPATION  
AFTER LOCKDOWN  
CIBSE VENTILATION  
GUIDANCE ON COVID-19  
BUILDING A BETTER  
FUTURE DIGITALLY

## TIME FOR CHANGE

CIBSE President Stuart MacPherson  
on why it can no longer be  
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## Flattening the curves



The new CIBSE President Stuart MacPherson has taken up office during one of the most challenging periods in the history of the Institution. While the infection rates for Covid-19 are falling, economists predict that the global economy will soon be facing the steepest recession in living memory.

In his presidential address, delivered online from his home in Scotland, MacPherson said governments must be encouraged to invest in a sustainable recovery, rather than one fuelled by deregulation and indiscriminate spending. He says they should be focusing on low carbon initiatives that target zero carbon as well as economic renewal.

MacPherson believes building services professionals must strive to flatten the climate-change curve by embracing clean technology and learning from other countries that are successfully lowering carbon emissions. He cites Denmark, which, as well as successfully controlling the spread of Covid-19, has also built an extensive low energy heat network that is redistributing heat from industrial processes into people's homes and businesses.

In the short term, countries are planning how they can move to a semblance of normal life without triggering flare-ups in virus infections. The return to workplaces and schools encouraged by Boris Johnson has put the onus on building owners and facilities managers to make their buildings Covid-secure.

With airborne transmission suspected to be a route for infection, the recommendation from CIBSE and others is to boost ventilation, turn off recirculation and avoid overcrowding. This means building managers have to make sure their HVAC systems are capable of safely providing increases in air-flow rates to dilute aerosols, while still offering adequate thermal comfort to occupants.

Before reopening, buildings will need to be risk assessed and systems checked. TB+A partner James Campbell says many people will find systems need to be adjusted before they work efficiently. He says remote monitoring and continual commissioning may need to be carried out to ensure they are working as intended. On page 17, he identifies common issues affecting performance that are uncovered during recommissioning.

Many workers won't be going back to their offices for months, but those living in modern apartments that are prone to overheating may prefer a return to their environmentally controlled workplaces this summer. On page 28, we report on a CIBSE Health and Safety group debate on thermal comfort in all types of buildings.

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### Hywel Davies

Why digitalisation will help the industry to 'build back better' after Covid-19 is bought under control



### Anastasia Mylona

Overheating will be a critical issue for many new homeworkers this summer



### James Campbell

The important issues affecting a building's health that can be picked up by continual commissioning



### Tim Dwyer

This month's CPD looks at rolling-piston rotary refrigerant compressors for air conditioning

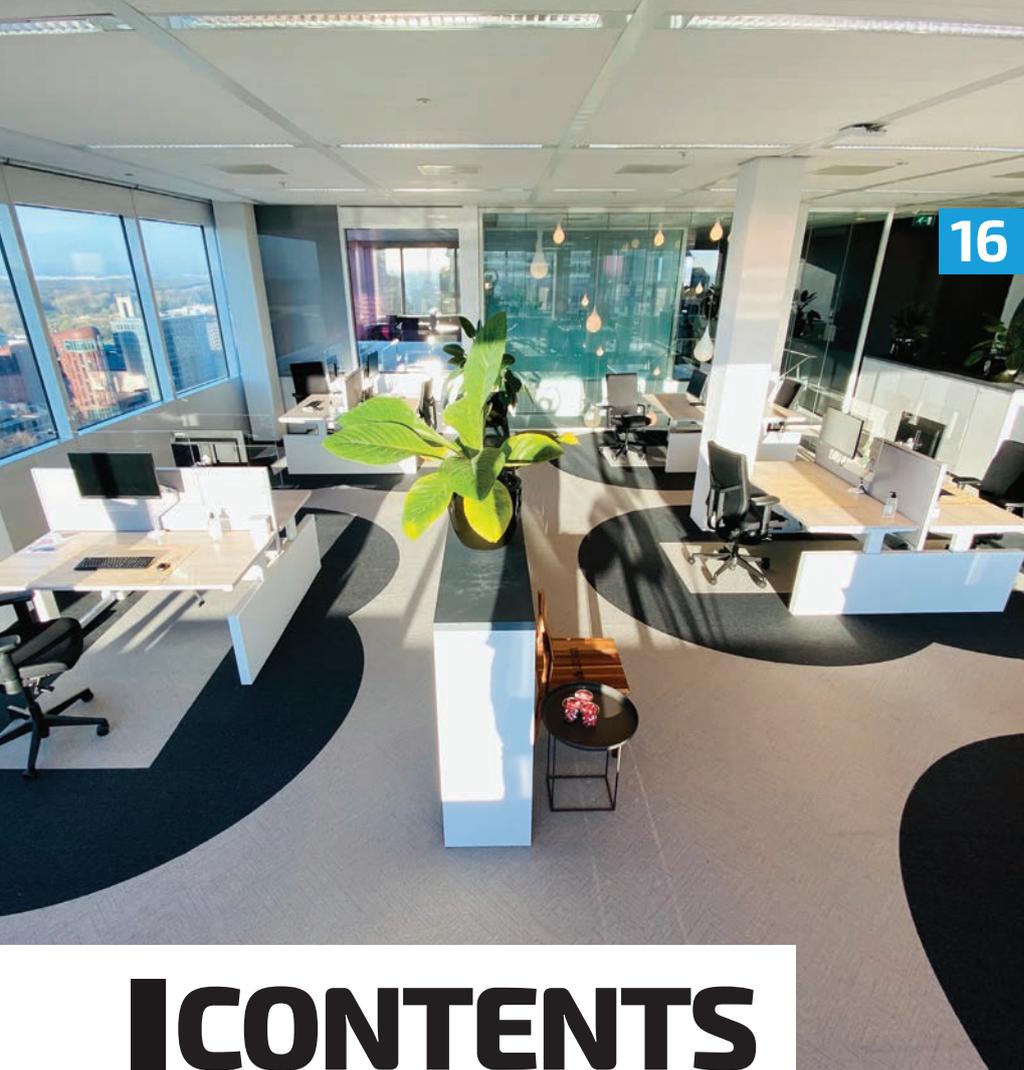
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## Coal-free month in UK

The UK operated for more than 30 days without relying on coal for power – the longest recorded period, according to the National Grid. Gas, nuclear and renewables were able to meet a lower-than-normal capacity requirement because of the coronavirus lockdown. Overall energy demand was 15% lower than normal in April.

The UK passed the 30-day landmark on 10 May, largely driven by reduced energy demands from industry and business. The weather also helped, as wind and solar accounted for 23% of total demand for the month.

Gas accounted for 32% of demand, and nuclear 22%, during the coal-free generation period of more than 700 hours. The rest was made up of a mix of imports, biomass (9%), large hydro (around 1%) and some storage.

## Grenfell Inquiry to restart hearings

The Grenfell Inquiry is to resume hearing evidence – with physical, rather than video, hearings – but the sessions won't start until July at the earliest, and will have limited attendance. The timing will depend on a relaxation of government guidance on social distancing.

This year will be the third anniversary of the fire on 14 June 2017, when 72 people died. The inquiry was suspended abruptly on 16 March, when the Prime Minister announced that non-essential contact must be avoided because of Covid-19.

# Hackitt praises industry for its coronavirus response

**Sector showed collaboration is possible, but a lack of leadership persists, she said**

In its response to the coronavirus emergency, the industry has demonstrated it is capable of making 'massive changes at pace', Dame Judith Hackitt has said.

The chair of the Independent Review of Building Regulations and Fire Safety, commissioned by the government in the wake of the Grenfell fire disaster, urged the sector to continue using the methods that

made it possible to build the emergency NHS Nightingale hospitals in record time.

During a webinar hosted by the Building Engineering Services Association, Dame Judith said those projects had shown it was possible to replace 'fragmentation and adversarial behaviour' with 'collaboration and cooperation'. She also stressed that her timetable for industry reform and a new regulatory regime would not be derailed by the crisis, and added that there was still a widespread lack of leadership across the sector.

'Some people have stood up to be counted and are doing the right thing, but not nearly enough... if you have continued building in the same old way, you will be held accountable,' Dame Judith told the webinar.

The industry should be seeking to regain the trust of the general public after the Grenfell Tower disaster, she said, as many people now felt unsafe in their own homes.

'Some companies are already changing... others are waiting to have their collar felt by the regulator... but it is the best companies who are already getting on with it,' Dame Judith added.



## £11bn investment will spark recovery

Researchers at Birmingham City University believe an £11.27bn investment in construction and housebuilding could be used to power the country's economic recovery.

Economist Steve McCabe and construction expert Mike Leonard produced the Build Back Better: Covid-19 Economy Recovery Plan, which includes: recommendations to stimulate demand for new homes and home improvement; details of essential infrastructure projects; and a plan for training a new generation of skilled workers. The authors claim the investment will deliver a return of £33bn.

The plan calls for a phased return to work; encouragement for small housebuilders; a strategy to tackle fuel poverty through direct intervention by local authorities using local companies; and incentives for consumers to replace inefficient and outdated gas boilers. It also proposes that changes to the Building Regulations be delayed 'in light of exceptional circumstances posed by the pandemic'.

## The perfect combination..... P-Sensor and the CMR Velogrid



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## More FM needed to make buildings Covid secure

### Regular maintenance and continuous commissioning will be required

Buildings managers will have to change the way they operate and maintain buildings to allow people to safely return to work in the wake of Covid-19.

CIBSE guidance on boosting ventilation rates to minimise the risk of airborne transmission of Covid-19 will mean that systems will have to be checked regularly to ensure they are working properly, according to Troup Bywaters + Anders partner James Campbell.

He estimates that 75% of the systems he's working on are not performing as expected. 'We have to ensure that buildings are fully operational and performing as designed, or better, otherwise people's health is at risk,' he says.

Cundall associate Kavita Kumari says building managers will need to ensure filters are regularly changed. 'A lot of buildings have record sheets saying areas have been

inspected, but that's not always the case.'

Austin Wikner, head of Building Services London at WSP, says maintenance will have to become much more regular. 'Irrespective of good practice, the volume of HVAC maintenance will increase, and filters will have to be cleaned regularly.'

Campbell suggests that continuous commissioning may have to take place to ensure systems critical to minimising transmission risk are working. Areas to focus on include the BMS, toilet ventilation, and heating and cooling, he says.

'Set points adjusted over time result in systems operating outside of their design parameters that may lead to reduced ventilation rates,' says Campbell.

He believes maintenance strategies will have to evolve as lessons are learned, and that facilities managers will become more prominent as a result.

'Now is the time for FMs to stand out. They will lead the reoccupation of buildings,' he says.

## CIBSE issues guides for reopening

ASHRAE and CIBSE have developed guidance aimed at managing potential health risks when buildings are reopened following the loosening of Covid-19 lockdowns.

CIBSE has published three documents on emerging from lockdown, including guidance on ventilation and lifts (see page 37 for more on ventilation).

CIBSE's *Safely Reoccupying Buildings* guidance outlines areas that need to be considered when it comes to safe-working practices and the assessment of building services. Version 3 of the guidance incorporates links to new information from the Health and Safety Executive on reducing the risks of legionella.

The guidance also lists systems covered by statutory requirement in the UK, including water systems, lifts, ventilation, emergency systems, electrical and gas safety, heating, and BMS systems.

ASHRAE's Epidemic Task Force has explained how building operators can develop a 'strategic plan' to make occupants feel safer, manage supply chains for critical items such as filters, and for communications.

■ For details, visit [CIBSE.org/coronavirus](https://www.cibse.org/coronavirus) and [ashrae.org/COVID19](https://www.ashrae.org/COVID19)

## Biggest disruption to energy sector for 90 years

The International Energy Agency (IEA) says the Covid-19 pandemic will create the biggest disruption in the energy market since the 1930s.

Its latest analysis shows that global electricity demand is set to fall by 5% and greenhouse gas emissions by 8% this year – the largest annual decrease in emissions ever recorded.

In its Global Energy Review for 2020, the agency reported that the fall in emissions would be six times greater than the one that followed the 2009 financial crash, and the slump in electricity demand is the steepest since the Great Depression of the 1930s.

Renewables will be the only energy source to grow in 2020, according to the report, with solar PV and wind energy – allied to more flexible grids – leading to a 5% rise in renewable electricity generation.

However, IEA's executive director, Fatih Birol, said that 'we are likely to soon see a sharp rebound in emissions as economic conditions improve'.

## UK and India working on vaccine cold chain

Scientists in the UK and India are collaborating on a project to develop a 'continuous cold chain' that could support the worldwide distribution of a Covid-19 vaccine.

The scheme hopes to overcome the problem that most of the world's poorest countries do not have a reliable electricity supply, so would struggle to store the vaccine when it becomes available.

According to the Global Alliance for Vaccines and Immunisation, fewer than 5% of health centres in many developing countries have vaccine-qualified refrigerators.

The universities of Birmingham and Heriot-Watt, in Edinburgh, are working with non-profit, commercial and academic partners to begin investigating the scale of the challenge, in a project supported by India's Shakti Sustainable Energy Foundation.

Research in India is being led by the Centre for Environment Education, and is being supported by a number of commercial partners.

Professor Phil Greening, from the Centre for Sustainable Road Freight at Heriot-Watt University, said the team was considering 'a radical approach such as community cooling hubs'.

**IN BRIEF****CLC guidance to avoid contract disputes**

The government has welcomed the publication of standard procedures to help contractors avoid expensive and disruptive contractual disputes in the aftermath of the coronavirus pandemic.

It supported practical guidance produced by the Construction Leadership Council (CLC) Covid-19 Task Force, which includes standard letters for 'without prejudice' dialogue, and notice of delays needed in JCT design-and-build and NEC contracts. The document also highlights likely causes of disputes and ways to resolve them without recourse to legal action.

The Cabinet Office endorsed the document and called on everyone 'to act responsibly and fairly, and support national efforts to protect jobs and the economy'.

**Cash crunch coming for construction**

Construction firms could run out of cash in the third quarter of the year, according to research by Mace, which highlighted a potential £29bn hole in contractors' cash flows between March and July.

Delayed payments as sites re-open and the easing down of government support could put many firms in serious difficulties, the contractor said.

Its forecast is based on the Office for Budget Responsibility's estimate that construction output could drop by 70% in the second quarter of 2020 because of disruption caused by the coronavirus.

Firms typically have to wait 60 days for payment, which could create a 'time bomb' for finances in the third quarter, according to Mace.

**Minister condemns 'David v Goliath' payment abuse**

**Government is looking at how some of the £4.5bn held in retention payments might be released**

Too many large firms have changed their payment terms during the Covid-19 crisis to protect themselves at the expense of smaller businesses, according to the minister for small business.

Paul Scully MP told a webinar hosted by the Building Engineering Services Association (BESA) that the government would be 'calling out' companies that indulged in poor payment

practices during the pandemic. 'Everyone must be responsible and play nice,' he said.

'The government should be taking the lead at central and local level by setting a good example on payment practices - we want to keep working with our supply chains.'

'However, far too many big businesses are changing their payment terms, which is creating a huge David versus Goliath impact.'

Scully asked BESA to point out examples of payment abuse to his department, but also to highlight best practice that could encourage others to follow suit. He repeated the Prime Minister's warning that, when this is all over, people would be asking: 'What did you do to help other businesses and your community?'

The minister said the government was looking at how some of the £4.5bn held in retention payments might be released to help cash flow in supply chains. He also acknowledged the important role construction would play in the economic recovery and said the government was keen for projects to continue as long as it was safe for workers.

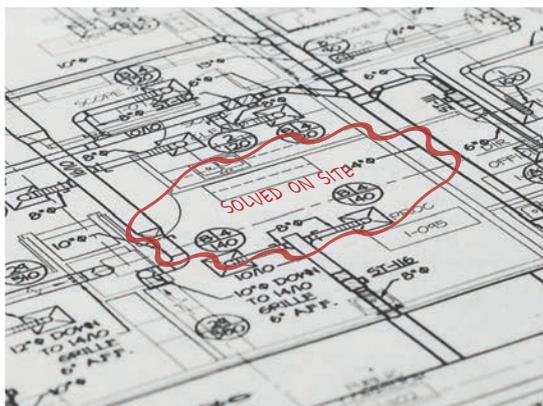
**Energy efficiency inquiry launched**

An inquiry into energy efficiency, with a focus on a post-Covid stimulus, has been announced by the Environmental Audit Committee. The committee will follow up on the findings of the former BEIS Committee's inquiry into energy efficiency - which concluded that major policy gaps still exist - and consider whether its recommendations have been implemented.

In the UK, homes account for just less than 30% of energy use and around 20% of greenhouse gas emissions, and housing is one of the few sectors in which emissions reductions have stalled. Space heating is the dominant driver of energy consumption in existing homes (making up 63% of annual energy consumption), followed by hot-water demand and appliance demand.

The government has pledged £9.2bn to improve the energy efficiency of homes, schools and hospitals, and investments could be particularly relevant to kick-starting the economy in the aftermath of Covid-19 by making it a national infrastructure priority.

