

CIBSE **JOURNAL**

#Build2Perform

June 2018

www.cibsejournal.com

Achieving lasting change is the very least we can all do for the bereaved and the survivors of the tragedy that occurred on 14 June 2017

Dame Judith Hackitt



**BIM/Digital
engineering
special**

BIM. ACCURATE PIPE DESIGN

at your fingertips



FREE!

wavin

**REVIT CONTENT
PACKAGE**

**Download
yours today!**

FEATURING

- Quickest way to a complete 'as built' pipe system
- Precise designs with intelligent assistance
- Fully integrated Bill of Materials

Download now at wavin.co.uk/bim

Mexichem
Building & Infrastructure

wavin

CONNECT TO BETTER

No ifs, no buts...



The UK construction industry is at a crossroads. Dame Judith Hackitt's in-depth review of construction processes in the aftermath of Grenfell has found systemic failure across the industry. She has put forward a radical programme of reform – and now industry and government have to decide how to embrace the changes needed to create a culture of collaboration in design and construction.

It should be wholeheartedly; 72 people lost their lives at Grenfell and, as Dame Judith says – in her quote reproduced on the cover – transforming the industry is the least we can do for the victims and the survivors.

She also notes that we've been here before. Reports such as Sir John Egan's *Rethinking Construction* (1998) highlighted many of the cultural issues that need to be addressed. The question is, can we finally make the changes that need to happen?

To pull it off, industry will have to adopt a whole raft of recommendations by Dame Judith. On page 26, we list those affecting building services engineers. They include the introduction of clear responsibilities for project members and a Joint Competent Authority, which will have to approve any designs amended during construction. The Hackitt report also says guidance should be outcome-based rather than prescriptive. This approach relies on an improvement in competence across the industry, and Dame Judith recommends the formation of a body with oversight of competency requirements. She also wants a more effective product-testing regime, and for poor procurement processes to be tackled to ensure full life-cycle costs are taken into account.

New CIBSE president Stephen Lisk believes construction must change and that every CIBSE member has the 'power to make a positive and significant impact'. 'As a body that exists for the public benefit, we are committed to being at the forefront of delivering that change,' he says.

Lisk also speaks of the need for CIBSE to broaden its appeal and attract some of the three million people in the industry who are not part of a professional institution. He also welcomes the fact that, after his year in office, CIBSE will have its first female President, Lynne Jack FCIBSE – which, Lisk says, is long overdue.

Sharon Duffy is another CIBSE Fellow in a position of influence as Transport for London (TfL) Engineering's head of infrastructure. At the Technical Symposium, she called on engineers to help reuse the 500GWh of heat trapped in the Underground network every year. Our feature on page 30 describes what TfL is already doing to reuse unwanted heat and so keep its customers cool.

ALEX SMITH, EDITOR asmith@cibsejournal.com

Editorial

Editor: Alex Smith

Tel: 01223 378034

Email: asmith@cibsejournal.com

Deputy editor: Liza Young

Tel: 01223 378048

Email: lyoung@cibsejournal.com

Technical editor: Tim Dwyer

Designer: James Baldwin

CIBSE Journal is written and produced by CPL (Cambridge Publishers Ltd) Tel: +44 (0)1223 378000. www.cpl.co.uk 1 Cambridge Technopark, Newmarket Road, Cambridge CB5 8PB.

Editorial copy deadline: First day of the month preceding the publication month

The opinions expressed in editorial material do not necessarily represent the views of the Chartered Institution of Building Services Engineers (CIBSE). Unless specifically stated, goods or services mentioned in editorial or advertisements are not formally endorsed by CIBSE, which does not guarantee or endorse or accept any liability for any goods and/or services featured in this publication.

Advertisement sales

Display and sponsorship Jim Folley

jim.folley@redactive.co.uk

Tel: +44 (0) 20 7324 2786

Products & services Callum Nagle

callum.nagle@redactive.co.uk

Tel: +44 (0) 20 7880 6217

Recruitment advertising Dario Cappelli

dario.cappelli@redactive.co.uk

Tel: +44 (0) 20 7324 2756

Advertising production Jane Easterman

jane.easterman@redactive.co.uk

Tel: +44 (0) 20 7880 6248

Editorial advisory panel

George Adams, engineering director, Spie Matthew Hall

Patrick Conaghan, partner, Hoare Lea Consulting Engineers

Rowan Crowley, managing director, CIBSE Services

Chris Jones, Fläkt Woods

Philip King, director, Hilsen Moran

Nick Mead, engineering consultant

Jonathan Page, building services consultant engineer, MLM

Geoffrey Palmer, director, Sweco

Dave Pitman, director, Arup

Christopher Pountney, senior engineer, Aecom

Paul Reeve, director, ECA

Andy Ford, director of research, School of Built Environment and Architecture, LSBU

Gethyn Williams, regional director, Amerlux

Hannah Williams, mechanical engineer, Atkins

Ant Wilson, director, Aecom

CONTRIBUTORS



Hywel Davies

Theresa May's call for new technologies to halve energy use in new buildings is encouraging



Kate Dougherty

Engineers should talk to clients about unregulated operational energy right at the start of a project



Paul Reeve

Cross-industry standardisation will help create a circular economy within construction



Tim Dwyer

This month's CPD looks at improving the performance of vapour compression air-cooled chillers

CONTENTS

News

6 News

Hackitt review; tackling late payments; RHI 'not value for money'

14 CIBSE news

Lisk becomes president; UKAS approves CIBSE Certification for ISO 9001; Gilchrist honoured

Voices

16 Policing the policies

Julie Godefroy scrutinises the government's consistency

18 Unregulated energy: why we should care

It is our duty to educate clients, says Kate Dougherty

20 Grand challenges

Hywel Davies looks at the clean growth Grand Challenge

22 Circular economy: material advantages

Paul Reeve considers the scope for applying circular economy principles to reducing impacts

65 Q&A

CIBSE Young Engineers Network mentor Andrew Saville

Features

24 COVER FEATURE

A radical rethink

How Dame Judith Hackitt's review will affect building services engineers

28 Be the change

Liza Young speaks to the Institution's new President about the year ahead

30 Tunnel vision

Using heat produced in the tunnels and stations of London Underground

34 Taking root

How a micro greens farm below Clapham is helping researchers understand the impact of plants on their surroundings

38 Testing the water

Good engineering design and client-side control management are key to the containment of legionella bacteria