The inquiry is accepting evidence until Monday 22 June. For details, visit [bit.ly/CJJun20EAC](https://bit.ly/CJJun20EAC)

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## IN BRIEF

### Award launched in memory of young lift engineer

The University of Northampton and LECS UK has announced a new student award in memory of lift engineer Alex MacDonald who died in February this year.

The Alex MacDonald Award for Lift Engineering, plus £200 prize money, will be awarded annually for an outstanding dissertation submitted by the MSc lift engineering students at the University of Northampton.

Alex, 29, who worked for LECS, gained a degree in lift engineering from the University of Northampton and was due to start a Master's degree in lift engineering in September.

Dave Cooper, CIBSE board member, said: 'Alex was just about to get his membership of CIBSE – which was a great achievement for a man of such tender years.'

### Area backs 'fresh air' ventilation approach

The European contractors' group Area has published systems advice during the Covid-19 outbreak.

Its latest technical bulletin, reflects similar guidance from other organisations in recommending that ventilation or air conditioning systems should be set to run on 'full fresh air', with recirculation turned off.

Area's document also sets out a range of special maintenance measures, with particular reference to the changing and cleaning of filters.

### New grant scheme to replace RHI

The government has said it will replace the Renewable Heat Incentive (RHI) with a new Clean Heat Grant.

The non-domestic RHI scheme will close to new applicants from April 2021, although the scheme for households has been extended until March 2022. A consultation had been launched to consider the new grant that would then take its place and offer funding of up to £4,000 for each household or business that invests in renewable heating, including heat pumps.

An eligible list of technologies applicable for funding support will also be published.

# Checklists offer safety advice as sites return to operation

**Guidance will help firms ensure health and safety principles are embedded in their day-to-day operations**

Training body the CITB has worked with the Construction Leadership Council (CLC) to produce a range of interactive checklists and forms to help construction employers apply 'site operating procedures' (SOPs).

The guidance is designed to help construction sites interpret and apply rules on a wide range of safety concerns – including social distancing, close working, cleaning and what employees should do if they become unwell – as more sites open up after the Covid-19 lockdown.

Among the checklists is one designed to ensure compliance with current guidance on protecting the workforce on site. It can be amended with additional comments to make sure it aligns with specific site policies.

Another helps organisations establish whether health and safety principles are embedded in their day-to-day operations during the pandemic.

There is also a guide offering example control measures for those required to do risk

assessments of the workplace and specific activities on site. This is accompanied by an interactive risk-assessment template.

In addition, the CITB has provided a 'toolbox talk' for construction workers, which is designed to be delivered by their manager or supervisor.

'Good communication is essential for health and safety management on construction sites,' said the CITB. 'It is vitally important that contractors, managers and supervisors engage and consult with workers, as it is an effective way of identifying hazards and controlling risks.'

To complement the SOPs, the government has also published its 'Covid-19 secure' guidelines. Business Secretary Alok Sharma said: 'This guidance provides a framework to get the UK back to work in a way that is safe for everyone.'

'These are practical steps to enable employers to identify risks that Covid-19 creates and to take pragmatic measures to mitigate them.'

An extra £14m has been made available to the Health and Safety Executive to help police the new guidelines, Sharma said.

# Buyers report sharpest fall on record

Construction buying activity has fallen at its steepest rate for nearly a quarter of a century. The IHS Markit/CIPS UK Construction Activity Index, which started recording figures 23 years ago, has reported a series of new lows. Its headline figure fell from 39.3 in March – where a score of 50 indicates no change – to just 8.2 in April. The previous record low was 27.8 in February 2009, after the financial crash.

All three main categories of construction work experienced record-breaking falls, with housebuilding (7.3) and commercial activity (7.7) below civil engineering (14.6). The lower volumes of output were almost exclusively because of business and site closures.

Supply chains were also hit hard, with many builders' merchants closed and limited manufacturing production resulting in supply shortages. The average lead times for the delivery of construction products and materials was also at its worst level since the survey began in 1997. The survey also indicated the steepest decline in subcontractor usage in its history.

## IN BRIEF

### Member appointed to HK government

Congratulations to CIBSE Distinguished Steward Alfred Wing Hang Sit on his appointment in May as Secretary for Innovation and Technology of the HKSAR government's Innovation and Technology Bureau. In his former post as director of electrical and mechanical services, he stressed the importance of innovation in our profession. Eric Yiu Hung Pang will succeed him as CIBSE Distinguished Steward.

### Applications update

If you are submitting a membership application, CIBSE no longer requires you to send a hard copy through the post. Please only send an email copy of your application to [membership-apps@cibse.org](mailto:membership-apps@cibse.org). The closing date for UK Associate (ACIBSE) and Member (MCIBSE) applicants is 1 August.

For details of what to submit, visit [cibse.org/closingdate](http://cibse.org/closingdate)

### New position statements

CIBSE has published four new position statements that summarise its position and policy recommendations on four topics: overheating; air quality; operational net-zero carbon buildings; and towards a better planning frameworks to address climate change. Read them at [bit.ly/CJJun20pos](http://bit.ly/CJJun20pos)

### New WeAreCIBSE blog

As part of the #WeAreCIBSE campaign, CIBSE is asking members to share inspiring stories of how they have contributed to the fight against Covid-19, using the #WeAreCIBSE hashtag.

A new blog post was published in May, by CIBSE member Adrian Cairns, building services lead engineer on the Nightingale Hospital, Yorkshire and the Humber. See [cibseblog.co.uk](http://cibseblog.co.uk)

### Flat-roof design bulletin

The Society of Public Health Engineers has published a technical bulletin on rainfall intensities and drainage design for flat roofs. You can download it for free at [cibse.org/knowledge](http://cibse.org/knowledge)

# Guidance on reoccupying buildings after lockdown

## Documents cover safe working practices and the assessment of building services

CIBSE has published guidance for business owners and managers on the safe reoccupation of buildings after lockdown.

As businesses start to consider bringing

staff back into work premises, several issues need to be considered for the safety of everyone entering the building. Government guidelines should be followed.

The CIBSE guidance document is intended to give business owners and managers an outline of the main areas that need to be considered concerning safe working and the assessment of building services.

Additional guidance is available that looks at the issues around ventilation, and lifts and escalators:

*Ventilation guidance* is aimed at building owners/managers and operators when reopening buildings after a period of inactivity and considering the requirements for the ventilation system (see page 37).

*Recommissioning of lifts and escalators post-lockdown* – many lifts and escalators will have been switched off during lockdown. While most will go back into service without any glitches, some precautionary steps should be taken before returning them to regular service.

● Visit [cibse.org/coronavirus](http://cibse.org/coronavirus) to access the guidance.



## Circular economy insight is out

CIBSE's new *Research Insight on Circular Economy* publication builds on the work presented in CIBSE TM56: *Resource efficiency of building services*, and introduces circular economy principles for mechanical, electrical and public health (MEP) systems. The findings presented in the document are based on *Servicing the Circular Economy*, a research project conducted by Arup and University College London (UCL), sponsored by Schneider Electric and supported by Aecom.

The project investigated the application of circular economy principles to the MEP systems of UCL's new Marshgate building under five discrete scenarios. A comparison is presented in terms of high-level indications of life-cycle cost and life-cycle carbon impact.

CIBSE's document is intended to provide a framework to facilitate circular economy thinking in any project environment, to address environmental issues associated with the production of building services equipment and the challenges faced by building operators. A webinar on the publication will take place on 18 June. To register, visit [cibse.org/GrowYourKnowledge](http://cibse.org/GrowYourKnowledge)

● To download the publication, visit [cibse.org/knowledge](http://cibse.org/knowledge)

## New officers elected to CIBSE

Stuart MacPherson FCIBSE took up office as CIBSE President at the Institution's AGM on 5 May, taking over from Professor Lynne Jack. CIBSE also welcomed Kevin Kelly FCIBSE FSLL as president elect, and the new CIBSE officers and Board members, including:

■ **Immediate past-president:** Lynne Jack FCIBSE FSOPHE

■ **Vice-president:** Ashley Bateson FCIBSE

■ **Vice-president:** Susan Hone-Brookes FCIBSE

■ **Vice-president:** Kevin Mitchell MCIBSE

■ **Hon treasurer:** Adrian Catchpole FCIBSE

■ **Board members:** Vince Arnold FCIBSE, David Cooper FCIBSE, Les Copeland FCIBSE, Fiona Cousins FCIBSE, David Fitzpatrick.

Details are on [cibse.org/board](http://cibse.org/board) and the AGM minutes will be published in July's *CIBSE Journal*.

## New members, fellows and associates

### FELLOWS

**Dawood, Nadha**  
London, United Kingdom

**Doherty, David John**  
Dublin, Ireland

**Johnson, Kristian**  
Auckland, New Zealand

**Macklin, Adrian Roger**  
Chesham, United Kingdom

**Phillips, Matthew Dean**  
Henlow, United Kingdom

**Rathbone, Timothy James**  
Newport, United Kingdom

**Zhao, Xudong**  
Beverly, United Kingdom

### MEMBER

**Alygizos, Andreas**  
London, United Kingdom

**Ashman, David Philip**  
Lytham St Annes, United Kingdom

**Au Yeung, Shing Chung**  
Yuen Long, Hong Kong

**Aye, Edmund**  
Auckland, New Zealand

**Babiker Abdelgadir, Abdelrahman**  
Almadinah, Saudi Arabia

**Baptista, Carlos Rafael Nunes**  
Birmingham, United Kingdom

**Bonizzato, Andrea**  
Epsom, United Kingdom

**Borg, Louis**  
Zejtun, Malta

**Broatch, Anthony**  
Freemans Bay, New Zealand

**Chan, Ka Ming Matthew**  
Shatin, Hong Kong

**Chan, Wing Chun**  
Kowloon, Hong Kong

**Chan, Chak Sing**  
Tuen Mun, Hong Kong

**Favatello, Serena**  
London, United Kingdom

**Fuk Hung, Wong**  
Kowloon, Hong Kong

**Gwyn, Thomas**  
Singapore, Republic of Singapore

**Haines, Jonathon**  
Auckland, New Zealand

**Ho, Siu Fung**  
Ngau Tau Kok, Hong Kong

**Ip, Chung Tak**  
Tseun Wan, Hong Kong

**Koo, Tony Chun Wing**  
Jalan Damanlela, Malaysia

**Kumar, Ranjan**  
Mumbai, India

**Lee, Siu Lun**  
Kowloon, Hong Kong

**Lee, Man Kei**  
Quarry Bay, Hong Kong

**Lee, Ka Hon**  
North Point, Hong Kong

**Lee, Wai Sheung Alan**  
Tseung Kwan O, Hong Kong

**Lee, Hoi Yiu**  
Fanling, Hong Kong

**Leung, Ka Yu**  
Shatin, Hong Kong

**Morello, Paride**  
Casale di Scodosia, Italy

**Mousa, Ihab**  
Nasr City, Egypt

**Ng, Sui Kwan**  
Tung Chung, Hong Kong

**Papa, Dorotea**  
London, United Kingdom

**Patterson, Alastair**  
Edinburgh, United Kingdom

**Piekarski, Alekzander**  
Sydney, Australia

**Price, Caitlin**  
London, United Kingdom

**Ricq, Damien Guillaume**  
Mallemort, France

**San, Bing-Yea**  
Loanhead, United Kingdom

**Savvopoulos, Ioannis**  
London, United Kingdom

**Sotiriadis, Michail**  
Manchester, United Kingdom

**Summers, David**  
Auckland, New Zealand

**Thomaidis, Ioannis**  
Cobham, United Kingdom

**Tombolesi, Benedetta**  
London, United Kingdom

**Tse, Lung Hin**  
North Point, Hong Kong

**Vissariou, Pafsanias-Athanasios**  
Edinburgh, United Kingdom

**Wong, Wai Kit Alan**  
New Territories, Hong Kong

### ASSOCIATE

**Bevans, Alun**  
London, United Kingdom

**Kadu, Adam**  
Blackburn, United Kingdom

**Nicol, Graeme Donovan**  
Warrington, United Kingdom

### LICENTIATE

**Ale, Divas**  
Bristol, United Kingdom

**Blackshire, Harry**  
Bristol, United Kingdom

**Farncombe, Arlow**  
Solihull, United Kingdom

**Harris, Idrees**  
Preston, United Kingdom

**Hiscocks, Daniel**  
Manchester, United Kingdom

**Lambton, Alexander James**  
Darlington, United Kingdom

**Leung, Ka Wai**  
New Territory, Hong Kong

**Mcnaught, Andrew**  
Nottingham, United Kingdom

**Mott, Elliot**  
Sheffield, United Kingdom

**Penny, April**  
Liverpool, United Kingdom

**Russell, Tom**  
York, United Kingdom

**Skarvold, Anthony**  
South Shields, United Kingdom

**Tahir, Khawaja Noman**  
London, United Kingdom

# Pause, reset... inspire!

The current crisis has created a new collaborative culture and focus on wellbeing, says **Josh Emerson**

New CIBSE President Stuart MacPherson has called on us all to take stock as we emerge from the coronavirus crisis. This is a time to pause for breath, evaluate, and see what we can learn from this extraordinary experience.

The building services sector did a great job in rallying around essential services – not least the NHS Nightingale hospitals, which were designed, built, commissioned and handed over at lightning speed. Dame Judith Hackitt was impressed, pointing out that the industry proved it was more than capable of making the changes she is demanding. The process where ‘collaboration and cooperation replaced fragmentation and adversarial behaviour’ should become the blueprint for future projects, she believes.

The NHS emergency projects encouraged companies to avoid confrontation and legal conflict in the interests of getting the job done to a high standard and within a short timeframe.

We also benefited from an acceleration in the use of digital technology to support remote working, and to monitor and maintain building systems that were hard to access during lockdown. Another unanticipated benefit of an imposed remote-working culture was the chance to spend more time talking about projects with clients – and, so, on upfront design.

There was a welcome focus on health and wellbeing, too, and Covid-19 will continue to focus our minds on the need for high-quality indoor environments and the value of the systems (and expertise) needed to provide them.

Our work in building services directly contributes to the health and wellbeing of occupants, but this has not always been apparent to the public. Now, through the media and discussions with friends and colleagues, greater emphasis is being placed on the impact building services can have on societal development. This is a great profile-raiser for our profession, particularly with young people who might consider joining the industry eager to make a difference. And it could not be better timed, as this year marks the 25th anniversary of the CIBSE ASHRAE Graduate of the Year Award. As a long-term sponsor, Swegon is delighted to continue its support.

We will emerge from this crisis with lessons learned, and a powerful message around health and collaboration with which to inspire a new generation. Let's make sure it does not go to waste.

● For details of the Young Engineers Awards, visit [cibse.org/yea](http://cibse.org/yea)



# Swegon

# Building back digitally

There are calls to ‘build back better’ as we seek to recover from the Covid-19 pandemic. Hywel Davies describes the role digitalisation has to play in making buildings safer and more cost efficient

In 2011, the government’s Construction Client Group Building Information Modelling (BIM) Working Party produced a strategy paper for the UK. It came to be known as the UK BIM Strategy, and led to the creation of the UK BIM Task Group and the ‘BIM Level 2’ mandate for central government construction projects.

Adopting digital working practices in construction is commonly referred to as ‘BIM’, but this can lead to undue focus on software and insufficient attention on adopting digital working practices to transform processes and outcomes.

The BIM Task Group commissioned a series of standards and Publicly Available Specifications (PAS) to support the BIM mandate. These included the PAS 1192 series for BIM in the capital and operational phases of a building.

The BSI BIM committee brings together stakeholders from industry, government, and professional and trade bodies. In 2013, it decided that the UK interest was best served by taking the emerging PAS 1192 series to ISO, to develop an international standard for digital information management in construction. This resulted in the ISO 19650 series of standards. These are now adopted as European standards – which means they are British Standards, too. While the UK has left the EU, BSI remains a member of CEN and we continue to adopt European Standards under the rules of that European standards body.

The BIM Task Force was stood down in 2016 and the Centre for Digital Built Britain (CDBB) set up at the University of Cambridge to lead development of digital thinking for the built environment and wider UK perspective. Its *Gemini Principles* report on digital twins was published last year.



“Effective information about a building can deliver lasting benefits and significant cost savings”

The UK BIM Alliance is an industry-funded body of digital practitioners committed to the adoption of digital technologies in construction. After adoption of the first two standards in the 19650 series in 2018, it worked with BSI and CDBB to create the UK BIM Framework to replace the BIM Level 2 concept. The guidance supports and explains the new standards in terms of UK practice and process. The fourth edition was published in April 2020.

CDBB recently led a review of digital interoperability in UK construction. It recommends a renewed mandate for BIM to drive development of open interoperable data, with a steering group to lead, and champion, the development and implementation of this new mandate.

One benefit of adopting BIM, proposed in 2011, was to measure ‘how well a construction asset meets the target outcomes’. If meeting legal or specific building safety requirements is considered to be a target outcome, then BIM can certainly help to measure outcomes.