43 Water ways

The importance of good material selection for drainage pipes and fittings



BIM and Digital Engineering Special

Articles on Digital Built Britain; cloud-based BIM collaboration at London's Royal Wharf; BIM guides on security and health and safety; and a BIM manager's reflections on being a team player

Technical

SPECIAL FEATURES
Cooling: chillers and air handling units

47 AHU and chiller news

A round-up of product innovations

49 The refrigerant threat to VRF

Chillers may make inroads into the air conditioning market if VRF manufacturers cannot develop safer refrigerants, says Tim Mitchell

50 Catalyst for change

Research by Staffordshire University's Derek Wardle suggests incorporating catalysts in air handling units can control dangerous levels of ozone



SOCIAL MEDIA



@CIBSEJournal



CIBSE LinkedIn



CIBSE Journal newsletter



www.cibse.org

FOR CIBSE

Journal production manager: Nicola Hurley
Tel: 020 8772 3697, nhurley@cibse.org

CIBSE, 222 Balham High Road,
London SW12 9BS

Tel: +44(0)20 8675 5211

©CIBSE Services Ltd. ISSN 1759-846X

SUBSCRIPTION ENQUIRIES

If you are not a CIBSE member but would like to receive *CIBSE Journal*, subscribe now! Costs are £80 (UK) and £100 (international). For subscription enquiries, and any change of address information, please contact Nicola Hurley at nhurley@cibse.org or telephone +44 (0) 20 8772 3697. Individual copies are also available at a cost of £7 per copy, plus postage.

The 2017 US annual subscription price is £100. Airfreight and mailing in the US by Air Business, C/O Worldnet Shipping NY Inc, C/O Air Business Ltd / 155-11 146th Street, Jamaica, New York, NY11434. Periodical postage pending at Jamaica NY 11431. US Postmaster: Send address changes to *CIBSE Journal*, C/O Air Business Ltd / 155-11 146th Street, Jamaica, New York, NY11434.

CREDITS

Cover image Getty Images / Jack Taylor / Stringer P08 iStock.com / Monkeybusinessimages P09 Credit © Mark Power / Magnum Photos P10 iStock.com / StockSolutions P12 iStock.com / Amoklv P14 iStock.com / MasterLu P24-25 Getty Images / Jack Taylor / Stringer P26 iStock.com / Milanvirijevic P31 iStock.com / MarioGuti P34 iStock.com / Madeleine_Steinbach P38 iStock.com / Bet_Noire P39 iStock.com / Nikkytok P40 iStock.com / CHIARI_VFX P43 iStock.com / Mucella P44 iStock.com / TzahiV P50 iStock.com / 8213erika



ABC audited circulation:
18,331 January to December 2016
Printed by: Warners Midlands PLC



CPD

55 Improving the performance of vapour compression air-cooled chillers

The application of a novel condenser design that can improve system effectiveness without increasing the equipment footprint

Classified

59 Products

A round-up of systems and services for the industry

Jobs

63 Appointments

Jobs at jobs.cibsejournal.com

Events

66 Looking ahead

Facilities Show; SLL LightBytes; CIBSE training; CIBSE groups, regions and societies



IN BRIEF

Cities can be fully decarbonised by 2050

Europe has the technologies to 'fully decarbonise' heating and cooling in its cities by 2050, according to a series of presentations from the recent Decarb Cities conference in Vienna.

Representatives from cities, the European Commission and the European heat pump industry debated the policies and technologies needed to reach that goal, including reformed city planning, the use of digitisation, gas infrastructure and hybrid systems.

'If industry and policy-makers pull on the same string, I am sure we can make it,' said Thomas Nowak, secretary general of the European Heat Pump Association.

Crofts elected ECA president

Malcolm Crofts is the new president of the electrotechnical and engineering services body ECA.

He has been managing director of DH Crofts since 2000, having started his career as an apprentice at Crawley College, and worked as an electrical engineer for 15 years, before moving up to run the company. Crofts takes over the presidency from Mike Smith, of SES Engineering Services.

'The industry faces challenges ranging from prompt payments and retentions, to ensuring that Brexit works for our sector,' said Crofts. 'I look forward to working with ECA's staff and members, our partners, and government, to tackle these issues head on. I will also look to raise further the positive profile of our industry.'

Dining and debate club seeks new members

The Rumford Club is hosting a membership promotion from 6pm on 14 June, on the terrace at the National Liberal Club, Whitehall Place, London SW1A 2HE.

The purpose of the evening is to introduce potential new members to the social, dining and debating club for the built environment and engineering services sector. The annual subscription for membership is £30.

The event will include a brief presentation about The Rumford Club and the Rumford 70 Legacy Project.

If you would like to attend the evening, email the secretary at mikehammond65@hotmail.com

Lisk calls for 'golden thread' of information to be preserved

New CIBSE President said construction in the UK must learn lessons from Grenfell

We all have a responsibility to ensure lessons are learned from the Grenfell Tower disaster, new CIBSE President Stephen Lisk said last month. During his presidential address at the Royal Society on 8 May, Lisk told the audience that built environment professionals must help to shape a better future.

Dame Judith Hackitt's *Independent Review of Building Regulations and Fire Safety* identified several areas in which change is needed,

including regulations and guidance, roles and responsibilities, standards, procurement and competence. Lisk said: 'Dame Judith recognised the need for the original design intent to be preserved, recorded, and for any changes to go through a formal review process involving people who are competent and who understand the key features of the design.'

'That information needs to be kept up to date throughout construction and handed over to those who will operate the building, preserving the "golden thread" of building information, from construction into the operational life of the building.'

CIBSE responded to the review's call for evidence, with input from the Society of Façade Engineering. The Institution also supported the Royal Academy of Engineering's and the Construction Industry Council's responses.

CIBSE members have the power to make a positive and significant impact on people's lives, Lisk said, whether through the products they make, the projects they design, the buildings they manage, operate, maintain and refurbish, or the codes and guidance they write.

'It is clear that construction in the UK must change and, as a charitable body that exists for the public benefit, we are committed to being at the forefront of delivering that change,' he said.

■ Read our interview with Stephen Lisk on page 28.



Stephen Lisk with outgoing president Peter Y Wong

Election of first female President in 2019 will be of 'huge importance'

Professor Lynne Jack will become CIBSE's first female president when she takes office next year. The director of Heriot-Watt University's Royal Academy of Engineering Centre of Excellence in Sustainable Building Design is president elect for 2018-19, and her appointment is regarded by CIBSE President Stephen Lisk as a massively overdue, positive change for the Institution.

'We are an institution that needs to be representative of its membership, and I am delighted my successor will be CIBSE's first woman President. I look forward to working with Lynne in the coming year,' he said.

Susie Diamond, founding partner at Inklings, said the prospect of a female President was of huge importance, because she will be a figurehead for the organisation.

'It matters because we are not attracting enough new talent into the profession, and

increasing diversity has concrete business benefits,' said Diamond.

'It's hard to be the first [female President], but the second time will be easier. It matters because it is 2018 and because actions speak louder than words.'



Lynne Jack

Dame Judith Hackitt said reform is needed to rebuild trust



Sector backs Hackitt's attack on 'broken' system

Focus on systemic problems rather than technical details praised

Dame Judith Hackitt has received support from across the building services sector after calling for fundamental change to the way high-rise and 'at risk' buildings are planned, built and managed. The current regime is 'broken', according to the inquiry Dame Judith led into building regulations and fire safety after the Grenfell Tower fire, and reform is needed to improve safety and rebuild trust among those living in high-rise buildings.

Her report highlighted a culture of 'indifference' to the regulations that produced a 'race to the bottom' on price, which undermined safety and building performance. The construction industry will now have to take responsibility for delivering safe buildings 'rather than looking to others to tell them what is or is not acceptable', said Dame Judith.

CIBSE technical director Hywel Davies said the review addressed issues that members have grappled with for years.

'Ensuring the safety of the buildings in

which we live and work requires exactly the root-and-branch reform set out in this thoughtful and well-informed document,' he said.

The institution welcomed the review's focus on the need to improve competence within the construction and fire-safety sectors, and establishing a more robust system of oversight. It also supported the commitment to produce clearer regulations and guidance.

CIBSE will be taking part in further consultation on the measures needed 'to achieve real change in the industry'.

Key recommendations

- Products critical to the safety of tower blocks should be re-tested by manufacturers at least once every three years
- Formation of a Joint Competent Authority, covering local authority building standards, fire and rescue services and the HSE
- Independent body with safety oversight on behalf of residents
- Register of building owners or landlords responsible for safety aspects of tower blocks

Housing Minister promises reforms and tougher sanctions

The government is already implementing many of the recommendations set out by the Hackitt Review, according to Housing Minister James Brokenshire.

He welcomed the review's call for sweeping reforms to the industry's regulatory systems, which would change how the responsibilities of clients, designers and contractors are defined. The minister said the Building Regulations covering fire safety would be made clearer, and the use of 'inappropriate desktop studies' to assess the safety of certain building systems is expected to be restricted after consultation. The government is also consulting on the use of combustible cladding materials.

The use of private building control will end, with the establishment of a new, single building-standards body, the Joint Competent Authority, formed from Local Authority Building Standards, fire and rescue authorities and the Health and Safety Executive.

Brokenshire promised a 'meaningful and lasting reform of the building regulatory system', with strong sanctions for those who fail to comply.

Review demands BIM on high-rise projects

Building information modelling (BIM) should be used in the design, construction, refurbishment and operation of all new high-rise residential buildings, says the Hackitt Review.

Creating comprehensive digital records is a key recommendation in the report, with BIM used to deliver a 'golden thread of information' that runs through every project, from design to operation.

'Government should mandate a digital (by default) standard of record keeping for the design, construction and... occupation of new HRRBs [higher-risk residential buildings, of 10 storeys or more]; the report said. 'This is to include any subsequent refurbishments within those buildings.'

It added that digital records should be in a format that is 'open and non-proprietary', and that the information would be used by duty holders deemed responsible for building safety under reinforced CDM Regulations.

England faces significant water shortages by 2050

England will have water shortages by 2050 unless action is taken to prevent leaks and reduce demand, the Environment Agency (EA) has warned.

A third of water taken from the environment is lost through leaks, treatment and wasteful use in the home, with a fifth lost through leaks alone, said EA in *The State of the Environment Water Resources* report.

It warned that climate change, combined with a growing population, would see shortages by 2050, particularly in the South East.

In 2017, the EA said the amount of water taken out for homes, agriculture and households was unsustainable for 28% of ground water sources and 18% of surface water surfaces, such as rivers.

The report said energy generation was a major user of water and warned that new technology to capture and store carbon underground could also lead to higher water use.

'Extinct' CFC gas back in the atmosphere

Scientists have spotted the mysterious return of ozone-depleting CFC refrigerant gas in the atmosphere. CFC11 (R11) was a common refrigerant and insulation propellant, but production controls were introduced in the late 1980s. The US stopped manufacturing it in 1996 and worldwide production ended in 2010. But according to the National Oceanic and Atmospheric Administration, emissions have been rising again since 2013.

Its findings, published in *Nature* magazine, show a 25% jump in R11 emissions, with about 13,000 tonnes released every year since 2013. Clandestine production in East Asia is suspected to be the main cause.

School's out, Caspian's in!

- Easy installation and ongoing maintenance
- Available from stock*
- Industry leading 5 year warranty

* Available on most common variants



The summer holidays are the perfect time to replace your old heaters with the NEW Smith's Caspian Fan Convectors



01245 324900 | sales@smithsep.co.uk
SmithsEP.co.uk | @SmithsEP_UK | #ThinkSmiths

Demand for blast-proof buildings on the rise

Services can be braced using reinforced pipework, ductwork, and suspended and floor-supported equipment

A growing number of UK building projects are calling for seismic and blast protection, according to ASHRAE distinguished lecturer Jim Tauby.

While it is still not common knowledge because of the nature of the projects, government, healthcare and education facilities are increasingly being protected against the threat of terrorist blasts, Tauby told a joint seminar of the CIBSE ASHRAE and FM groups at London South Bank University. He warned, however, that improved methods of 'field enforcement' were required to ensure contractors do not undermine the building services specifications by changing the designs on site.

'We check the blast and seismic loads for every part of the building services installation, but - on a number of occasions - we found the system was not installed with the extra reinforcing features required to make them blast-proof,' said Tauby, chief executive of New York-based Mason Industries, and lead author of ASHRAE's *A practical guide to seismic restraint*.

He said there was a growing focus on ensuring 'critical use buildings' could continue operating in the event of a major explosion or extreme weather. As a result, demand for features such as isolated plantrooms and rubber insulators was rising, to ensure services plant could remain operational even if the structure of the building was damaged.



'Critical use buildings' such as hospitals are increasingly being made blast-proof

Government policy results in clean energy downturn

The amount of money invested in clean energy projects fell by 56% in 2017, according to a report by the parliamentary Environmental Audit Committee (EAC).