This concept relates closely to provision of the data required for the ‘golden thread’ of information, a key strand of the building safety programme. This is a great opportunity to embrace the huge amount of work and investment already made by the UK BIM Alliance, BIM Task Group, CDBB and BSI to develop the existing UK BIM framework.

We have the capability to deliver essential information about a built asset, whether that be on fire safety, ventilation or water systems, or other areas of particular interest as we seek to reopen buildings safely. Effective information about a building can deliver lasting benefits and significant cost savings in operation. The Gateway process envisaged by the Hackitt Review offers an ideal framework for achieving that. Access to that information at appropriate stages during design and construction can allow regulators and building control professionals much more insight into a design. Regulators working digitally and interoperably with the design and construction team could reduce delays and improve information exchange.

In the new socially distanced world, there is also an opportunity to reduce site visits or meetings by working online. It needs investment in software and training, and in implementing the UK BIM Framework effectively – but if we build back digitally, we can build back much better.

**DR HYWEL DAVIES**  
is technical  
director at CIBSE  
[www.cibse.org](http://www.cibse.org)

## BIM STANDARDS

ISO 19650 *Organization and digitization of information about buildings and civil engineering works, including building information modelling (BIM) — Information management using building information modelling* was published in 2018. There are two parts: *Part 1: Concepts and principles*; *Part 2: Delivery phase of assets*.

ISO 19650-3, covering the operational phase and ISO 19650-5, which addresses security concerns, will be published shortly.

In addition to the ISO 19650 series, there is a considerable body of other standards covering information exchange, data templates and interoperability being developed within CEN and ISO.



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# KEEPING CARBON IN MIND AMID COVID-19

He is starting his CIBSE presidency under lockdown, but **Stuart MacPherson** FCIBSE is determined to reduce the performance gap and push for net-zero carbon in buildings. To do so, however, will potentially mean a radical rethink of how we work

**W**hen Stuart MacPherson was named CIBSE president-elect last year, he did not expect to be leading the Institution through one of the most tumultuous periods in recent history.

The Covid-19 pandemic has so far killed more than 300,000 people across the globe, and is threatening the livelihoods of millions as the world economy teeters on the edge of a precipice.

‘The ramifications of Covid-19 have impacted everyone, and the professional institutions are, of course, no exception,’ said MacPherson, in his presidential address from his home in Scotland last month. ‘I realise that many listening will have experienced the loss of someone or be enduring the stress of working in the healthcare estate – or, perhaps, managing on a much-reduced income.’

CIBSE and its members have a crucial role to play in minimising the spread of Covid-19 in buildings, as governments slowly encourage their reoccupation. MacPherson drew attention to what CIBSE has done so far in response to the pandemic, including the publication of technical guidance for safeguarding buildings, and the advice given to government through the Royal Academy of Engineering and the government’s Scientific Advisory Group for Emergencies.

He also highlighted the generosity of CIBSE members in the Hong Kong region, who raised £12,000 to send personal protective equipment to the NHS.

Expert guidance produced by CIBSE will help form the basis of HVAC strategies drawn up by building managers striving to make premises safe for returning workers and school pupils. ‘The future health of nations and their populations will depend on how well the rate of infection is controlled as lockdowns are lifted,’ said MacPherson.

While acknowledging the severity of the impact of Covid-19, MacPherson is determined that the presidency should not be overshadowed entirely by the virus. ‘A crisis takes our eye from other pressing problems, which also need action, and it can deplete the reserves of personal energy and hard finance that we need to deal with the longer-term issues,’ he said.

MacPherson noted that, in a ‘brutal irony’, the effect of Covid-19 had done much to curb CO<sub>2</sub> emissions, but he warned that other crises over the past 50 years had always resulted in emissions falling before they rebound to higher-than-previous levels within a short time.

‘Governments anxious to stimulate their economies have tended to deregulate and delay things such as

stricter building regulations, for fear of inhibiting investment,’ said MacPherson, who urged governments to, instead, choose economic stimulus packages that reduce emissions through investment in clean technology and associated skills.

High on the list of the President’s priorities is to drive net-zero carbon emissions in building stock while decarbonising the energy supply. ‘We need to embark on a much more ambitious programme of refurbishment of the existing building stock, combined with ways of decarbonising the energy supply to those buildings,’ he said.

It is imperative that industry defines what is meant by net-zero carbon, MacPherson added in an interview with the *CIBSE Journal* after his address. Currently, if buildings use more energy than onsite

Credit / Jennifer MacPherson

## CAREER CV

**Born:** Scotland

**Education:** BSc Physics, MSc Building Services Engineering, MBA, PhD, all from Heriot-Watt University, Edinburgh

**Career:** Engineer with Premier Control Systems in the mid-1980s; researcher and lecturer at Heriot-Watt University in the early 1990s; senior engineer, then director at Irons Foulner Consulting Engineers from the mid-1990s; CIBSE Member since 1990

**Outside interests:** Field Judge for UK Athletics, and assistant Scout leader

“A crisis takes our eye from other pressing problems, and can deplete the personal energy and hard finance we need to deal with longer-term issues”

renewables can generate, owners are allowed to 'offset' the carbon emissions associated with the building's net energy use by reducing emissions elsewhere.

'The danger is that there is an opportunity to fudge the issue by not balancing CO<sub>2</sub> emissions in a legitimate way,' says MacPherson. 'We must find a way of genuinely offsetting. It may mean the construction of more offshore wind farms or the planting of forests, but it needs to be done in a way that is auditable.'

'Some existing buildings are hard to treat, especially the historic stock. Even if you make all the fabric improvements you reasonably can, you won't have a super-efficient building. So what do you do? You try to decarbonise the energy supply.'

MacPherson hopes to see new CIBSE guidance on carbon offsetting and retrofitting during his period in office. District heating and energy from waste are low carbon energy sources that he is keen to promote, and he believes the UK should be looking at best practice from around the world – for example, Denmark, for innovations in district heating. 'Some countries do better than others in certain areas,' he says.

In the UK, MacPherson believes the government should be paying more attention to demand-side policy, instead of prioritising supply. He would like a longer-term guarantee for the renewable heat incentive scheme and the reintroduction of the feed-in-tariff for onsite renewable electricity generation.

But he warns that energy must not be the only driver in the design of new buildings. Too often, he adds, other aspects of building performance – such as thermal comfort, safety and air quality – are

## "We must find a way of genuinely offsetting. It may mean constructing more offshore wind farms or the planting of forests, but it needs to be done in a way that is auditable"

'subordinated in the pursuit of net-zero carbon'.

More holistic systems thinking is needed in design processes, says MacPherson, who thinks buildings are too sensitive to external influences, such as changes in occupant density or breakdowns in plant. 'In our industry, we have a well-known gap between models and actual building performance that suggests our models do not properly reflect the real world.'

Part of the explanation, he adds, is that models are usually optimised to an ideal – and, therefore, wrong – set of assumptions, where 'nothing changes and nothing ever goes wrong'. 'We need optimisation that is not so sensitive that our systems fail because of relatively minor variations in external influences.'

MacPherson believes modelling needs to account for a wider range of factors than just energy efficiency – for example, thermal comfort, indoor air quality and the visual environment. 'We need to focus on resilience as well as peak performance,' he says.

CIBSE is partnering the University of Strathclyde in a Resilience Testing Project that aims to find out how building models respond to a range of variables over a simulated time period. These simulations could provide accurate information on the sensitivity of buildings to disruptive events. 'It is a very ambitious programme, but we hope to prove the concept that such simulations are possible,' says MacPherson.

Data will play an increasingly important part in the optimisation of buildings and energy use, he adds, with smart grids and buildings enabling the Grid to match supply with demand by shifting loads. 'Big data can harness the mass of information that is all around us to identify where problems have occurred or where building performance can be improved.'

However, MacPherson spells out two threats to such information systems: the misuse of data gathered from buildings and people, and the potential for hackers to take control of BMSs and damage systems, or hold building owners to ransom. CIBSE publication *Cyber Security DE 6.1* draws attention to such risks, he adds: 'It identifies the need for dedicated security experts to review and feed into building design.'

As countries emerge from the Covid-19 crisis and start to rebuild economies, MacPherson says the industry must reflect, and look at new ways of approaching projects. He calls on engineers and other professionals in the built environment to do what they can to 'ensure we have real influence, and deliver on tangible solutions for safe, energy efficient, high-performing buildings and infrastructure after this crisis has passed'.

'It should not be a return to business as usual,' he says. **CJ**



# STAYING SAFE

To protect staff from the risk of being infected by Covid-19 as they return to workplaces, buildings managers will have to adopt rigorous maintenance regimes to ensure the virus can't take hold. **Alex Smith** finds out why facilities managers will be key to creating Covid-secure buildings

**T**he government's plans for a return to work amid the coronavirus pandemic has put buildings' reoccupation strategies under intense scrutiny. Workers want reassurance that their offices, factories and schools are safe to go back to. Their fears are reflected in a survey of homeworkers, who were asked about the possibility of returning to the office; 30% of respondents were concerned about office layouts, while 28% feared travelling in congested elevators.<sup>1</sup>

The onus for ensuring buildings are safe to reoccupy falls on the buildings and facilities managers (FMs) responsible for maintaining and operating them. They will have to ensure that systems meet statutory requirements, and that activities to prepare a building for reoccupation are risk assessed and done using a safe method of working, following guidance such as CIBSE Guide M and BESA SFG20/30.

CIBSE's new *Emerging from Lockdown*<sup>2</sup> guidance details the building systems covered by statutory requirements. It also has new guidance on lifts (see panel, left, 'Recommissioning lifts and escalators') and ventilation (see page 38).

Guidance, from CIBSE and others, on creating Covid-secure workplaces includes reducing the risk of airborne particles by boosting ventilation, turning off recirculation, and ensuring negative pressure in toilets.

'The facilities managers will lead the reoccupation of buildings, and businesses will look to ensure they have done everything possible to make them safe,' says James Campbell, partner at building services consultant Troup Bywaters + Anders (TB+A), which operates as a technical consultant to property services companies. He adds that it is important to first understand how buildings are operating: 'It's easy to assume a building was performing well before the outbreak, but issues that weren't critical before Covid-19 may now be. We need to rectify these.'

Campbell estimates that around 75% of systems on projects on which TB+A is working are not performing as designed and, in some cases, he recommends that HVAC be recommissioned to identify issues. 'We now have to ensure the building is fully operational



**"It's easy to assume a building was performing well before Covid-19, but issues that weren't critical before the outbreak may now be"**

and performing as it was designed, or better, otherwise people's health is at risk,' he says. (See panel, 'Continuous commissioning'.)

Austin Wikner, head of Building Services London at WSP, says that Covid-19 means maintenance will become more regular. 'Irrespective of good practice, the volume of HVAC maintenance will increase, and filters will have to be cleaned regularly.'

Generally in the UK, new buildings are well designed in terms of ventilation and being able to stop recirculation of air, says Campbell, as systems can be adjusted to be supplied with 100% fresh air. Where systems need recirculation, then filtration and air-treatment methods will need to be considered. 'It's important to understand where there might be spare capacity,' he adds. 'For example, we're operating on a building that's been

## RECOMMISSIONING LIFTS AND ESCALATORS

Many lifts and escalators will have been switched off for lockdown, so some precautionary steps should be taken before returning them to regular service, according to CIBSE's new guide *Covid-19 recommissioning of lifts and escalators*, released on 12 May

Lifts with a rated load of 20 people or fewer will only be able to carry one person and observe the 2m social-distancing rule, so the guidance suggests staggered working hours to reduce peak demand on lifts. It also advises cleaning surfaces - including push buttons - frequently, bearing in mind that some cleaning agents may cause damage to buttons and/or cause them to stick.

You should ensure the Loler certificate is up to date. Loler applies to workplaces, and requires passenger-carrying lifts to be thoroughly examined every six months.

If the lift has been out of service and decommissioned properly, the lift contractor should reinstate it. A routine maintenance visit will also be useful to get the lift back into service, the guidance says.

Escalators may need their drive and steps chains lubricating - and make sure no foreign bodies that may cause a comb-plate trip are on the step band when restarted.



Left: Cushman & Wakefield has created a pilot of a 6ft Covid-secure office in Amsterdam. The property services company has a six-point plan for reoccupation: prepare building and workforce; control access; create social-distancing plan; reduce touch points; increase cleaning; and be honest with occupants. See more at: [bit.ly/CJJun20Covid3](https://bit.ly/CJJun20Covid3)

## CONTINUOUS COMMISSIONING

A continuous commissioning programme of a building's engineering services can help identify system performance and operational issues that may not be apparent normally, says TB+A's James Campbell. These are some of the typical issues identified in recommissioning:

### General ventilation systems

Incorrect fan-speed settings, system balancing and faulty or incorrectly set dampers are some of the issues found when recommissioning.

This will result in reduced air-volume flowrates provided to spaces than originally designed, so they may not be providing the correct level of fresh air and air changes. Impaired ventilation rates can cause stagnation of air within spaces, increased CO<sub>2</sub> levels and poor indoor air quality.

### Toilet ventilation systems

Toilet ventilation is often found to be unbalanced, which may lead to an area not achieving negative pressure.

### Heating and cooling systems

In an attempt to satisfy all occupants all the time, it is common to find that local adjustments have been made at terminal units, such as fan coils. This may be adjustment of fan speeds or even heating and cooling commissioning sets and isolation valves.

It is not uncommon to find FCUs isolated completely because of occupant complaints. This can cause reduced fresh air supply to the occupied space and air stagnation in concentrated areas that is undesirable.

### BMS

Recommissioning of the BMS can be a significant exercise, but simple checks and periodic calibration of field devices – such as sensors and actuators – is critical to ensure correct operation of systems as a whole.

A faulty temperature sensor within an AHU, for example, may result in overheating or cooling, and an incorrect ratio of fresh air to recirculated air, resulting in poor internal environmental conditions.

## References:

- 1 Your day in the office is unlikely to be the same ever again, D2E Vertical Transportation consultants, May 2020 [bit.ly/CJJun20Covid1](https://bit.ly/CJJun20Covid1)
- 2 Emerging from lockdown guides, CIBSE, May 2020 [bit.ly/CJJun29Covid2](https://bit.ly/CJJun29Covid2)

designed for a density of one person per 10m<sup>2</sup> of floorspace, but it can achieve enough ventilation for one per 7m<sup>2</sup>, which means we can increase air changes by using the spare capacity within the system if required.'

WSP's Wikner says higher ventilation rates may mean noisier fans as they run at higher speeds. 'Quite often, fans are sized up so they can run at a low rate quietly. We may have to accept that, with higher ventilation, it will be noisier,' he says. The impact of lower occupancy will also have to be considered. 'There may be lower heating and cooling demand, and that may affect the performance of plant,' Campbell says. The recommended increase in ventilation, and running plant 24/7, will also significantly affect the drive towards zero carbon, he adds.

If offices have zoning set up properly, HVAC could be adjusted for smaller heating and cooling loads, says Cundall associate Kavita Kumari – although social distancing must be maintained. 'Just because you have a quarter of the staff doesn't mean squeezing them into one corner of the office,' she says.

## Smart systems

According to Wikner, smart technology has a role in managing coronavirus risk by ensuring that buildings can be touch free for occupants. 'For not a huge amount of money, motors on doors, sensors, touch-free taps and toilets can be installed everywhere,' he says.

Covid-19 will accelerate the use of real-time data to monitor equipment, adds Campbell: 'Engineers have to be able to analyse data to make quick decisions about HVAC operation. Industry skill sets will have to change.'

While smart technology can quickly identify issues in modern buildings, Campbell says, older buildings may miss out unless they have the operational engineering skills or the technology retrofitted, which can be costly. He expects strategies will evolve constantly as lessons are learned, and he sees building managers having key roles in making properties Covid secure.

'For a long time, FMs have not been given deserved representation in firms. Now is the time for us to stand out and support our businesses reoccupation to safe buildings.' **C** >>

**HOW THE UNIVERSITY OF LEEDS' ESTATE HAS STAYED SECURE**

» As the University of Leeds gears up for the start of the next academic year, it is planning a gradual reoccupation of its buildings on a prioritised basis. Matthew Tidmarsh MCI BSE, deputy director of estates (operations) says the university has a diverse range of spaces, including offices, research and teaching laboratories, workshops, small seminar rooms, large lecture theatres and libraries and cafes, and the challenges in each are very different.

After drawing up a list of buildings that need to be operational first – for admissions planning or critical research, for example – the team will focus on the technical compliance of each building, to ensure all services and statutory provision are in a fit state for safe operation. They will then look at: social-distance planning; safe access and egress; transit routes and movement within buildings; and access to, and use of, facilities such as kitchens and toilets. Finally, specific risk assessment of activities within each building will be undertaken to guide staff and, eventually, students on safe use of facilities.

During lockdown, Tidmarsh's team identified the buildings that had to remain operational, including support for the adjacent acute hospital, which is involved in treating Covid-19 patients. 'For the small group of staff on campus, we had to quickly introduce new methods of working that included social distancing and PPE,' he says.

They then looked at buildings that have intermittent access – for example, where critical research equipment is serviced – and introduced a reduced level of compliance support to include life-safety systems and water-hygiene maintenance. 'We carried out a flushing regime that simulates as close to normal occupation to limit the potential for legionella growth,' says Tidmarsh.

In mothballed buildings, water systems have been dosed and left,



The University of Leeds is planning a gradual reoccupation of its buildings

and will be cleaned and flushed before use. 'We will have to carry out testing to make sure our water services remain safe to use,' he says.

Tidmarsh adds they will also need to allow time to enforce social-distancing measures, erect signage, manage access to areas and potentially modify workspaces. New ways of working will become the norm. 'We don't envisage large study groups immediately, so online learning will become an important part of our offer for at least the first term of the next academic year – and, possibly, beyond,' he says. The crisis has created opportunities to understand the practicalities and possibilities of homeworking for staff. 'If we are able to invest in facilities again, we will have a different view on how space might be used,' says Tidmarsh, who adds that ventilation is a big challenge.

'We have buildings dating from the early 20th century that have mechanical displacement ventilation built into the structure, and it's very difficult to change the way they operate,' he says.

'Based on guidance, we are looking to increase fresh air rates to spaces as much as we can, reduce the amount of recirculation to the lowest possible level, and try to avoid sharing air between adjacent spaces, to reduce potential transmission,' he adds.



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IN A CHANGING CLIMATE

## LEADING EDGE

How smart technology will optimise health  
and wellbeing at Edge London Bridge

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# Home comforts



At this time of year, as the weather gets warmer, we are reminded of the adverse affects of climate change. The UK is predicted to experience hotter, drier summers and wetter winters by 2050 – so maintaining comfortable indoor temperatures, while minimising energy use and keeping levels of productivity high, are at the forefront of engineers' minds.

As the Covid-19 crisis rages on, however, many workers will be confined to their

homes for the foreseeable future – and this has shifted the focus away from offices. So how can we ensure homeworkers, without the benefits of air-conditioned offices, stay cool this summer?

As experts point out on page 28, having control over your environment can affect perceptions of comfort, increasing people's tolerance for feeling less physically comfortable. This, as well as adopting a more casual dress code, is much easier at home. The cooling effect of air movement, created through natural ventilation solutions for example, is also key – it can be equivalent to reducing the operative temperature by around 2°C.

While homeworking isn't a choice, it must be fit for purpose.

■ **LIZA YOUNG, DEPUTY EDITOR** lyoung@cibsejournal.com

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# A new way of working



In these uncertain times surrounding the wellbeing of staff members in workplaces, employers may not be considering the importance of the building in boosting employee comfort.

The idea of developing a workplace where

technologies are optimised to encourage wellbeing has been growing in popularity for some years. The importance of a workspace that values employee wellbeing applies not only to traditional workplaces, but also to the now very common working environment – our homes.

Covid-19 will force business to look at different ways of working; the Google and Apple flexible-office approach may no longer be seen as radical, but practical and necessary.

Employers will have to find innovative ways to keep their staff motivated and productive if social-distancing measures continue in the coming months. Flexible working strategies are likely to be high on the agenda for many, and may solve one of the biggest business and environmental dilemmas – growth v building capacity. With a likely increase

in flexible working, companies can – in the, hopefully, not too distant future – still have scope to grow, despite 'staying put'.

The rise in smart home systems, such as lighting, makes it easier for people to create the ideal working environment at home. Traditional workplaces may have a lot to do to convince employees that the office is still the best place for them to be productive and comfortable.

Lighting, as a key component of our circadian rhythms – and particularly noticeable when implemented in a bad design – is crucial for maintaining staff wellbeing in the workplace. So ensuring workplaces are fitted with the latest, human-centric lighting designs is crucial to employee retention, comfort and efficiency.

Companies wishing to continue with the traditional office will need to offer something better for their staff. Lighting would be a good place to start.

■ [tamllite.co.uk/wellbeing](http://tamllite.co.uk/wellbeing)



# TM40 guidance relevant to Covid-19 pandemic, says CIBSE

**Document advises on ventilation rates, cleaning, maintenance and humidity**

Some guidance in CIBSE TM40 is relevant to the prevention and recovery stages of Covid-19 in general buildings, CIBSE has said.

The main relevant section in TM40 *Health and wellbeing in building services*, published in March 2020, is Chapter 9, on air quality. It covers:

**Ventilation** – including guidance on locating inlets away from sources of pollution, such as exhausts, and limiting transmission risks by avoiding recirculation and limiting mixing.

**Cleanliness of ventilation systems: designers' responsibilities** – this addresses cleaning after construction and before handover. Ductwork cleaning is recommended for general cleanliness and air-quality purposes.

At this stage, there is no research to indicate that ventilation or air conditioning systems are contributing to the spread of the virus. REHVA advises that 'viruses attached to small particles will not deposit easily in ventilation ducts and, normally, will be carried out by the air flow'.

**Operation and maintenance** – in normal operation, airborne contaminants should be minimised by effective filtration, regular maintenance and cleaning of ventilation systems, as set out in industry guidance.

More information can be found in Chapter 8, on humidity. In line with REHVA guidance, this recommends avoiding very low humidity levels (below 10-20%).

**Filtration and purification** – TM40 was produced before the current coronavirus



pandemic. While it includes general guidance on microbial contamination, knowledge on how to address this particular virus is rapidly evolving. Next month's *CIBSE Journal* will be addressing the suitability of filters in ventilation systems for Covid-19. REHVA advises that contamination from the outdoor air would occur in 'very rare occasions', for example if air intakes were close to exhausts. In this case, some of the virus particles would still deposit on the filter, even if it is not an ultra-fine one. REHVA also advises that special UV cleaning equipment may be installed for the supply air or room air treatment to kill viruses, but this is normally suitable in healthcare facilities – this is in line with TM40 advice.

- TM40 is available at [cibse.org/tm40](http://cibse.org/tm40)
- See also [bit.ly/CJJun20Rehva](http://bit.ly/CJJun20Rehva)

## BESA publishes new documents on air quality

SFG004 *Clean indoor air for health, productivity and wellbeing* is one of two new air quality guides launched by BESA, and advises on achieving clean, filtered air through ventilation.

The other guide is SFG001 *Air filter selection to provide clean healthy indoor air quality for city buildings*, focusing on fitting effective air filtration to clean incoming supply air for mechanical ventilation systems.

It says consideration should also be given to additional measures, such as sealing new buildings to ensure the filters are not by-passed by building leakage, and using elevated room ventilation rates and recirculated air in existing leaky building structures.

## REHVA updates Covid-19 guidance

Revisions and additions to REHVA's Covid-19 guidance include the latest information on airborne transmission and implications for HVAC systems, plus updated ventilation continuous operation guidelines.

The SARS-CoV-2 stability data at different temperatures and relative humidity has been added, and heat-recovery equipment guidance has been revised, including the recommendation of inspection.

Guidance for room-level circulation units has been updated, while advice on HVAC maintenance personnel protection and a summary of 14 practical measures for building services operation have been added.



# Study looks at effect of PU emissions on indoor environmental quality

A summary of research exploring the impact of off-gassing from materials used to insulate homes has been published in the Natural Ventilation Special Interest Group newsletter.

Dzhordzhio Naldzhiev, of University College London, introduces his latest paper exploring emissions from polyurethane (PU) products and how they affect indoor environmental quality.

The researchers examined all chemical emissions from PU products, and concentrations found in real environments, throughout the entire product life-cycle, including raw materials, emissions during production, application and use, and even emissions in extreme scenarios, such as during fires.

In the next phase, Naldzhiev plans to record long-term (six to 12 months) emission rates from various PU materials, to understand how volatile organic compound emissions vary over time.

He said the data should provide a better understanding of how building furnishings and building materials interact with the indoor environment, and how their emissions could be controlled through ventilation strategies.

Naldzhiev's laboratory and field work data could be used for the development of robust air-quality simulation tools, and for coupling indoor air quality and energy models. See [bit.ly/CJJun20HW](http://bit.ly/CJJun20HW)

# Gaining an Edge

Smart-office pioneer Edge is coming to London and aiming for the highest ratings possible for Breeam and Well certification. **Andy Pearson** speaks to Atelier Ten's Meredith Davey about balancing sustainability and wellbeing, and designing safe services around Covid-19

In April, Dutch developer Edge revealed its designs for what it claims will be London's most sustainable office tower. Edge London Bridge is a new 23,500m<sup>2</sup>, 27-floor commercial office tower, to be built in St Thomas Street, adjacent to London Bridge Station on London's South Bank. The scheme is aiming for Breeam Outstanding and Well Platinum certification, which will make it the first office tower in London to achieve both accreditations at the highest level.

Architect Pilbrow & Partners' design for the scheme includes façades designed to maximise daylight levels, combined with strategically positioned shading and solid elements to minimise unwanted heat gains and losses.

The building is located in a landscaped park, which will be doubled in size as part of the development; the green landscape surrounding the building will continue inside, via a publicly accessible ground floor, which will include extensive vegetation and a coffee bar. The vegetation theme continues vertically, on the balconies of the upper floors.

'We did not want this building to appear to be sealed off; we wanted something open and permeable and green – so we've tried to create an office tower with the feel of a smaller-scale building by opening its lower floors to the park for fresh air and daylight, and to encourage interaction with the community and our

neighbours, which is important for health and wellbeing,' says Bernard Heersche, executive development director at Edge.

The project is being designed to create a sustainable working environment enabled by technologies. Heersche says that building CO<sub>2</sub> emissions have to be addressed as they make up 32% of the global total.

'The other issue is that people are not always engaged because of the buildings we put them in – they need to contribute to the health and wellbeing of occupants,' he says.

Alongside sustainability and wellbeing, smart technology is the third pillar of the developer's design philosophy. What makes its properties smart is a state-of-the-art technology platform that connects everything and everyone in the building.

The lower floors will open on to a park for fresh air and light



'It is only by continuously measuring and monitoring that you can ensure you get air and light to the right places, and that you can adjust the systems in your building all the time to make it run as efficiently as possible,' says Heersche.

Sustainability, wellbeing and smart technology are integral to the building services scheme. 'The focus of almost every design decision on this project has been through the lens of sustainability and health and wellbeing in one form or another,' says Meredith Davey, a director of its building services engineer Atelier Ten. Even though Breeam is focused on the sustainable

environmental performance of the building, and Well Certification on occupant health and wellbeing, Davey believes there is no conflict in developing a design to comply with both schemes. He does, however, say there is some trade-off from a sustainability perspective, with the extra fan power required to move the additional volume of fresh air through the buildings to comply with Well.

Deciding on an appropriate fresh-air rate for the building was 'the focus of a lot of discussion', says Davey. Currently, the design is based on a fresh-air rate of  $2 \text{ L s}^{-1}\cdot\text{m}^{-2}$ , which, he adds, is 'industry leading for a building of this scale in London'. Davey looked at fresh air rates of comparable buildings, and found the highest rate to be  $1.9 \text{ L s}^{-1}\cdot\text{m}^{-2}$ . BCO guidance recommends between  $1.6$  and  $1.8 \text{ L s}^{-1}\cdot\text{m}^{-2}$ . 'We are aiming to have greater volumes of fresh air than others,' says Davey.

Towers are compact forms, so this enhanced quantity of fresh air will come at a cost to core and plant areas. 'There was an informed team discussion about how healthy we can make the building and at what development cost,' says Davey.

An underfloor system delivers fresh air to the office floors. The decision to



"The focus of almost every design decision on this project has been through the lens of sustainability and health and wellbeing"



London Bridge is the location for Edge's new project

### BUILT-IN INTELLIGENCE

Real-time data from the thousands of sensors at Edge London Bridge will be collected to help operators and the tenants to analyse, understand and optimise the building and its systems.

'Smart technology is not an end goal in itself,' says Heersche, 'but - if you have a lot of smart technology in your building - it will, for example, enable you to pump less air through your building in total, because it allows you to only pump air to the populated areas at any point in time.'

On previous schemes, the sensors have been used to tell a business how well its meeting rooms are being used, for example. 'If the meeting rooms have been designed for six people, and the sensors show that, on average, there are 2.2 people using them, we'd advise the business to think about reconfiguring them,' says Heersche.

The smartphone will be the workers' passport to Edge London Bridge. On previous schemes, Edge has used an app to let users personalise their workplace and customise the lighting and temperature. The app gives users access to the building, and enables them to locate their colleagues quickly and find available meeting rooms or workplaces.

Over time, it will enable Edge to add extra services to meet the changing needs of tenants and users, to continue to optimise user comfort, productivity and creativity. The app also offers a mechanism to relay to people, individually, the impact of decisions they make on building performance.

Over time, it is hoped that the smart technology will provide information that will be able to measure productivity improvements and benefits: 'We know from Deloitte, when they moved to the new Edge Amsterdam, that sick leave went down, absenteeism went down, and staff retention went up,' says Heersche.

» supply air through the floor was driven by occupant wellbeing considerations and the system's ability to 'wash out pollutants from bottom to top', says Davey. It is not true displacement ventilation where the air flow is sized for thermal loads, says Davey, but it is similar and provides fresh air only from a floor-based system.

This solution also ensures the building's exposed soffits will remain free of ductwork. By contrast, a high-level air-supply solution would have mixed the fresh air with vitiated air in the space. The extract grilles are at the face of the core with controls within the riser to allow for balancing.

In addition to mechanical ventilation, the scheme will incorporate perimeter openings to allow the office floors to be naturally ventilated. 'This was a ventilation solution developed in response to a number of drivers,' Davey says.

The windows will have contact sensors and will locally shut the system down in the naturally ventilated areas, says Davey. The modularity of the ceiling radiant panels (climate islands) allow them to be individually turned on and off depending on how far the natural ventilation penetrates.

Of course, the biggest issue when talking about designing for occupant wellbeing at the current time is ensuring the building is designed to minimise the spread of coronavirus. The International Well Building Institute has formed a Covid-19 task force<sup>2</sup> to inform future enhancements to the Well Building Standard, but it has yet to publish guidance on the measures it recommends to deal with the virus. The design does, however, align with the initial Covid recommendations published by CIBSE and other HVAC bodies.

'On a technical level, CIBSE's initial document<sup>1</sup> says to: *try to use natural ventilation* - we've got the ability to open the façade; and to *run the ventilation system out of hours*, which we've got, too,' says Davey.

'The guidance is obviously going to evolve, but designing a sustainable, healthy building has led us to the position that is closely aligned to where the industry is very likely to end up as a result of the coronavirus.'

Radiant ceiling panels provide heating and cooling to the office floors. The panels at Edge London Bridge are an iteration of a solution developed and used on previous Edge schemes, including the Edge Amsterdam. 'We came with a strong



Covid-19 must now be taken into account when designing for occupant wellbeing

preference for radiant heating and cooling, because we know it is sustainable and much better from an occupant-comfort and health perspective,' says Heersche.

The radiant panels will be supplied with heat and coolth using a combination of heat pumps and chillers. Davey says the site is too small to get 'anything meaningful from the ground', so he's looking at how energy can be recovered from the system instead.

'The cooling system is going to have a constant demand, particularly from tenants' IT loads throughout the year, so I'm looking at how we can recover that heat for use in the building's heating and domestic hot-water systems,' he explains.

In addition to the radiant heating/cooling elements, the ceiling panels incorporate light fittings and eight sensors, including ones for motion detection and to measure light levels, temperature and humidity. The output from the ceiling panels will form part of the digital infrastructure that will connect everything and everyone within the building's walls; the system is fundamental to what makes such buildings smart (see panel, 'Built-in intelligence').

Work is set to start on the construction of what is planned to be London's most sustainable office tower next year, with completion in 2024, when the developer expects the first occupants will take up residence.

Heersche is optimistic the combination of sustainability and wellbeing will be a winning formula in London.

'Intrinsically, sustainability and wellbeing are the right things to do,' he says. 'It also makes sense from an occupier's perspective, because the cost of rent compared with the cost of paying their workers means that it is an absolute no-brainer to pay a small amount more on rent if you can have a more productive workforce.' CJ

**References:**

- 1 Coronavirus Covid-19 and HVAC systems, CIBSE, April 18 2020 [bit.ly/CJJUNE20Edge1](https://www.cibsejournal.com/bit.ly/CJJUNE20Edge1)
- 2 Task force on Covid-19 and other respiratory infections, Well [bit.ly/CJJune20Edge2](https://www.cibsejournal.com/bit.ly/CJJune20Edge2)



The Edge Olympic building in Amsterdam

# Cleaning up

Arbn well is a CIBSE award-winning data analytics platform that could help building managers make their buildings Covid-19 secure.

**Phil Lattimore** looks at how it tracks indoor environmental quality



**M**onitoring and evaluating performance is essential for understanding whether a design is operating as intended, and for ensuring that occupants' health and wellbeing is not compromised by under-par buildings. With multiple performance criteria contributing to occupants' wellbeing and productivity, however, it is a complex area to measure and evaluate.