The cross-party group of MPs said investment was now at its lowest for a decade and this was because of shifting government policy, which could undermine the Clean Growth Strategy.

Scrapping the Zero Carbon Homes Policy, cutting Feed-in-Tariffs (FiTs) for small-scale renewables, and curtailing the Renewables Obligation (RO) have all contributed to the drop, the committee said. The outcome of the UK's EU referendum also resulted in a fall in lending from the European Investment Bank.

The EAC believes the government should try to maintain the UK's relationship with the European Bank to help 'riskier, early-stage green projects'. It also called for the creation of a Sovereign Green Bond to help raise capital for low carbon schemes.

BLENDED WHISKY

An undulating green roof, engineered by Arup, blends the new Macallan Distillery into the rolling hills of the Moray countryside, in Scotland. The consultant also provided the structural building services, fire and civil engineering designs for the recently completed building, designed by Rogers Stirk Harbour +Partners. The architect wanted to showcase the distilling process in the most elegant way possible under the timber, gridshell roof. This meant the designers had to ensure the timber soffit was clear of visible services, and Arup had to work closely with the architect and contractor. As there are inherent risks in whisky distilling, this also meant the fire engineers had to work closely with process engineers on their plans.



Labour pledges to tackle growing retentions issue

Carillion used SME suppliers like a private bank, report said

A member of the shadow cabinet has committed a future Labour government to tackling the growing problems of late payment and retentions in construction. Bill Esterson, shadow minister for small business, told the annual CIBSE Patrons lunch at the House of Lords that unsecured debts were crippling many small and medium-sized enterprises (SMEs) in construction supply chains.

He attacked the government's record on enforcing late-payment legislation and its 'lack of oversight and corporate governance' during the run-up to the collapse of Carillion. 'There is already legislation in place to ensure government clients pay their prime contractors within 30 days, but it also says they must make sure money due to subcontractors is passed promptly onto the supply chain,' said Esterson. 'The sad fact is that many contractors will not get paid anything at all following [the collapse of] Carillion.'

His comments came days before a report by two parliamentary committees concluded that government had 'lacked the decisiveness or bravery' to address the failures in corporate regulation that allowed Carillion to become a 'giant and unsustainable corporate time bomb'.

The report said Carillion had used its SME suppliers like a private bank by withholding payments, and blame was

laid firmly at the door of the company's board of directors, which was 'responsible and culpable for the company's failure'. 'The mystery is not that it collapsed, but that it lasted so long,' the report added.

Carillion was holding £800m in retentions money due to subcontractors – a debt that has been written off by the company's liquidators. Esterson said a future Labour government would support retentions deposit accounts that would protect SMEs' cash. These form part of the retentions reform measures in a draft bill proposed by Conservative MP Peter Aldous, which is due to have its second reading in parliament on 15 June.

Patrons chair David Fitzpatrick said: 'We have a unique insight into the problem and have witnessed the havoc it can cause in supply chains.'

■ For more about CIBSE Patrons, visit www.cibse.org/patrons



Bill Esterson addresses the CIBSE Patrons lunch

Late payment causing mental health 'epidemic'

An increasing number of construction company owners, managers and directors are suffering from panic attacks, anxiety, depression and feelings of extreme anger because of cash-flow problems, according to a survey by the Prompt Payment Directory (PPD).

The payment-rating organisation surveyed 400 senior figures in small construction businesses. It found that 74% had been close to bankruptcy or liquidation this year – 30% up on the same period in 2017 – while 48% said problems with cash flow had affected their mental health, a rise of 27% on last year. Some admitted to contemplating suicide because they were struggling to get invoices paid on time and/or in full.

The collapse of Carillion in January, carrying £3bn in debt – including £800m in retentions withheld from subcontractors – has had a major impact, but late-payment practices are common across the industry.

The PPD survey revealed that: 62% of owners had not been able to pay themselves for lengthy periods because of late payment; 15% had been forced to delay payment to their staff; and 17% had cut their own pay. Others have had to raid pension pots, sell personal assets and cancel family holidays.

'Recent high-profile cases, such as Carillion, have made many more people aware of the cost of late or non-payment, but, in reality, this has been going on for years,' said Hugh Gage, managing director of the PPD.

The Building Engineering Services Association (BESA) said the industry was in the grip of a 'mental health epidemic'.

'This is a national scandal and the government must legislate because the human toll is mounting,' said chief executive David Frise. 'The suicide rate in construction-related professions is already well above the national average, and the scourge of late payment is creating unbearable stress for many more small business owners and managers.'

Double appointment at BakerHicks

BakerHicks, the multidisciplinary design and engineering company, has appointed two senior executives to its building services team. James Chorley and Graham Furness are head of mechanical and head of electrical, respectively. Chorley rejoins from QODA Consulting, where he managed mechanical, electrical and sustainability designs, while Furness joins from WSP, where he was associate director and managed data centres across Europe.

CABE aims for chartered status

The Chartered Association of Building Engineers (CABE) has applied to become a member of the Engineering Council. If successful, its members would be eligible for Chartered Engineer status on equal terms with other engineering professional bodies.

In a poll, 91% of CABE members who voted were in favour of the move. 'This clear mandate for change puts CABE within touching distance of the industry top table,' said chief executive Gavin Dunn.

RHI will not deliver value for money at £23bn cost

Rates of fraud and non-compliance too high, and forecasts for take-up of the scheme 'wildly optimistic', says parliamentary committee

The Renewable Heat Incentive (RHI) will not deliver value for money, according to the Public Accounts Committee (PAC). It is expected to result in just one-fifth of its target 513,000 new heating systems, but will eventually cost the UK taxpayer £23bn.

'Some of the installations funded by the RHI would have been built regardless of whether the scheme was in place,' the PAC report said. 'Rates of fraud and non-compliance are too high, and the costs of people manipulating the scheme's rules

through "gaming" are not known.'

Energy efficiency schemes were better value for money, said PAC, and more effective at reducing carbon emissions than the RHI, which is administered by Ofgem. Government forecasts for take-up of RHI were 'wildly optimistic' and 'other policies are having to work harder to enable the government to meet its legal obligations,' it added.

Ofgem said it was trying to improve its RHI fraud detection and was 'continuing to make improvements to our monitoring and compliance processes... including changes in line with the PAC's recommendations'.