Scottish building performance technology company arbnco has developed a software platform, arbn well, that measures the health and wellbeing of a building and its occupants in real time. This means building managers can be alerted to subnormal environmental performance before it negatively impacts buildings and people.

Earlier this year, arbn well won the Product or Innovation of the Year - Wellbeing category at the CIBSE Building Performance Awards. It is designed to track a building's operation through a mesh of sensors that measure everything from temperature, relative humidity and CO<sub>2</sub> to total VOCs, particulate matter and light. There are also plans to introduce pollutant sensors for SO<sub>x</sub>, NO<sub>x</sub>, and ozone.

Parag Rastogi, lead building physicist at arbnco, describes arbn well as 'a human-centric solution', which is reflected in the approach to the sensing layout and incorporation of subjective feedback. 'It helps with continuous post-occupancy evaluation (POE),' he says. 'The idea is to move POE from spot checks and one-off surveys to continuous feedback and improvement. This will influence design if designers and engineers are able and willing to take on board the feedback.'

The sensors communicate over a private network using an improved version of long range (LoRa) network protocol that does not interfere with Wi-Fi or mobile signals. They deliver a continuously updated picture of the indoor environment to the cloud-based arbn well platform, which gives real-time information, via a user-friendly dashboard, to building managers, who can access it on a mobile app, PC or other device.

Trends are highlighted and alerts delivered based on customisable thresholds for a variety of environmental criteria. Users can view building data across a portfolio or for a single sensor. Reports are generated automatically to identify long-term issues and trends in building performance, enabling managers to benchmark performance, get actionable insights, and quickly identify and address potential environmental issues.

The third part of the system is feedback collected from occupants via an app or from display terminals, which record personal perceptions and preferences to the nearest sensor in an anonymised way. This allows people to participate in how their building is operated, which, arbnco says, contributes to satisfaction and productivity gains.

The problem with indoor environmental quality is less to do with the guidelines or standards and more to do with implementation, says Rastogi: 'Arbn well was developed because we realised design intent does not translate to operational reality. There are always going to be issues with indoor environments, even

in the best-designed buildings. What we need to get better at is measuring, analysing, and improving continuously.'

## Developments and re-entry

Arbnco has launched a partnership with the US Green Building Council's Arc platform, which will enable users of Arc to report indoor air quality data automatically for Leed certification. It is also undergoing certification with air-quality standard Reset.

In addition, the company is working on hardware and software tools to enable back-to-work protocols after the loosening of the Covid-19 lockdown.

'This leverages arbn well's capabilities to help people understand how well their buildings comply with recommendations from CIBSE, ASHRAE, REHVA, and other professional organisations, when they reopen,' says Rastogi.

The firm has published a white paper<sup>1</sup> summarising Covid-19 guidance and explaining how its service can help facilitate workplace reoccupation.

'A focus on indoor environmental quality is a focus on people,' Rastogi says. 'That should have been the goal of the industry all along. It shouldn't take such a devastating event as Covid-19 to concentrate people's minds.' **CJ**

## References:

- 1 A data-driven indoor air quality framework for post-Covid-19 workplace re-entry, 2020 [bit.ly/CJJun20Well](https://bit.ly/CJJun20Well)



The sensors communicate over a private network, without interfering with Wi-Fi or mobile signals

# Lighting for **Wellbeing**

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In a warming climate, what can be done to maintain thermal comfort and productivity levels in buildings without resorting to excessive cooling? **Phil Lattimore** reports from a CIBSE Health and Wellbeing Group video debate

# The comfort zone

'Comfort standards in a climate-changing world' was the theme of a recent roundtable hosted by the CIBSE Health and Wellbeing Group. The debate discussed the implications of a changing climate for thermal comfort in a range of building types.

Introducing the debate, Ashley Bateson FCIBSE, chair of the CIBSE Health and Wellbeing Group, outlined how climate change will have implications for health and wellbeing in the UK. 'We are expecting hotter, drier summers and wetter winters, and this could detrimentally impact workplace productivity and comfort in schools and homes,' he said.

Bateson explained that, in some circumstances, overheating is already a serious problem, and cited the example of some recently completed student residences that experienced internal temperatures above 30°C, partly because window openings were inadequate. He said much can be done to mitigate discomfort with an appropriate review of the design.

According to CIBSE, six factors directly affect thermal comfort: a person's metabolic rate and clothing level, and the air temperature, mean radiant temperature, air speed, and humidity of the space. The perception of thermal comfort may vary greatly between individuals depending on personal and environmental factors. The participants discussed a variety of adaptation and coping strategies, such as more casual dress codes in offices and flexible homeworking. They also spoke of dispersed working practices within offices, which allow workers to occupy spaces that suit their thermal comfort needs.

Adaptive thermal comfort was discussed as a way of reducing the use of additional cooling as temperatures rise. This is where comfort temperatures gradually rise with the increase of external air temperature, so occupants become comfortable with higher temperatures after an extended period of warm weather, having the flexibility to adjust their clothing and their surrounding environment. Rather than be fixed all year round, temperature setpoints could be adjusted as outdoor temperatures change. Generally, occupants are more tolerant, and have a greater sense of adaptation, if they are in naturally ventilated buildings or in mechanically ventilated buildings with openable windows.

'Our offices in Doha and Melbourne won't switch the air conditioning on until it reaches 30°C,' says Alan Fogarty, sustainability partner at Cundall. 'As the weather gets warmer, people are willing to adapt.'

For occupiers to accept higher temperatures in offices, they need to understand the HVAC, says Derwent London's Olivia Allen. 'In my experience, education around how these systems work is important.'

Henry Pelly, senior sustainability consultant at Max Fordham, said that having some control over decisions, such as using natural ventilation solutions, affected perceptions of comfort. 'Psychologically, if you have a sense of control and ownership over building decisions, there is likely to be more tolerance for feeling less physically comfortable,' he says.

Anna Mavrogianni, associate professor in sustainable building and urban



design at Bartlett School, UCL, highlighted research on how acclimatisation levels vary for different populations.

Susan May, head of housing design at Urban Design London, pointed out that, for many people outside of the office sector, adapting to the warming of climate change by using air conditioning is not an option. 'We need to be thinking about occupants who don't have a choice about their comfort conditions - how, then, can we make all our building types work?' (See panel, 'Covid-19 and homeworking').

Fogarty said air movement was an undervalued, flexible way of improving comfort: 'The old way of dealing with overheating was by using ceiling fans. These are very, very effective - and you can have different levels of air movement around the office with the same air temperature. You can provide different levels of perceived comfort for different people, and you get a far wider range of comfort levels in the office without throwing loads of energy at it.'

CIBSE says that the cooling effect of air movement created by local fans can be equivalent to reducing the operative temperature by around 2°C.<sup>1</sup>

COVID-19 AND HOMEWORKING

Those working in offices might have varied options for dealing with high temperatures. For example by relaxing dress code, adding desk fans and even using mechanical cooling, writes Anastasia Mylona.

This year, because of Covid-19, millions of homeworkers have the challenge of keeping cool. This becomes greater for those in modern urban flats, many of which are highly glazed, to maximise daylight and winter solar gain. A lot are single aspect, limiting natural ventilation potential, and many have no easy access to outdoor green space.

Those characteristics put homes in the high risk overheating category. For most of these properties the only realistic solution is mechanical cooling. However, this may not be affordable to many and will have an impact on the National Grid, particularly in a heatwave.

As well as being resilient to climate change we must be resilient to other unprecedented events such as pandemics. For government, this raises the need to regulate overheating risk. Designers need to consider 24-hour occupancy in calculations, maximise the potential of natural ventilation and balance daylight and solar gains. Planning will need to demand outdoor green space in new housing developments.

“Designers need to consider 24-hour occupancy in calculations and balance daylight and solar gains”

CIBSE’s Julie Godefroy and Anastasia Mylona looked at the wellbeing impact of climate change, and gave an overview of *TM40 Health and wellbeing in building services*. This makes reference to adaptation and organisational measures to mitigate overheating and other risks – in particular, having some control over one’s environment to improve comfort, such as openable windows and desk fans.

They drew attention to *TM52 The limits of thermal comfort: avoiding overheating in European buildings*, which provides a methodology for the assessment of adaptive thermal comfort. Mylona also spoke about *TM59 Design methodology for assessment of overheating risk in homes*, which allows designers to assess the vulnerability and robustness of overheating mitigation options in residential accommodation. It can also be used to review the impact of building form and shading at an early stage. Bateson said there was a need to optimise building designs to minimise overheating risk long

before they are submitted for planning. This may impact how we configure accommodation on new sites, to avoid problems that might arise later.’

Godefroy said that, historically, industry criteria for the internal environment have been based on studies in offices involving large proportions of healthy male adults, rather than other groups, including women. She also highlighted the need for future research and guidance to look at other criteria affecting building health and wellbeing in a more holistic way, considering inputs from organisations such as Public Health England or the World Health Organization. ‘What we don’t have are more complex criteria that would take account of exposure to multiple factors – heat and noise together, for example, or noise and air pollution,’ she said.

As the discussion turned to standards, Fogarty suggested that the process for implementing CIBSE and BCO standards – and probably the standards themselves – are inadequate: ‘If you have higher velocities of air – say 0.6-0.8 metres per second – then you’re getting a perceived reduction in temperature of around 3°C. The thermal modelling doesn’t take that into account. It will be average air velocities throughout a whole space as opposed to what a person is perceiving within a space. That makes an enormous difference.’

May said buildings needed to be better designed to avoid the need for climate-change mitigation measures in the future. For example, dual-aspect homes should be mandatory, because single-sided design contributed to overheating. ‘We really need to be bold in looking ahead to 2050 and saying that all buildings need front to back ventilation as a minimum,’ she added. The multiple benefits of dual-aspect buildings are included in *TM40*, and Godefroy said CIBSE was advocating for this to be much better accounted for and encouraged in the regulatory framework.

Joe Jack Williams gave a presentation on a project with the Department for Education (DfE) and the CIBSE Schools Design special interest group to understand climate-change adaptation strategies for school buildings, and how to assess these. It used modelling on recently built schools to look at projected performance with 2°C and 4°C temperature increase scenarios. While the results were concerning, particularly for a 4°C change, the project did identify design strategies that reduced temperatures, such as cross-ventilation, thermal mass, high ceilings, and room depth. Ann Bodkin, from the DfE, emphasised that such work was essential for informing regulation change and establishing best practice.

Mavrogianni spoke about the *ClimaCare* research project into care homes, funded by the National Environment Research Council and supported by CIBSE. It demonstrated extensive overheating in care homes, where temperatures were usually set high because of the perception that it was beneficial for older people. However, this raised issues about the impact of heatwaves on residents’ health.

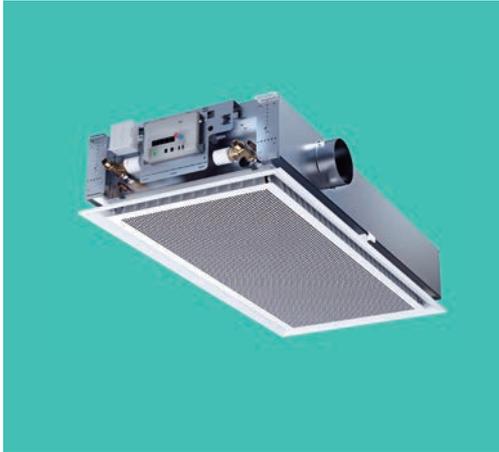
She added: ‘We should be tackling these issues not as purely engineering and building physics problems, but by adopting a human-centric approach and thinking of social norms, human behaviour and perception.’ **CJ**

Reference

1 CIBSE Overheating Position Statement [bit.ly/CJJun20Comfort](https://bit.ly/CJJun20Comfort)



As part of the comfort adaptation strategy, the School of Architecture at the University of the West of England has window openings and external shading to mitigate impacts of solar heat gains. Hoare Lea provided the environmental design consultancy



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## Occupant thermal comfort for building productivity

This module explores key aspects of thermal comfort for office-type environments and their impact on productivity

As many around the world adapt their environments to new work practices, there is heightened awareness of productivity. This CPD will consider some key aspects of the thermal environment and their contribution to what is, effectively, the 'productivity cocktail'.

The focus of this article will be air and mean radiant temperature, air speed, and relative humidity – parameters that may be most readily controlled by the building systems. (*CIBSE Journal* CPD module 147, in June 2019, drew on a draft of CIBSE TM40 (2020) *Health Issues and Wellbeing in Building Services* and touched on aspects relating to the visual environment.) These will combine with other parameters – including the attributes of building users, the space, and the environmental systems – to form the working environment. The recently published edition of TM40 provides an excellent, and accessible, discussion of the broad range of factors that impact the productivity of occupants in buildings.

The productivity of occupants is often key to whether an environment is deemed a success, whether a traditional place of work – such as an office, restaurant, or healthcare, teaching or manufacturing facility – or, possibly, a newly established, 'distanced' or isolated workspace. Productivity may be interpreted in many ways. It can be as simple as being able to watch a film in 'comfort'; creating a product; or, maybe, to undertake a life-saving medical procedure successfully. Numerous parameters have been identified as impacting productivity, as discussed by Clements-Croome<sup>1</sup>, and so – as with the many design challenges in building services engineering – a holistic appraisal of factors is required to maximise opportunity for productivity, while avoiding potential, unintended, deleterious consequences on micro, local and global environments. As with any evaluation, the methodology used to assess productivity will undoubtedly affect the outcome (see box, 'Seeking a measure of productivity'). However, as clearly identified<sup>2</sup> by Bordass and Leaman, and reflecting their decades of evaluating the

performance of buildings: 'The cat's cradle of causality and association differs from one building to the next, making it dangerous to be over-assertive about causation without careful appreciation of contexts.' A popular example of a regularly expressed generalisation that highlights the need for suitable contextualisation is the impact of CO<sub>2</sub> in inhaled air on human performance. A typically quoted performance CO<sub>2</sub> limit for building occupants is around 1,000ppm, which has been informed by a number of studies, including that undertaken recently by Allen et al,<sup>3</sup> as illustrated in Figure 1. Using a test group of 24 professional-grade employees in New York, USA, over a six-day longitudinal study, this indicates a significant reduction in occupant higher-level cognitive capability as CO<sub>2</sub> levels rise towards 1,500ppm.

In Allen's experiment, cognitive assessment was performed daily using the Strategic Management Simulation (SMS) software tool. The same tool was employed by Rodeheffer et al,<sup>4</sup> although this experiment used submariners as the test subjects. (The test also differed because the subjects had



» just a 45-minute acclimatisation period to the CO<sub>2</sub> levels, and it was undertaken in a test chamber, rather than an office environment.) However, the outcomes were completely different. At exposure conditions of 600, 2,500, and 15,000ppm CO<sub>2</sub> there were no significant differences for any of the nine SMS measures of decision-making for the submariners. This provides a persuasive reminder that context, the specific occupant population, acclimatisation and adaptation are key determinants in assessing the environment in terms of productivity.

As reported by TM40, there is a consensus that the physical environment affects general employee satisfaction, which will impact productivity in workplaces.

The dry-bulb temperature (DBT) in a space is likely to be the variable with which occupants most readily relate, as well as having some expectation of what numerical value would deliver personal comfort and so aid their productivity. The influence on 'temperature' was explored by Sepänen *et al* by reviewing<sup>5</sup> 24 field studies that had investigated the relationship between indoor temperature and occupants' ability to undertake office tasks. From this work, TM40 provides a simplified chart, as shown in Figure 2. This indicated that the most productive temperature was between 21°C and 23°C (the indoor temperature of this work was not specifically noted as being DBT). In their influential research, Oseland and Burton<sup>6</sup> noted that the impact of temperature was rated among the most important physical indoor environment parameters, and the average effect on task performance was estimated to be 15–20%. In the case of free-running buildings, optimum temperatures would take account of adaptive approaches that tend to more closely follow the outdoor temperatures.