FREE webinar

Ventilation Solutions to improve air quality for Part F

Speakers:

Martin Passingham - Product Manager
Warren Clark - Product Specialist

12 June 2018 | 13.00 BST



SIGN UP NOW ▶▶ bit.ly/cibsewebinars

Brought to you by:

CIBSE JOURNAL

DAIKIN

Envirofresh 73 Quiet

Low Energy, Air Source Heat Pump System, Silenced with Acoustic Treatment as used in Hundreds of Projects

Envirofresh 73 Quiet

Out Performs



Benefits

- Meets TM52 for Schools
- Meets BB93 Feb 2015
- Renewable Energy Source
- BMS Controls Installed in Unit
- Factory Pre-Commissioned
- Low Energy Consumption
- Reduced Site Installation Cost
- Heating and Cooling from One Source
- 50% Less CO₂ Production than a Gas Boiler
- No External Condensing Units, Pipework or wiring
- Low Noise Emissions with Silenced Compressors
- Tempered Air Supply without Defrosting
- No Increase in Footprint over Standard AHUs
- No Loss of Heating Capacity at Low Temperatures
- High Specification UKAS Certified Low Breakout Casework
- Room Heating and Cooling available at Reduced Air Volumes
- More Pleasant Appearance than Condensing Unit or Chiller Installations



BSRIA

University of **Salford** MANCHESTER

BIM & REVIT Engineering Solutions

air HANDLERS

Air Handlers Northern Ltd.

Alfred Procter House, Bute Street,
Salford, Manchester M50 1DU
Tel: 0161 745 8888 Fax: 0161 743 9190
sales@airhandlers.net
www.airhandlers.net



BIG ON PERFORMANCE



SMALL ON SPACE

VRV IV

You can count on the Watercooled VRV IV W+ range

The perfectly versatile climate control solution for high-rise buildings, hotels and developments where space is at a premium.

- A small footprint for space saving benefits.
- Easy compliance with building regulations.
- Delivering the highest and most reliable levels of performance, whatever the ambient conditions.
- Stackable units: 120kW in just 0.429m² of floor space.
- Zero heat dissipation: unique benefit, as no need to cool the plant area.

Water flow control, Variable Refrigerant Temperature (VRT), and heat recovery across your entire building for greater energy efficiency.

Find out more at www.daikin.co.uk/vrv



Humidifying the UK
for over 30 years



World leading humidifiers



Nationwide humidifier service team



Specialist advice and system design



Dedicated humidifier spares department

Contact us for free expert advice

Tel: +44 (0)1903 850 200

Email: uk.sales@condair.com

Web: www.condair.co.uk

Humidification and
Evaporative Cooling


The new name for JS Humidifiers

Home stoves a target for Clean Air Strategy

Proposals will ban the most polluting wood burners from 2022, while government will work with industry to reduce VOCs

The government has revealed how it plans to halve the number of people living in areas with high levels of air pollution by 2030. Defra's *Clean Air Strategy* aims to clamp down on toxic pollutants emitted from homes and the transport, industry and farming sectors.

According to the document, a rise in the popularity of wood-burning stoves is having a significant impact on air pollution, accounting for 38% of all particulate matter (PM) emissions. Defra is proposing a ban on the sale of the most polluting wood burners and fuel from 2022, but stops short of prohibiting the use of existing appliances and open fires.

BSRIA test engineer Allan Wilson said: 'Educating people about how to operate their new and existing appliances would contribute greatly to the reduction of 'real' emissions.'

The government's proposals would give councils more powers in high-polluting areas and enable them to create 'non-burn days'. Defra said it also plans to reduce the air-quality impacts of the Renewable Heat Incentive (RHI) by tackling non-compliance and consulting on excluding biomass from the scheme if installed in urban areas on the gas grid. It will also consult on making coal-to-biomass conversions ineligible for funding.

In addition, Defra will target non-methane volatile organic compounds (NMVOCs), particularly in the home, where emitters include cleaning products, and new carpets and furniture.

Secretary of State Michael Gove said the proposals could cut the cost to society of air pollution by £1bn every year by 2020, rising to £2.5bn annually from 2030.



Asthma-related deaths in UK rise by 20% in five years

The UK has one of the worst asthma rates in Europe, according to research published on World Asthma Day. Asthma-related deaths have risen by 20% in the past five years, putting the UK fourth from bottom of the European list, with a fatality rate 50% higher than the EU average.

An estimated five million people in the UK suffer from asthma, and poor air quality is one of the biggest factors, according to campaigners.

The UK is one of six EU member states recently referred to the European Court of Justice for failing to tackle air pollution. It has received a 'final warning' over nitrogen dioxide, levels of which have been above the legal limit in most urban areas since 2010. The government has until the end of this year to impose tougher air-quality measures or face potential multimillion pound fines.

'We have waited a long time and we cannot possibly wait any longer,' said European commissioner for environment Karmenu Vella. The Commission said the six countries had failed to deliver 'credible, effective and timely measures to reduce pollution... as required under EU law'.

Emergency lighting.
Quality assured.
Giving you peace of mind.



Visit tamllite.co.uk

Emergency Lighting for a Living

As a UK manufacturer we have one of the widest lighting ranges across:



T | 01527 517 777 E | sales@tamllite.co.uk

Institution wants you to get on board

New arrangements for the nomination and election of CIBSE officers and board members were approved at the extraordinary general meeting on 8 May, and will take effect for next year's election process, subject to confirmation by the Privy Council.

To ensure the widest possible range of candidates is available, the nominations panel would welcome suggestions from CIBSE members for potential volunteers, who could be considered for elected board positions or the role of president elect. Candidates can also be suggested for election to the consultative council of the Institution.

The nominations panel will meet during the summer and consider all suggestions received, before making recommendations to the board on candidates for election at the 2019 AGM.

Further information about the process, eligibility requirements for candidates, and the role and responsibilities of those elected can be found on the website at www.cibse.org/nominations

A form is included and this should be completed for any potential candidate you wish to suggest, to ensure the panel has sufficient information to consider them fully.

All suggestions must be received at CIBSE HQ by Monday 2 July.

SLL Lighting Knowledge Series

The final event of the SLL Lighting Knowledge Series 'LightBytes' will take place at the Barbican, London, on 7 June.

The peer-reviewed, bite-size presentations focus on key factors relating to four areas: design; specify; build; and future. Each of the speakers – Les Thomas, of Fagerhult, Graeme Shaw, of Zumbotel Group, Helen Loomes, of Trilux, and Roger Sexton, of Xicato – will deliver presentations on an aspect of these topics.

The event also includes guest speaker Carl Collins, digital engineering consultant at CIBSE, who will offer his perspective on the role of BIM and digital engineering within lighting. Collins will consider aspects such as: the exchange between modelling and calculation software; daylight analysis; product data templates; and blockchain ordering.

For more information and to book, visit www.cibse.org/sll

Lisk takes CIBSE reins on historic evening

■ Stephen Lisk steps into President role

Stephen Lisk FCIBSE FSLL took over as CIBSE President at the Institution's AGM on 8 May, succeeding Peter Y Wong FCIBSE.

Lynne Jack FCIBSE assumed the role of president elect and, in 2019, will become the first female President in the Institution's 42-year history. The new CIBSE officers and board members are:

■ Immediate past president: Peter Y Wong FCIBSE

■ Vice-president: Ashley Bateson FCIBSE

■ Vice-president: Stuart MacPherson FCIBSE

■ Hon treasurer: Adrian Catchpole FCIBSE

■ Board member: P L Yuen FCIBSE

Further details and biographies can be found at www.cibse.org/board, and the full AGM minutes will be published in July's *CIBSE Journal*. Read our interview with Lisk on page 28.



From left: Adrian Catchpole, Kevin Kelly, Lynne Jack, Stephen Lisk, Ashley Bateson and Stuart MacPherson

UAE Region's five-year highlights

CIBSE UAE Region held its second AGM in Dubai in April, to present the annual progress report and elect its new committee for 2018-19.

Raef Hammoudeh, chair of the region for 2017-18, highlighted some of its achievements. After it was formed in 2013, CIBSE UAE arranged technical seminars in Abu Dhabi and Dubai, giving presentations and advice to building services consultancies, contractors and manufacturers. All of its groups have also contributed to technical seminars and CPD

activities aimed at connecting with local and future members.

In April 2016, the UAE Region was officially launched in Dubai, at an event attended by the CIBSE President, CEO and the director of membership. It was the first region to be established in 28 years. Last year, the Abu Dhabi Chapter and SoPHE UAE were added to its SSL, YEN UAE and WIBSE subcommittees.

The UAE Region continues to work with CIBSE HQ and other regions, through the International Task Force, to devise strategies and policies aimed at growing membership numbers in the UK and internationally.

A highlight for the region was CIBSE UAE Week, in October 2017, when it hosted the YEN annual conference in Dubai, a technical conference on the 'Challenges of tall buildings design in the Gulf region', and the annual dinner in Dubai – attended by 120 guests, including CIBSE President Peter Y Wong.

Reid Donovan, has been elected 2018-19 UAE committee chair, and aims to build on the achievements made over the past few years.



Flying the flag for female engineers

International Women in Engineering Day is on 23 June, and CIBSE will be supporting and celebrating the contribution of its female members.

Set up by the Women's Engineering Society (WES) to support, inspire, celebrate and raise the profile of women in engineering, the event is now an international awareness campaign.

The day is an opportunity to focus attention on the amazing career opportunities in the industry for women and to celebrate the achievements of women engineers around the world.

The sub-theme for 2018 is 'Raising the bar' – so get involved and use #INWED18 #RaisingtheBar on Twitter.

On the day, the 'Top 50 women in engineering under 35' list will be released in the *Daily Telegraph*. WES has a resource pack available to download at www.inwed.org.uk

Find us on Facebook

CIBSE's Facebook page, launched in January, is going from strength to strength. It features lots of video content not hosted on the CIBSE website, as well as news and details of events. In the short time since its launch, CIBSE has gained more than 300 likes, and is aiming to build on this over the second half of the year. Please find us – and like our page – at www.facebook.com/CIBSE

President's Prize is up for grabs

The deadline for the CIBSE Undergraduate Award is fast approaching, with 20 July the closing date for entries.

The award – known as the President's Prize and sponsored by Hays Building Services – is open to all CIBSE student members in their final year of BSc, BEng or MEng study. It is designed to encourage young engineers to develop their potential and aim for excellence.

The winner will receive a £500 cheque and trophy. Two runners-up will each receive £100.

For more information and to enter, visit www.cibse.org/awards

UKAS approves CIBSE Certification for ISO 9001

Accreditation enhances ability to offer certification of management systems

CIBSE Certification has been accredited by the United Kingdom Accreditation Service (UKAS) to certify quality management systems (QMS) against the international standard ISO 9001.

The standard is an internationally recognised quality framework to provide products and services that meet customer and regulatory requirements. This latest UKAS recognition enhances the existing accreditation to certify energy management systems to ISO 50001.

Running an ISO 9001-certified QMS demonstrates a business's commitment to meeting the needs of its customers and prioritising their satisfaction. It also guarantees a streamlined and efficient quality-assurance procedure that maximises success, while keeping costs as low as possible. The standard opens new business opportunities for clients looking for assurance over quality, and fulfills requirements for some tenders, particularly in the public sector.

Dr Andrew Geens, head of CIBSE Certification, said: 'This is an exciting development, which extends our ability to offer certification of integrated management systems covering quality and energy. I hope the building services community will support this initiative by using us for their ISO 9001 certification and for their clients' ISO 50001 certification. CIBSE Certification is working towards accreditation for ISO 14001 and ISO 45001 to expand the scope of our management systems certification service.'

Any organisation that has implemented the requirements of the standard, and operated the system for six months, can apply to CIBSE Certification for ISO 9001 certification. By doing this, they can benefit from CIBSE Certification's reputation as a UKAS-accredited body, as well as from its industry-leading knowledge of the built environment sector. Organisations that already have a UKAS-accredited ISO 9001 certificate can transfer to CIBSE Certification very easily.

■ For more information, contact CIBSE Certification at ccms@cibse.org

The new accreditation is 'an exciting development for CIBSE Certification'

Gilchrist honoured by his peers

CIBSE Fellow Stephen Gilchrist has been initiated into the Air Conditioning, Refrigeration and Building Services (ARBS) Hall of Fame.

The accolade was bestowed in May, at the awards dinner after the biannual ARBS Exhibition, of which CIBSE ANZ region is a founding member.

Gilchrist played a key role in developing the professionalism of the industry in Australia and New Zealand. He has been an active CIBSE member, and was a founder of the region in 1987, honorary treasurer from 1992-95, and chair from 1995-98. He represented Engineers Australia – Sydney Division on the Building Regulations Advisory Council from 1996-2016, under the auspices of the New South Wales Department of Planning and Environment. In 1998, he was chair of the Society for Building Engineering Services – a technical society of Engineers Australia, which he helped to create – and treasurer from 1999-2007.