The dry-bulb air temperature in the

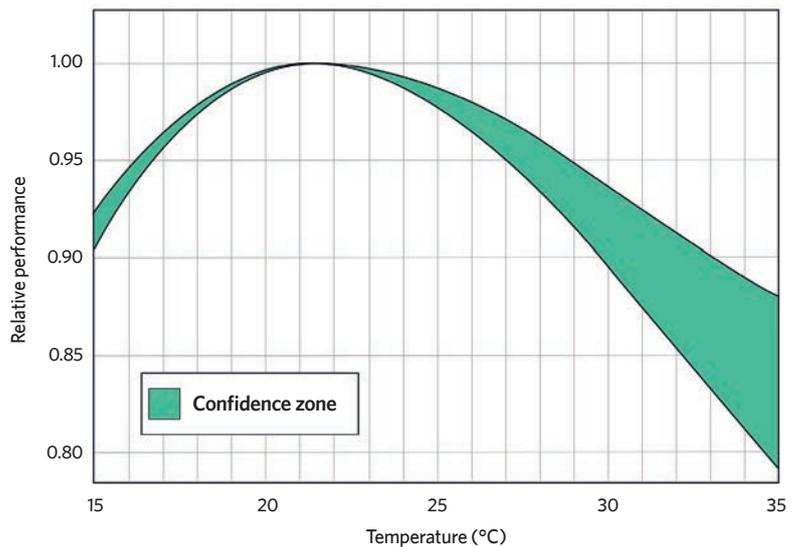


Figure 2: Indicative relationship between room temperature and occupant performance (Source TM40 – adapted from Sepänen *et al*<sup>5</sup>)

occupied zone may be readily monitored using proven technologies. However, it is more challenging to determine the impact of radiant temperature on the individual. The value of operative temperature – the index of basic environmental parameters that influence thermal comfort – is influenced, at typically low room air velocities, by the mean radiant temperature (MRT) as much as it is by DBT. As MRT is explicitly related to shape, relative locations and emissivity factors, it is practically difficult to continuously assess the MRT from the viewpoint of individual occupants (although new<sup>7</sup> sensing techniques promise future potential). In spaces with high levels of thermal insulation, multiple-glazed fenestration and solar shading (characteristics of many 'high-performance buildings'), the difference between the MRT and the DBT may be limited, so the typically convenient approximation of the MRT being close to the value of the DBT may be valid. The challenges in practically assessing MRT has inevitably led to a paucity of measured field studies that consider the impact on the individual's thermal comfort and productivity. This may be a significant deficiency in the current evidence base, as discussed by Chauduri *et al*.<sup>8</sup>

The impact on specific occupants in spaces with asymmetric radiant temperatures and dynamic radiant temperatures is difficult to assess, although recent work undertaken by Barnaby and Pedersen<sup>9</sup> has developed a tool that may assist in evaluating this. The influence of radiant asymmetry can be approximated by employing such techniques as illustrated in section 1.6.6.4 of CIBSE Guide A,<sup>10</sup> which engages the work of Ole Fanger to suggest that, in the vertical direction, radiant temperature asymmetry (warm ceiling) should be less than 5K and, in the horizontal direction (cool wall), less than 10K. Similarly, for a cool ceiling the

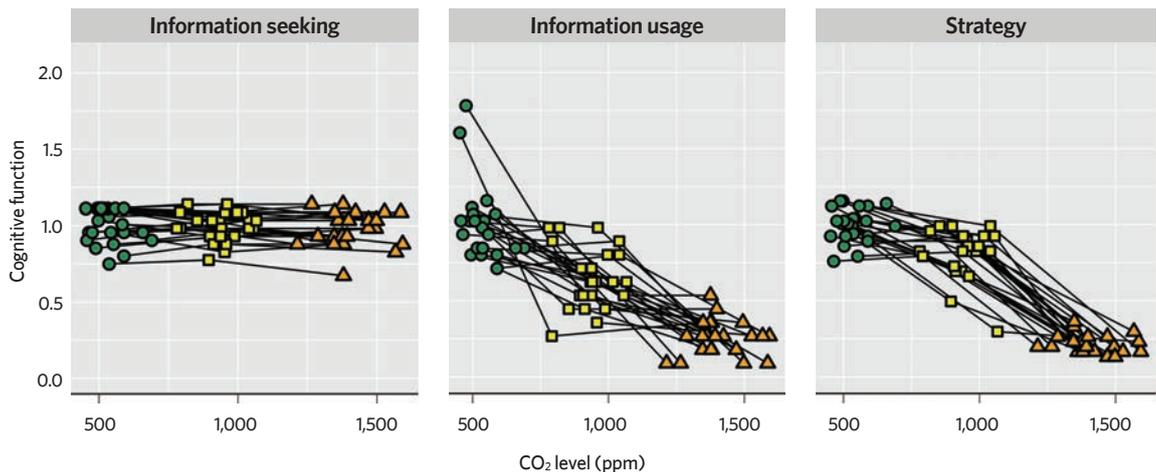
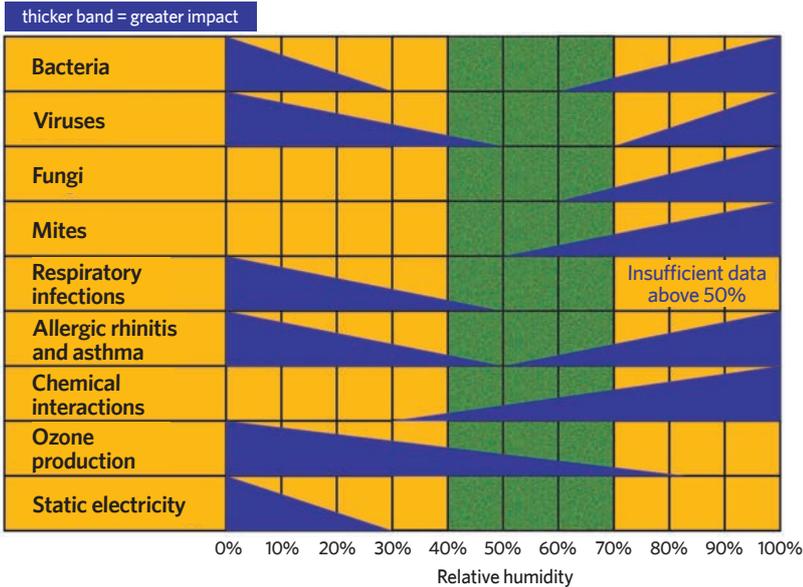


Figure 1: Selected findings from Allen *et al* summarising SMS experiments undertaken to determine the cognitive performance of occupants in a controlled office environment with different concentrations of CO<sub>2</sub> (Source: Allen *et al*<sup>5</sup>)



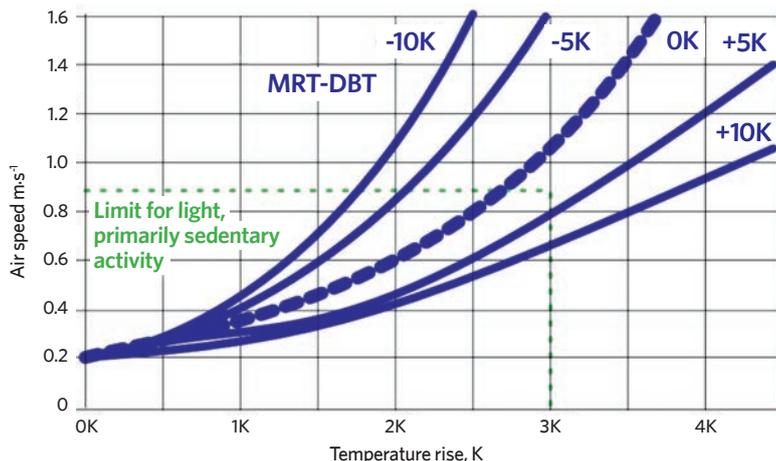
**Figure 3: Indicative prevalence of environmental hazards at room humidities, indicating CIBSE-recommended operating band for controlled environments (Developed from Arundel et al<sup>11</sup>)**

maximum recommended radiant temperature asymmetry is 14K, and for a warm wall 23K.

The humidity of the air is likely to noticeably impact thermal comfort at extreme values and, as indicated in Figure 3, the effect on occupant wellbeing is also more pronounced at high and low values of relative humidity. If the relative humidity is maintained in the comfort range of 40-70%, as recommended by CIBSE<sup>10</sup>, this will also provide a reasonable compromise in terms of humidity-associated risks. The adverse impact of higher humidities on comfort may be reduced by localised air movement – for example, as generated by ceiling or desk fans.

Air speeds in an environmentally controlled occupied zone would typically be expected to be between 0.05 and 0.2m·s<sup>-1</sup> (and the various comfort criteria are probably founded on this assumption). Greater air movement will increase the convective and evaporative heat loss from the body, which can provide a useful means of compensating for the discomfort of higher air DBTs. The ASHRAE chart – shown in Figure 4 – provides this correction in terms of both the temperature rise compared with the base comfort temperature, and the difference between the MRT and the DBT. This chart also illustrates the impact of relative values of MRT and the DBT.

Oseland and Burton report<sup>7</sup> that ‘it is generally not acceptable in the UK to include productivity benefits in financial investment appraisal’. As staff are by far the largest cost in offices – typically<sup>12</sup> 85-90% in the UK and US – a small improvement in staff productivity can result in large improvements in profit



**Figure 4: Offsetting the discomfort of higher internal temperatures with air movement (Based on: 2017 ASHRAE Fundamentals Handbook, Chapter 9)**

margins. In Seppänen’s review of productivity in offices,<sup>13</sup> he notes that even a 1% increase in work performance can offset the annual cost of ventilating a building. In a recent assessment by real-estate firm Stok,<sup>14</sup> based on aggregating research across the past 15 years, thermal comfort in office environments is potentially influencing productivity by approximately 8%. As reported in TM40, there is also a consensus from repeated studies and user surveys that providing personal control over an individual’s work environment, along with a rapid-response environment, positively influences satisfaction and productivity.

It is clear that the work of the building services designer and operator can make a significant impact on occupant productivity with appropriate control of basic environmental parameters – but, importantly, this must be appropriately contextualised to deliver a properly balanced and palatable productivity cocktail.

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■ Turn to page 34 for references.



## SEEKING A MEASURE OF PRODUCTIVITY

There is no shortage of methods of, and publications on, defining and determining productivity. Quantitative and qualitative methods abound, with some protagonists asserting that quantitative techniques are inappropriate as a means of reflecting – or, possibly, even defining – the complexity and variety of ‘output’, while the qualitative methods are considered, by some, as being unacceptably influenced by bias or preconception.

### TM40 identifies four principal methods:

- Self-reported productivity, with the caveat that, although a useful indicator of an individual’s perception, it may overestimate the impact after a change in their environment or, conversely, they may not be able to recognise the influence on their activity.
- Objectively assessed productivity that employs task measurements and standardised tests may struggle to assess creative outputs, with the majority of published materials focusing on applications where tasks and output may be readily measured. However, TM40 notes that this may overestimate the impact of the physical environment.
- Behavioural analytics is the rising star of techniques as a result of the practical ubiquity of personal smart devices combining with information from sophisticated building monitoring systems. This provides a highly accessible method of assessing occupant activity, but may be constrained by privacy concerns.
- Organisation performance, such as output, profitability or personnel data, has the benefit of taking a broader range of factors into account, rather than extrapolating from task-performance results. However, such high-level measures may be difficult to relate to specific attributes of the physical environment.

# Module 164

June 2020

» 1. Which CIBSE TM has recently been revised that covers the range of factors impacting the productivity of occupants in buildings?

- A TM37
- B TM40
- C TM52
- D TM57
- E TM60

2. Whose work indicated that the cognitive skills of submariners appeared unaffected by levels of CO<sub>2</sub>?

- A Allen
- B Clements-Croome
- C Hongshan
- D Rodeheffer
- E Seppänen

3. What did the data in the article indicate as the approximate level of relative office performance for a room temperature of 30°C (compared with 23°C)?

- A 0.84
- B 0.88
- C 0.92
- D 0.95
- E 0.98

4. According to the work by Arundel et al, which of these relative humidities would be least likely to encourage bacteria?

- A 5%
- B 25%
- C 45%
- D 65%
- E 85%

5. In the research study undertaken by stok, by what approximate percentage was thermal comfort found to potentially impact productivity?

- A Less than 1%
- B 1 to 5%
- C 5 to 10%
- D 10 to 15%
- E 15 to 20%

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# Gas safety – the next logical step ...



Gas safety systems have always been designed as localised, standalone systems, and despite the recent advancements with the 'smart building', the base design for most gas safety systems has remained relatively unchanged over the past 20 years, with the only information provided to the outside world being a volt-free contact for system faults. Perhaps the reason for this is that the market has been waiting for the right protocol.

BACnet is quickly becoming the most common communication protocol used in the UK HVAC market because of the ease of integration and level of detail provided, with very little programming required. Following the success of our range of BACnet CO<sub>2</sub>, temperature and relative humidity sensors in 2019, Flamefast is delighted to announce that its entire range of safety systems are now fully networkable, with a dedicated BACnet MS/TP interface.

Gas safety systems are one of the few local interfaces the occupant has; however, they are one of the only interfaces that gives active notifications of local issues. Most passive systems simply raise a remote alarm on the BMS, but a gas safety system's requirement to be interlocked to systems such as the ventilation dictate that it should provide local indication of any faults. Local interlocks are often supplied by the BMS using additional relays, which require extra wiring – and, if they are logic controlled, certain aspects of the safety system can be overridden, in some cases without knowing. There is a similar issue in plantrooms, with a gas detection system simply being part of a safety circuit including thermal fuses, remote stop buttons and the fire alarm system, although these are typically hardwired through the BMS with very little feedback, other than a generic fault.

The new Flamefast range looks to revolutionise the market, making the

gas safety system the focal point of the installation, irrespective of the application. With all local systems and sensors wired back to a single panel, every conceivable piece of information can be provided to the BMS by a purpose-built safety system using the BACnet MS/TP interface. This allows full integration without compromising the primary functions of the safety system. The BACnet object list includes the status of every input and output, levels on connected sensors and other critical information, such as gas pressures and service intervals.

■ For more information on Flamefast visit [www.flamefast-gas-safety.co.uk](http://www.flamefast-gas-safety.co.uk)

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## CLEARING THE AIR

Covid-19 ventilation guidance published by CIBSE last month has advice for ventilation and air conditioning systems in the UK. **Alex Smith** summarises guidance aimed at mechanical systems and shares advice from Cushman & Wakefield on checking chillers before reoccupation

**T**he falling infection rates of Covid-19 have led to the easing of lockdown restrictions around the world and, with that, an increase in the number of people reoccupying buildings such as offices, factories and schools.

The UK government, for example, revealed a roadmap for emerging from lockdown on 10 May. It stated that people should return to work from 12 May (if it was not possible for them to work from home) and it announced plans to reopen some schools on 1 June.

To ensure that infections don't rise again as populations remobilise, the government and organisations such as CIBSE, ASHRAE and REHVA are issuing guidance aimed at minimising the risk of people falling ill with Covid-19 in reoccupied buildings.

Current guidance from Public Health England (PHE) states that Covid-19 is assumed to be primarily transmitted through respiratory droplets from coughing and sneezing, which come into contact with others directly or via contaminated surfaces.

The government's Chief Scientific Advisor, however, has acknowledged that airborne transmission is a route, particularly in poorly ventilated spaces. As a result, organisations including CIBSE, ASHRAE, REHVA and BESA are advising that workplaces boost ventilation so indoor air is sufficiently diluted



### KEY ACTIONS

- Understand the ventilation system
- Run ventilation at higher-volume flowrate
- Avoid recirculation/transfer of air from one room to another unless this is the only way of providing adequately high ventilation to all occupied rooms
- Recirculation of air within a single room where this is complemented by an outdoor air supply is acceptable
- If applicable, thermal wheels should be switched off, but the pressure difference between supply and extract will need to be maintained to minimise any leakage flow from the extract to supply side

to eliminate the potential for airborne viral transmission. In an April briefing note, *Coronavirus Covid-19 and HVAC Systems*, CIBSE said that dilution of the internal air reduces exposure time to any airborne viral aerosols and lessens the chance of these aerosols settling on surfaces (the virus has been shown to survive for up to 72 hours on some surfaces).

Last month, the Institution published a more detailed document, *Covid-19 Ventilation Guidance* [bit.ly/CJJun29Covid2](https://bit.ly/CJJun29Covid2), aimed at building owners, managers and operators who are reopening non-domestic buildings in a temperate, oceanic climate, as experienced in the UK. It is not aimed at healthcare and hospital buildings, which are covered in guidance by the NHS and PHE.

The document outlines different types of ventilation, to help building managers identify systems in their facilities. It outlines the actions that should be taken to minimise transmission of Covid-19 for each system. >>



Cushman and Wakefield has compiled a checklist for assessing the physical condition of chillers

» Recommended actions are broadly classified under the headings of natural and mechanical ventilation. This article will look at guidance for the latter.

### Mechanical ventilation

CIBSE recommends that buildings with mechanical ventilation extend operation times, with nominal ventilation being established two hours before and after building usage time. In demand-control systems, CO<sub>2</sub> setpoints should be set to 400ppm to increase delivery of outside air, says CIBSE, which adds that ventilation should be kept on 24/7, with lower ventilation rates when people are absent. Where there is humidity control, relative humidity should be set above 40%.

Heat-recovery systems should not pose an increased risk if supply and extract streams are completely physically separated, such as twin coil units or plate heat exchangers, although CIBSE recommends an inspection in case there are any leaks that might lead to transfer of air from discharge to intake duct.

For thermal wheels (or rotary heat exchangers), CIBSE says there may be a risk of air leakage and moisture transfer between supply and exhaust air streams. A higher pressure on the extract side of the thermal wheel can cause air leakage to the supply flow, particularly in poor installations, so CIBSE recommends that the thermal wheel be bypassed. If it can't be, the rotor should be turned off and the ventilation rates increased as much as reasonably possible.

The heat-recovery equipment should be inspected, says CIBSE, and the pressure difference measured – and, if necessary, corrected by an appropriately trained

technician, using dampers or other arrangements. Workers should adopt usual safety procedures when working on thermal wheels.