Gilchrist was also instrumental in having building services recognised as an engineering discipline on the National Professional Engineers Register in Australia. His induction into the ARBS Hall of Fame is recognition from his peers that his efforts are greatly appreciated.



Stephen Gilchrist

Policing the policies

A flurry of consultations is letting us scrutinise the government’s consistency and resolve on carbon and environment targets, says CIBSE’s Julie Godefroy

RECENT CONSULTATIONS National Planning Policy Framework (NPPF), MHCLG

Civil servants recently asked us: how would you give certainty to industry that government is serious about environmental targets? Financial incentives and regulations are the obvious carrot and stick, but government seems to have little appetite for either. The remaining options are to lead by example, and to say it, say it again – and make sure others in government say it the same.

The NPPF has significant influence over the evolution of the built and natural environment, so its revision is precisely the way to demonstrate consistency and coordination between government departments. Unfortunately, it fails to do this. The revision intends to facilitate and speed up housebuilding. This is a pressing issue, but CIBSE believes it need not be to the detriment of quality and sustainability.

In our response, we highlighted that the NPPF needs to reflect the UK’s commitments to UN Sustainable Development Goals and Defra’s recent 25-year environment plan, which was, broadly, well received. It only sets a long-term vision, however, and needs implementation through more specific policies.

Our other recommendations included:

- Reverting to the current NPPF wording, that policies should be ‘in line with objectives and provisions of the 2008 Climate Change Act’. The proposed revision – to ‘within the context of’ the Act – is a downgrade and could undermine confidence in the government’s carbon-reduction plans
- Reinforcing the emphasis on health and wellbeing, with better use of multidisciplinary local health and wellbeing boards, strategic policies in local plans, and more encouragement for daylight and green infrastructure
- Properly addressing overheating risk – the planning system is crucial because this is inadequately covered in current Building Regulations, and early site planning and



“In some building types, unregulated energy can account for around 50% of total use”

design are fundamental to limiting risks, now and in future climates

- Better local authority resources – from plan-making through to monitoring, they are key to delivering objectives.

Future framework for heat, BEIS

This consultation is a significant chance to inform the government’s thinking on a low-carbon future for heat, starting with buildings that are off the gas grid. CIBSE is working with a small group of academics and practitioners, and liaising with BEIS directly. We are developing the following lines in our response:

- Systems thinking is required as the built environment, transport, heat and electricity are increasingly linked. Carbon plans should not be developed in isolation and jeopardise air quality targets¹
- Efficiency is crucial to the strategy, both for annual consumption and peak demand. Retrofit targets may need to be taken further than currently planned
- A combination of options will be required, but all scenarios will benefit from demand management
- Information and education are important to address public perceptions and encourage alternative heating systems, particularly if government adopts an approach light on regulations and subsidies
- BEIS should gather lessons on systems performance, skills and gaps in the supply chain from the Renewable Heat Incentive, ‘deep’ retrofit projects, and organisations weaning themselves off fossil fuels.

Environmental principles and governance after EU exit, Defra

This consultation² intends to address concerns that the Withdrawal Bill may lead to reduced environmental standards, including the precautionary and ‘polluter payer’ principles. It is an important consultation, with potentially far-reaching consequences. We will collaborate with other environmental and policy organisations in our response, and give an update in next month’s column.

Get in touch

All consultations we engage with can be found at cibse.org/news-and-policy/consultations

References:

- 1 This is not negligible: solid fuel domestic heating is responsible for 40% of the UK’s particulate matters emissions bit.ly/2IK97TN
- 2 For context, see ‘Achieving a green Brexit’, *CIBSE Journal*, January 2018

JULIE GODEFROY
is acting head of sustainability development at CIBSE

Consultation	Deadline for input to CIBSE	Closing date
National Development Framework for Wales	13 July 2018	23 July 2018
A future framework for heat in buildings, BEIS	4 June 2018	11 June 2018
Environment principles and governance after EU exit, Defra	19 July 2018	2 August 2018

Come on in, the water's fine

Hybrid VRF – the world's first R32 VRF solution

With the familiarity of a VRF system and the water-based performance of a chiller, our latest Hybrid VRF models use low GWP refrigerant R32.

Already used in a variety of UK buildings over the past 5 years, Hybrid VRF provides a future proof design solution.

- No refrigerant in occupied spaces
- Simple Cat A to Cat B conversion
- Low running costs and maximum efficiency

For more information on **R32 Hybrid VRF**
please visit: hybridvrf.co.uk

WIN
the ultimate
flyboard
experience
hybridvrf.co.uk

Unregulated energy – why we should care

There are many complexities and risks involved in predicting total operational energy – in particular, the unregulated element. Even so, WSP’s Kate Dougherty says it is our duty to assist and educate our clients

Traditionally, designers have presented Part L results as evidence of a building’s energy efficiency credentials – and, for the most part, this has been sufficient. Increasingly, however, clients and design teams are beginning to understand that Part L isn’t an accurate reflection of reality, and regulated energy is only half the story anyway.

There is a growing trend for construction clients to require designers to predict – and even influence – the total operational energy use of a building.

Total operational energy is made up of regulated components – including heating, cooling, hot water, fans, pumps and lighting – and unregulated ones, such as IT equipment, lab equipment, catering facilities, and so on. This means designers have to take some responsibility for unregulated energy use, which presents a challenge and, potentially, a risk.

As designers, our gut reaction may be to wash our hands of unregulated energy use. ‘We cannot influence user behaviour,’ we protest. ‘This is firmly outside our scope.’ This is true to some extent, but it misses the point of addressing what really matters to building occupiers and owners: the real-life energy use and running costs of their assets. This is the legacy with which they are left.

It makes sense, therefore, to discuss the intricacies of regulated and unregulated energy use with clients early in the design process. This includes tempering their expectations of the accuracy of operational energy prediction methods and discussing the influence of building occupant behaviour.

The drivers for predicting total operational energy

It goes without saying that building owners will be concerned with minimising the running costs associated with their assets. Increasingly, however, organisations are also faced with carbon emissions targets, whether internally or externally imposed. In some cases, this has led to caps being put on the allowable carbon emissions from new buildings. By addressing total operational energy more effectively, we can:

- Gain a better understanding of future energy use and, so, carbon emissions



“In some building types, unregulated energy can account for around 50% of total energy use”

- Understand how buildings are expected to perform, so control alterations and behaviour-change initiatives can be targeted effectively
- Build better quality buildings that assist users with energy efficient operation.

Who’s responsible?