CIBSE and others recommend stopping central recirculation during the Covid-19 outbreak, by closing dampers via the BMS.

While bypassing recirculation may impact the building's heating or cooling capacity, CIBSE says 'it was more important to reduce contamination risk and protect public health than to guarantee thermal comfort', and recommends relaxing dress codes.

Even if air handling units and recirculation sections had return air filters, it is not a reason to keep recirculation dampers open, as these do not normally filter out particles with viruses effectively because they

## CHECKING CHILLERS AFTER LOCKDOWN

Property services company Cushman & Wakefield has published a guide to reopening buildings, which includes a checklist for assessing the physical condition of equipment and services. This has advice for chillers.

### Air-cooled chillers

- Clean condenser coils and check for leaks and corrosion
- Check controls and safety circuits for proper operation
- Condenser fans should be cleaned; bearings need to be checked for wear, and lubricated; belts and couplings need to be examined, and tightness checked and adjusted
- The electrical disconnect and contactor needs to be inspected for tightness and no pitting
- Compressor oil should be tested for acid
- Check oil filter and change if needed
- Check piping and compressor for any signs of leaks and test refrigerant pressures
- Run a general system test to check for unusual noises, odours, and measure supply/return temperatures and system pressures as needed.

### Water-cooled chillers

- Check quality of condenser and chilled water chemical levels
- Check condition of condenser water tubes, and clean if needed
- Check refrigerant levels
- Check refrigerant purge unit
- Check oil heater
- Check oil levels
- Inspect motors and starters
- Run a general system test to check for unusual noises, odours, and measure supply/return temperatures on both condenser and chilled water and system pressures as needed.

**“Filters should be changed with systems turned off, and PPE must be worn. Used filters must be disposed of appropriately, in a sealed bag”**

have standard ISO coarse/ePM10 filter class rather than Hepa efficiencies. It warns that Hepa filters should only be used in filter housings designed for Hepa, otherwise there is the possibility of air leaking around the filter, or reducing the rate of supply of fresh air through increased resistance.

If guidance on heat recovery and recirculation is followed, CIBSE says the ductwork system should not be a source of elevated risk of contamination and no changes to normal duct-cleaning procedures should be necessary.

Outdoor air filters are not seen as a high-risk source of Covid-19 particles, so they do not need to be replaced, says CIBSE, which recommends normal maintenance procedures for replacement filters. Clogged filters are not a contamination source, but should be replaced because they reduce supply airflow.

Maintenance staff may be at risk from changing filters (especially extract), says CIBSE. Filters should be changed with systems turned off, and PPE must be worn. Used filters must be disposed of appropriately, in a sealed bag.

‘Split’ air-conditioning systems do not normally bring outside air into a room and, without a dedicated source of outside air supply, there is a risk they could recirculate and spread airborne viral particles, says CIBSE. It recommends having a source of outside air – either natural or mechanical ventilation – when these units are in operation.

For fan coil units, CIBSE says that, if there is little outside air ventilation, the action of a fan coil unit could spread airborne viral particles and should be turned off. However, with a good source of outdoor air supply, fan coil units may help mix the air and ensure dilution of any airborne virus everywhere.

Active chilled beams can operate normally, says CIBSE, as they form part of a ventilation system. Passive chilled beams do not bring outside air into the room, and will need a good supply of outdoor air to enable them to operate without risking airborne transmission of Covid-19.

CIBSE says room-air cleaners can be effective if they have Hepa filter efficiency and a substantial amount of room air passing through them. Devices that use electrostatic filtration principles can also work well. CIBSE says air cleaners should be located in the centre of the room, away from ‘stagnant’ areas – but the formation of any stagnant zones should be avoided. UV cleaning equipment for room-air treatment can also kill bacteria and inactivate viruses, but is usually only suitable for healthcare facilities.

Finally, CIBSE guidance states that, where there is no obvious ventilation strategy in a space, occupants should be discouraged from using the space. If the space is used transiently – for example, stairwells and corridors – then CIBSE recommends more robust cleaning regimes. **C**



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## Grand Mosque ready to reopen

The Grand Mosque in Makkah, Saudi Arabia, has been temporarily closed during the pandemic and Johnson Controls York HVAC systems was involved in cleaning the site and preparing it for re-opening.

The chillers at Al Shamiyah and Ajyad cooling plants and the air handling units were shut down, inspected, and the filters, ducts, drain pans and cooling coils were cleaned and sterilised.

Only 10% of the total cooling capacity was turned back on, but this helped to achieve the correct relative humidity to maintain the Mosque's structural integrity.

## Aermec becomes CIBSE patron

Air handlers, chillers and heat pumps manufacturer Aermec UK has become a CIBSE patron. The firm is looking forward to exchanging information and collaborating on multidisciplinary projects with CIBSE partners, while supporting future generations of engineers.

# F-Gas licence renewals and checks must go on

**Companies should ensure engineers are not holding expired registrations**

Mandatory checks of equipment under the F-Gas regulations must continue, despite the lockdown restrictions imposed during the Covid-19 crisis, according to UK's F-Gas register Refcom.

Refrigeration and air conditioning engineers are also being urged to renew expiring F-Gas registrations during the lockdown, so they can continue doing this work.

Head of Refcom Graeme Fox said clients must be reminded of their legal obligations to let scheduled testing and checks go ahead. But he added that engineers would not be held accountable if a client refused to allow access to their site, as long as they keep a record.

'Make sure you have your own copy of the F-Gas logbook for the equipment in

question,' he told the daily Covid-19 update webinar hosted by BESA, which manages Refcom. 'You should also note that you will attend to the work as soon as it is possible and safe to do so.'

Fox confirmed that F-Gas registration renewals would continue during the lockdown period, despite the closure of training centres, which is making it difficult for engineers to update their qualifications.

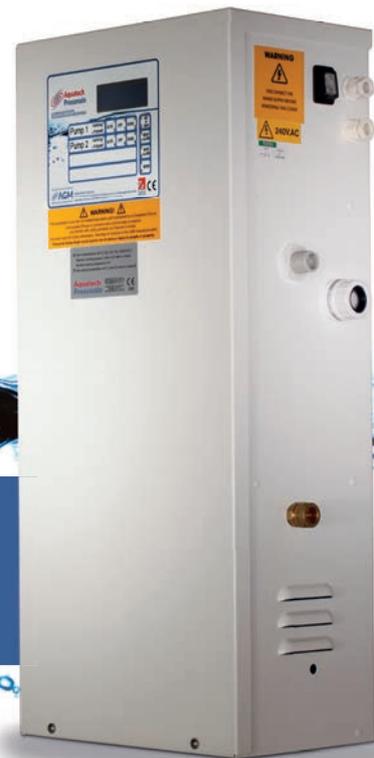
The peak renewal period in the three-year F-Gas cycle is fast approaching and a number of engineers hold expiring CITB J11/12 qualifications, which were issued five years ago.

Refcom is encouraging companies to renew their licences early so the qualifications will still be valid. It has assured them that they will not be penalised for renewing early, as any unused time from the existing registration will be added on to the new one.

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## How EcoMesh works

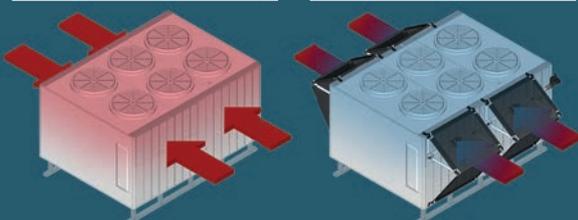
**EcoMesh's** unique design harnesses two natural cooling effects.

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## Rolling-piston rotary refrigerant compressors for air conditioning applications

This module considers rolling-piston rotary compressor technology and the impact of recent developments on air conditioning applications

The past 30 years have seen an explosion in the application of distributed air conditioning solutions. This has driven demand for reliable, small, lightweight, quiet and energy-efficient compressors. Throughout that period, the rolling-piston rotary compressor has evolved to meet this growing demand. This CPD will explore the technology of these compressors and consider some of the more recent developments that have made them suitable for application in both room units and larger chillers.

The compressor serves as the core for the refrigeration cycle by receiving the low-temperature, low-pressure refrigerant vapour from the evaporator and conveying the high-temperature, high-pressure vapour onward, towards the condenser. Refrigerant compressors that have evolved to serve unitary air conditioning units (or 'room units') have typically been positive-displacement compressors. Examples of displacement compressors are reciprocating (piston) compressors, scroll compressors and rotary compressors, including screw and vane compressors, such as the rolling-piston rotary compressor:

The single-vane rotary refrigerant compressor, also known as a 'rolling-piston' type compressor – and often referred to simply as a 'rotary compressor' – has seen significant development over the past 40 years. It comprises a drive motor mounted in line with, and above, the compression mechanism, which are both housed in the same shell (as shown in the diagram of a contemporary twin-cylinder rolling-piston rotary compressor in Figure 1). The shell provides a plenum for the high-pressure gas as it leaves the compression process.

The centreline of the drive shaft is the same as that of the cylinder in which it rotates. The shaft drives an eccentric cam inside the ring that drives the piston, so that as the piston revolves (or 'rolls' around the cylinder wall – as illustrated in Figure 2) it practically makes contact with the cylinder separated by an extremely thin film of specialist lubricating oil that acts to make a gas-tight seal between the piston and the wall of the cylinder.

There is a spring-loaded divider (the 'vane', typically manufactured in coated, high-speed steel) that is held in a slot-shaped chamber in the cylinder block that reciprocates (as it follows the eccentrically revolving piston). This acts to separate the suction and discharge sides of the cylinder by maintaining a seal with the surface of the piston – again, with the high-viscosity lubricating oil to ensure an appropriate seal – with the two metal surfaces never actually meeting.

The spring and outermost section of the vane is at the same pressure as the shell – so, effectively, at the discharge pressure. This acts to hold the vane onto the piston, overtaking the work of the spring (that is primarily there for start-up purposes). For the vane and the piston to maintain virtually perfect seals between the suction and discharge pressures, the *ASHRAE Systems and Equipment Handbook*<sup>1</sup> notes that a 'close tolerance and low-surface-finish machining is necessary to support hydrodynamic sealing and to reduce gas leakage'. The lubricating oil is held within the high-pressure outer shell, so providing sufficient pressure to move the oil to the working surfaces to reduce frictional losses and ensure seals at the sliding vane and >>

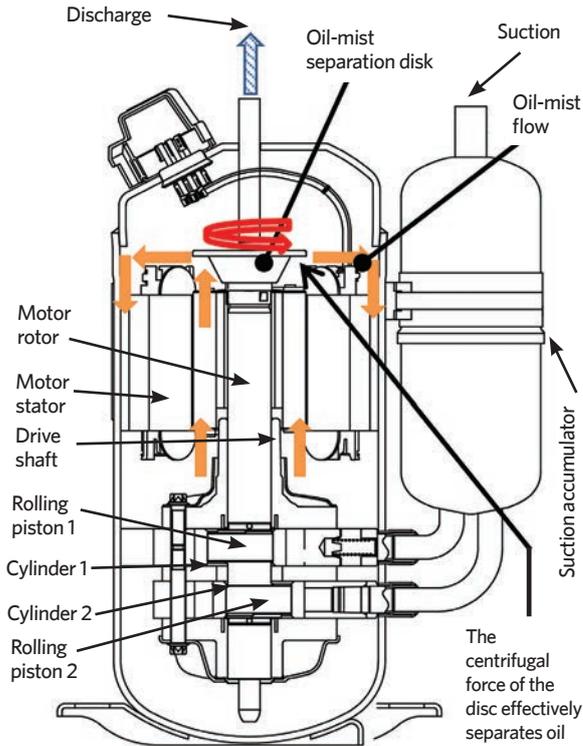


Figure 1: A twin-cylinder rolling-piston rotary compressor (Source: Toshiba)

» the interface of the piston and the cylinder.

For every two rotations, the compressor moves a volume of refrigerant from suction pressure to a higher pressure, into the discharge line. The suction is created by the increasing volume (on the low pressure side of the vane) as the piston rolls as shown in A -> B in Figure 2, so drawing the cool refrigerant gas into the cylinder. As the piston revolves, the low-temperature, low-pressure gas is compressed in the cylinder until it becomes high-temperature, high-pressure gas, as shown in B -> C in Figure 2. When the gas pressure in the cylinder rises above the high pressure inside the shell, the discharge valve opens (that is likely to be a simple reed valve) and the gas discharges, as shown in Figure 2 D.

In the example compressor in Figure 1, the high-temperature, high-pressure gas discharged from the cylinder passes into the space in the upper section of the shell, through gaps between the motor and the shell, and then to the discharge pipe. The rising gas will provide cooling for the motor windings, and the motor will also separate the oil from the refrigerant gas by the centrifugal force of the rotor. The example in Figure 1 also includes a specific rotating oil-mist separation disk to increase the oil separation. A small amount of oil passes from the rotary compressor into the discharge pipe – a fraction of that in other types of positive displacement compressors. Any excess oil circulating with the refrigerant, as it passes through the distribution system, will reduce the performance of heat transfer surfaces. Reducing the entrained oil is particularly beneficial when rolling-piston compressors are part of a system that supplies the lengthy piping of variable refrigerant flow (VRF) and other similarly extensive systems.

Interest accelerated in optimising the operating efficiency of rolling-piston compressors following the energy crisis of the 1970s, and was discussed in a paper by Matsuzaka<sup>3</sup> nearly 40 years ago. On investigating the performance of the hermetic rolling-piston rotary compressors of the time (and as confirmed latterly by ASHRAE<sup>1</sup>), he determined that the relatively small clearance volume (the volume of high-pressure gas that remains in the cylinder when the discharge valve closes) leads to very little re-expansion, and so the ‘volumetric efficiency’ – the ratio of the amount of refrigerant gas entering the compressor to the amount of gas leaving it – is very high. As designs have evolved in the intervening years, the discharge port has been optimised to both reduce frictional losses and further minimise the amount of residual gas.

In addition to high volumetric efficiency, rolling-piston technology has a resilience against ‘slugging’ (liquid refrigerant entering through the suction line). As a further safeguard against slugging, a suction accumulator (as shown attached to the compressor housing in Figure 1) provides a trapping device to ensure any returning refrigerant that is in a liquid state is vaporised before entering the compressor (together with entrained, returning oil).

As discussed by ASHRAE,<sup>1</sup> the mounting of the motor stator (fixed in the upper part of the housing), as well as the rotors, can cause significant torsional vibration that, unless properly minimised or compensated with appropriate resilient components, can transmit noise and vibration beyond the compressor housing. (There is, however, likely to be significantly less vibration compared with reciprocating compressors, as there is no conversion from rotation to reciprocation.) Although the motor provides a constant force, the compression process needs a varying force, as the compression rotation torque required just before discharge (Figure 2 C and D) is larger than that required at the start of compression (Figure 2 A). This difference between the force generated by the motor (the motor torque) and the compression torque required for compression will cause vibration. To reduce this issue, twin rotary compressors were developed that included two pistons, each in a separate cylinder, one above the other on the same drive shaft but rotationally positioned 180° apart. Not only does this reduce vibration by having the balancing forces of the two pistons, but it also makes it possible to design larger capacity rotary-piston compressors.

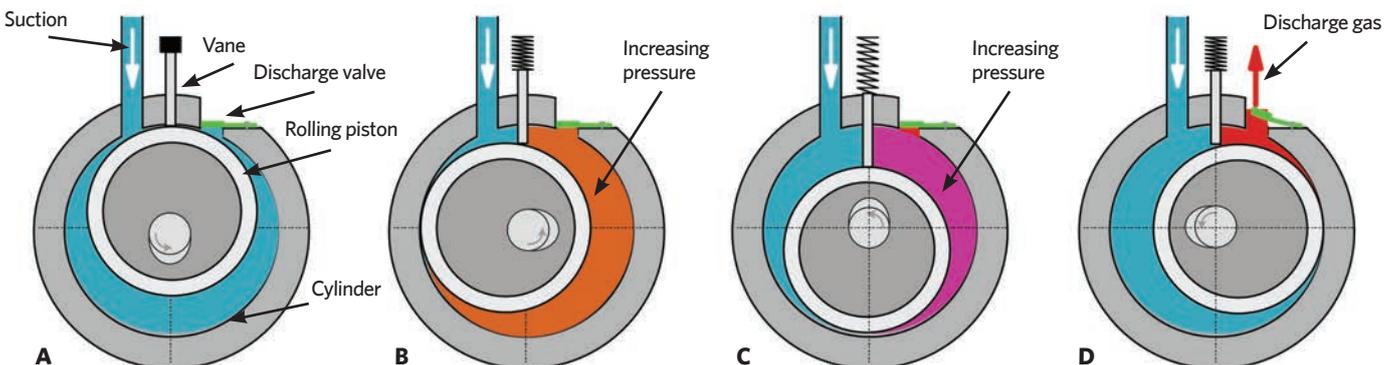


Figure 2: Simplified functional diagrams illustrating the 360° compression cycle of a rolling-piston rotary compressor

The advent of low-cost inverter-controlled motors has enabled operation at a wide range of speeds for the twin-rotary compressor. Being able to modulate output means that the compressor is better able to match the requirements of the load. For example, operating the compressor at low output provides a far more satisfactory system response compared with frequently cycling the compressor on and off.

However, at low outputs, the frictional losses at the interface between the vane and the piston have a greater impact on the operational efficiency. In their drive to improve operational efficiency, compressor manufacturers are continuing to pursue technical developments to reduce such friction losses. One of the technologies designed to improve operational efficiency at low outputs was reported by Hirano et al<sup>3</sup>, and a mechanism was subsequently developed over the past 10 years, as shown in the illustration of a simplified system in Figure 3. In normal two-cylinder operation, the lower compressor vane is pushed against the rolling-piston by the force generated by the pressure difference between suction pressure at the vane tip and the discharge pressure in a separated vane chamber acting at the back side of the vane (as in Figure 3 A) – note that in this system the second compressor vane does not have a spring. In this operating mode, the three-port valve is set in the normal operating position. When the refrigeration load does not demand the need for a second compressor, it is set to idle running by setting the three-port switching valve, as shown in Figure 3 B. In this position, the pressure in the separate chamber behind the vane of the lower cylinder will be maintained at low (suction) pressure, and so the vane is not pressed against the piston and a permanent magnet holds the vane back into the housing. The piston will, of course, continue to rotate but

will not suffer from the same frictional loss. When two-cylinder operation is required, the three-port switching valve reverts to its normal position. This arrangement provides an operating range to efficiently deliver between approximately 10% and 100% full load. This technology is capable of delivering high-efficiency operation. However, to date, it has only been applied in a limited number of high-end products.

The opportunities afforded by wider operating ranges have encouraged the development of larger rolling-piston compressors that, as they become larger, provide further challenges to maintain efficient and low-vibration operation. The use of electronic motor control, primarily used to vary the compressor speed, has enabled the development of advanced torque control, so that the provided motor torque can be automatically adjusted to deliver the force required by the compressor and reduce risks of vibration.

There are increased thrust forces on the vane as the cylinder increases in height (in larger compressors), so causing increased friction where the vane meets the piston. To overcome this, the vane has effectively been split in the axial direction to make a dual vane for each cylinder, with each one subject to a dispersed and reduced thrust force, so reducing the losses – and the potential wear – in the vane. In the past, nitriding was mainly used for surface treatment of vanes. Recently, diamond-like carbon (DLC) has been put into practical use to make vanes resistant to a higher temperature and a higher load, enabling a higher sliding speed. DLC has a coefficient of friction about two-thirds that of conventional materials, and so reduces the sliding loss of vanes.

The advances in rolling-piston compressors – including the adoption of two cylinders, enhanced digital motor control, new technology surface coatings and improved fabrication techniques – have combined to both improve the efficiency of the compressors and extend their operational range, as illustrated in the experimental data from Hirano<sup>4</sup> in Figure 4.

As the technology of rolling-piston rotary compressors continues to develop, they can provide a good solution for small air conditioning units. At the same time, they are also increasingly being applied to applications in large chillers where multiple rolling-piston rotary compressors can provide efficient modular, parallel compression for large centralised cooling and air conditioning applications.

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■ Turn to page 46 for references.

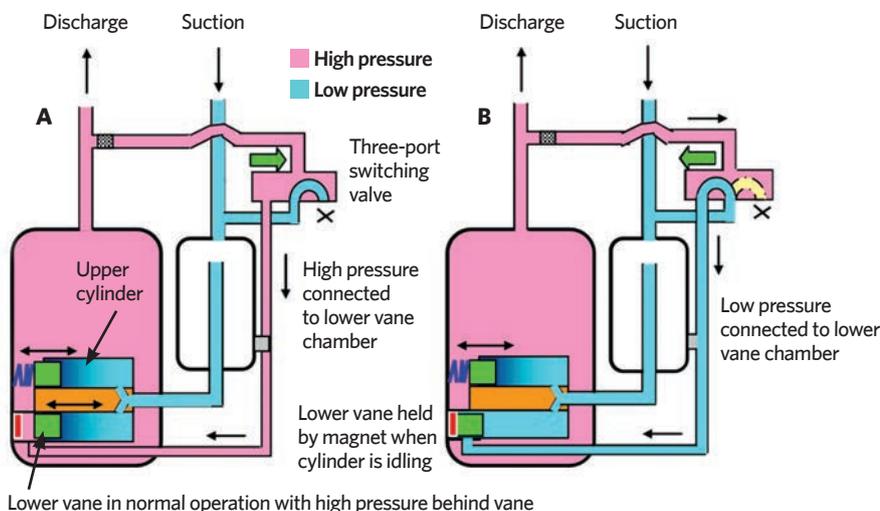


Figure 3: An illustration of a simplified system employing twin rolling-piston compressor modulation (based on Hirano et al<sup>3</sup>)

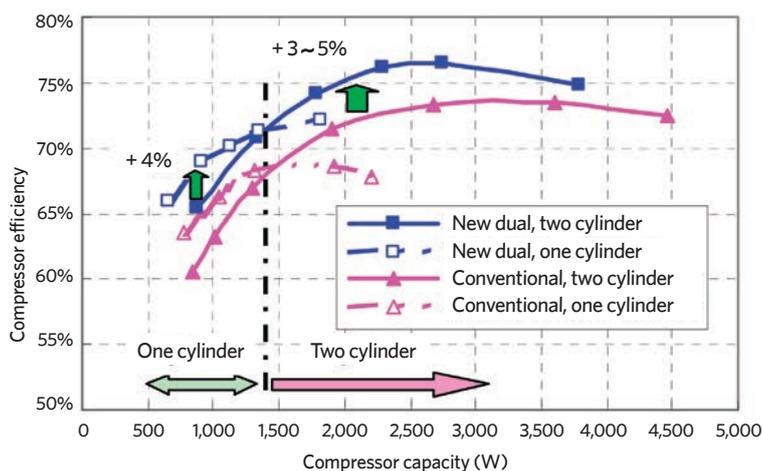


Figure 4: The indicative cumulative impact of technological advances on the performance of rolling-piston compressors, as obtained in experimental work (Source: Hirano et al<sup>4</sup>)

# Module 163

June 2020

» **1. Which of these is not a positive-displacement compressor?**

- A Centrifugal compressor
- B Reciprocating compressor
- C Rolling-piston rotary compressor
- D Screw compressor
- E Scroll compressor

**2. Which of these components is unlikely to be found in a rolling-piston rotary compressor?**

- A Cylinder
- B Discharge valve
- C Drive shaft
- D Inlet valve
- E Piston

**3. How many rotations of a rolling-piston rotary compressor are required to move an intake of refrigerant to discharge?**

- A 0.5
- B 1
- C 2
- D 3
- E 4

**4. Compared with other positive-displacement compressors, which of these is least likely to be the case for rolling-piston rotary compressors?**

- A Good resistance to slugging
- B High volumetric efficiency
- C Low vibration
- D Operating modulation limited to step control
- E Small carryover of lubrication oil

**5. In the modelled example of the improved twin (or dual) rolling-piston rotary compressor, what was the compressor efficiency working with a capacity of 2,500 watts?**

- A 69%
- B 71%
- C 73%
- D 75%
- E 77%

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### References:

- 1 2016 ASHRAE Handbook - HVAC systems and equipment, Chapter 28 section 3.
- 2 Matsuzaka, T et al, *Rolling-piston type rotary compressor performance analysis*, International Compressor Engineering Conference, School of Mechanical Engineering, Purdue University, 1982.
- 3 Hirano, K et al, *Development of a new mechanism for dual rotary compressor*, International Compressor Engineering Conference, School of Mechanical Engineering, Purdue University, 2012.
- 4 Hirano, K et al, *Development of a high-efficiency dual rotary compressor for air conditioner*, International Compressor Engineering Conference, School of Mechanical Engineering, Purdue University, 2010.

# PRODUCTS & SERVICES



## ◀ AET provides flexible, high-performing underfloor air conditioning system at central London development

The One Benjamin development in Farringdon, London, recently installed AET Flexible Space's underfloor air conditioning system throughout its three floors of premium office space. Main contractor Knight Harwood felt that AET's flexible system would be more able to cope with the variations in temperature across the building caused by increased or decreased sunlight.

One Benjamin chose AET's CAM-V system, which makes use of the raised floor void as a plenum for the distribution of supply air, while receiving return air at ceiling or high level. Conditioned air is induced into the space via recessed fan/tilt units.

Headroom height was a key consideration during this design and build, and by using the AET underfloor air conditioning system, the contractors were able to eliminate much of the ceiling-based services and ductwork.

The reduced amount of building materials needed, and its long-term flexibility, also makes AET's system an excellent choice for sustainable building projects.

■ Visit [www.flexiblespace.com](http://www.flexiblespace.com)

## ▶ Panasonic's TZ wall-mounted RAC connects with the future

Panasonic has introduced advanced updates to its domestic RAC TZ range. The new wall-mounted TZ has been designed with a smaller and more elegant chassis, while maintaining impressive power and efficiency, as well as using R32 refrigerant to satisfy the demand for reduced environmental impact.

Systems up to 5kW are only 779mm wide, making it the ideal solution for homes with limited space. The TZ Super-Compact also has built-in WLAN and, once connected to the internet, can be controlled remotely via smartphone with Panasonic's Comfort Cloud app.

■ Visit [www.aircon.panasonic.eu](http://www.aircon.panasonic.eu)



## ▶ Enhancing efficiency with Panasonic's latest Aquarea air-to-water range

Panasonic has launched the Aquarea High-performance J Generation Bi-Bloc, an advanced heating and cooling solution for new installations, refurbishments and low-energy homes. The heat pump can reach the highest possible energy rating of A+++ in heating.

Using air-to-water technology and R32 refrigerant, it is highly efficient - converting heat energy in the air into household warmth. It also helps to reduce CO<sub>2</sub> emissions and has less environmental impact than conventional boilers and electric heaters.

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## ◀ Rinnai innovation: mobile hand-wash and hot-water station

Rinnai's latest development is a mobile hand-wash and hygiene station geared up to supply any site needing instant, unlimited continuous flow hot water.

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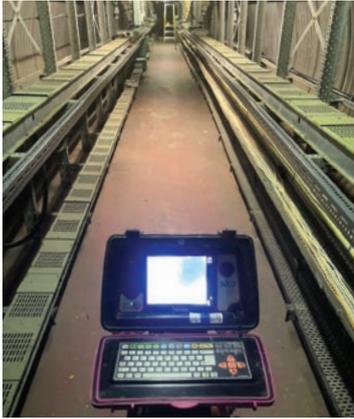
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### ◀ Lanes teams support NHS response to coronavirus pandemic

Drainage engineers from Lanes Group have supported the creation of the NHS Louisa Jordan Hospital, at the Scottish Events Campus, to treat patients during the coronavirus pandemic.

Lanes was commissioned by Graham to carry out CCTV drainage surveys and to clean sewers around the site in Glasgow. The company has also delivered similar services to support the opening of the 250-bed Rainbow Hospital Deeside.

NHS Louisa Jordan was completed on 20 April 2020 thanks to the combined efforts of 400 personnel.

■ Visit [www.lanesfordrains.co.uk](http://www.lanesfordrains.co.uk)

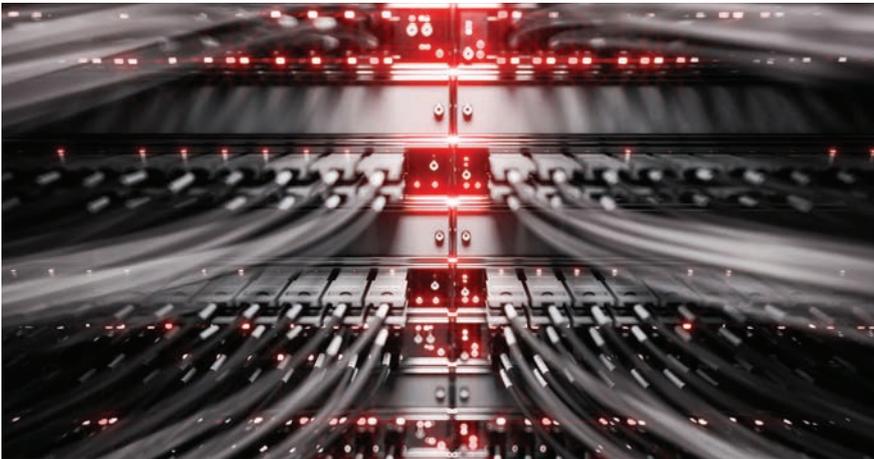


### ✓ Kelvion's heating and cooling solution has a range of applications

The Kelvion Mission Critical Plate Type NX350M series is suitable for heating and cooling in a wide range of applications. It is available with a broad selection of plate sizes and many different plate and gasket materials, including titanium and stainless steel.

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■ Visit [www.kelvion.com](http://www.kelvion.com)



### ▲ Fire regulations lower sprinkler entry point

Fire regulations have been under the spotlight for some time, including with a review of legislation concerning the building height limit at which sprinklers have to be fitted to properties in England and Wales.

This review has now reached its conclusion and clarified the position. Any new high-rise apartment blocks of 11m and higher will need to be fitted with suitable sprinkler fire protection.

This is a big decrease from the previous 30m limit, and is even lower than had been mooted within the industry.

Grundfos Pumps - which has been a key supplier to the fire industry for many years and has the capacity to design, test and build a wide variety of fire-protection equipment at its production facility in Sunderland - has welcomed this news.

There is no doubt that these regulations, alongside changes to various other aspects of construction, such as cladding, will save lives.

■ Visit [www.grundfos.co.uk/fire](http://www.grundfos.co.uk/fire)

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### Energy Efficiency



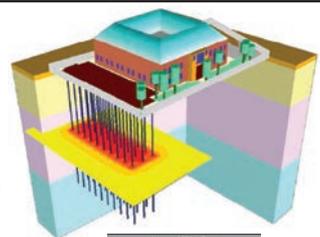
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The CIBSE Membership department continues to support members wishing to progress their membership. It is hosting free webinars to support members with applications for the Associate and Member grades, and for registration with the Engineering Council at Incorporated Engineer and Chartered Engineer levels.

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2-4 June

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The CIBSE ASHRAE Technical Symposium will now take place on 14-15 September at the University of Strathclyde, Glasgow. This year's theme is 'Engineering buildings, systems and environments for effective operation', and presentations will include case studies, research papers and poster presentations. Topics already confirmed include: heat networks for a low energy future; solar and passive strategies towards net zero; hydrogen and thermal batteries for low-impact buildings; IAQ - novel methods for evaluation, assessment and control; integration of fire safety and smoke control; and tall and mega-tall buildings - reality of net zero. Booking is now open at [cibse.org/technicalsymposium](http://cibse.org/technicalsymposium)



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[www.build2perform.co.uk](http://www.build2perform.co.uk)

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CIBSE Building Performance Award winner, Agar Grove

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- CIBSE climate action plan
- TM40 (2020) Health and wellbeing in building services



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**YOUNG  
ENGINEERS  
AWARDS  
2020**



# CIBSE Employer of the Year Award 2020

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The Employer of the Year Award is open to any organisation that is pro-actively committed to nurturing young talent in the building services sector.

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# CMR

## in complete control

CMR Controls manufactures low air pressure and air volume measurement sensors and control systems for standard air conditioning, clean rooms, sterile laboratories, containment facilities, and fume cupboard extract systems.

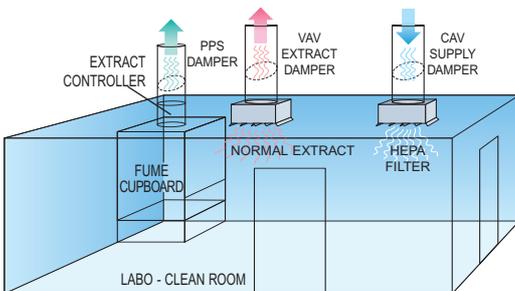


### DPM PRESSURE SENSOR

Panel Mount Pressure or Velocity Transducers with remote alarms, analogue and digital interfaces. Traceable calibration certificates supplied as standard.

### AIR MANAGEMENT SYSTEM

A complete turn-key system to control room pressure to +/-1Pa. Fume cupboard face velocity to 0.5m/s at high speed and provide constant air changes into the labo - clean room.



### DPC CONTROLLER

Fast and accurate controls to drive high speed dampers or invertors. Full PID stand alone controls with BMS interface.

### CAV AND VAV DAMPERS

Accurate air flow measurement with the unique CMR Venturi built into the airtight shut-off damper to control room pressure or constant volume.



Metal Damper

### PPS EXTRACT DAMPER

Poly-propelene control and shut off valve incorporating the CMR Venturi Nozzle. This is essential when dealing with corrosive extract air especially from fume cupboard systems.



PPS Damper

### PRECISION COMPONENTS FOR VENTILATION AND PROCESS CONTROL

# CMR CONTROLS

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