Regulated energy uses are inherent in the design of a building; they are related to the ‘quality’ of the building itself. While designers cannot predict how these things will, ultimately, be used, they can ensure they are installed to be as energy efficient as possible.

Unregulated energy uses, on the other hand, are often undetermined until very late on in the design process. They will also vary significantly throughout the life of a building, as spaces are used for different purposes. In some building types, unregulated energy can account for around 50% of total energy use.

It is true to say that designers have very little influence over which unregulated energy uses are included and how they are used. So it is unreasonable and impractical to demand that they are ‘responsible’ for total operational energy. Designers can, however, work with their clients to attempt

to predict total operational energy, and empower them to minimise it through the inherent building design and the way occupants use it.

Can designers really influence unregulated energy?

Undoubtedly, facilities managers and building occupants have the biggest influence over unregulated energy, but the way a building is designed can enable or hinder the occupants in using equipment efficiently.

Strategies to minimise unregulated energy use that we have employed in recent projects include:

- Locating shared facilities – such as freezer farms or autoclaves in laboratories – centrally, to discourage the inefficient use of smaller, individual pieces of equipment
- Master shut-off switches and easily accessible sockets, to encourage users to switch off equipment when it is not in use

KATE DOUGHERTY
is principal engineer
at WSP

- Dedicated chemical storage areas in labs, to discourage users from using fume cupboards as storage
- Energy monitor display screens, to raise awareness of energy use and influence user behaviour
- Integrated infrastructure for 'green' IT
- Post-occupancy evaluation and adjustments.

Calculating operational energy

The best methodology we currently have for calculating operational energy is set out in Technical Memorandum 54 (TM54), published by CIBSE in 2013. TM54 offers guidance on how to make more accurate energy estimates based on the intended use and operation of the building.

Case studies have shown that TM54 can predict operational energy of a building to within 15%.¹ In the two and a half years since its publication, however, uptake of the methodology is, anecdotally, low. One possible reason for this is the additional cost to clients. I have seen fees of up to £30,000 to undertake a TM54 for a large building.

A sensible approach for designers is to discuss the benefits and limitations of a TM54 analysis at the outset of a project. This could include an estimate of the associated cost and the payback on their investment.

The rebound effect

At this point, it is worth mentioning a further complication to the business of predicting operational energy use – a phenomenon known as the rebound effect.

This describes a situation where savings from energy efficiency may be cancelled out by an associated increase in energy intensive behaviour. Are you less inclined to switch off your new energy saving lightbulbs, for example? Are many energy efficiency measures a case of two steps forward, one step back?

Research into this phenomenon is in its infancy, and it isn't something we would attempt to account for in our operational energy calculations. However, this highlights the need to invest time in educating our clients to understand the many complexities of how occupant behaviour affects the energy use of their building, and what they can do to minimise it.

Conclusion

Savvy clients are increasingly aware of the importance of understanding the total operational energy use of their buildings.

For designers, there are many complexities and risks involved in predicting total operational energy – in particular, the unregulated element. However, it is our duty to assist and educate our clients.

It makes sense to start discussing operational energy, including the unregulated component, with our clients from the outset of a project. We should also be mindful of how our designs can enable or hinder building occupants in using equipment efficiently.

References:

- 1 Case studies have been carried out by CIBSE bit.ly/2GjNZyq and, more recently, by British Land bit.ly/2wKGLUI. Primarily, they have been done on office buildings; more complex buildings – such as research and technology buildings – would be much harder to predict, however.

Be alert to the Brexit benefits

The UK's decision to leave the EU next year can bring opportunity, says Robin Vollert

Ongoing political tussles over the UK's Brexit deal are troubling. Business people do not like uncertainty and the current volatility in the construction sector is, partly, the result of investors waiting to see what is going to happen before committing their money.

There was a significant dip in the first quarter of 2018, with construction activity down by around £1.5bn compared with the final quarter of last year, according to the Construction Products Association (CPA).

Brexit was not the only factor; the collapse of Carillion has also had a significant impact, so most analysts are predicting a flat market for the rest of this year. It should bounce back strongly in 2019, however, when the CPA is predicting 2.7% overall growth thanks, largely, to a surge in infrastructure investment – and this will feed through to building services.

There are other reasons to be optimistic. As with any period of economic change, our relative success will be as much to do with our own efforts and ability to adapt, and companies offering specialised services need to be ready. For example, there is a huge amount of work to be done in improving the performance of existing buildings, and our products and services are equally valuable in that market as in new build. Companies looking to import products into the UK may also face challenges if the Customs Union proposals do not work out, so firms that have invested in manufacturing and sales in the UK stand to gain.

Many international businesses believe you should invest in a market by having a physical base there and growing your staff locally. It makes sound business sense to have local manufacturing and product lines backed by technical development tailored for the local market. Brexit will prove the strength of this philosophy.

Currency fluctuations are putting pressure on prices, with many builders reporting shortages of materials and products. This is squeezing their profit margins and they need options. Again, local manufacturers and suppliers are well placed to win in this scenario.

Companies that have earned their place as part of a 'system' approach to building services – working as part of the design team and offering technical support, as well as products – will also find their expertise remains in demand, whatever the market situation.



Swegon
Air Management

■ **ROBIN VOLLERT** is managing director of Swegon Group UK&I
www.swegonair.co.uk

Grand challenges

The Prime Minister has announced the clean growth Grand Challenge and Dame Judith Hackitt's report into Building Regulations and fire safety has been published. Hywel Davies looks at the questions these pose to our readers

Harold Wilson, the former Labour Prime Minister, once said 'a week is a long time in politics'. It was quite a long week in May, with the publication of the review of Building Regulations and fire safety conducted by Dame Judith Hackitt, the announcement of £400m of taxpayer funding for the re-cladding of public sector high-rise apartment blocks, and a consultation on future regulations for the use of combustible cladding.

In the middle of that, the Prime Minister visited Manchester and made a major speech¹ on science, technology and innovation, including the announcement of a series of four Grand Challenges, the fourth of which relates to clean growth.

The government is clearly manoeuvring its industrial policy to support greater innovation after the UK leaves the EU. Its Industrial Strategy identifies areas in which the UK can develop a strategic and competitive advantage for the future. This is nothing new, as Theresa May acknowledged. The development of the marine chronometer, by John Harrison, was the result of a challenge that helped underpin British naval activity.

In her Manchester speech, May argued for the 'huge potential in a missions-based approach to drive faster solutions', before describing the first four 'missions' of the Industrial Strategy as ambitious, stretching, Grand Challenges with high ambitions.² Her fourth challenge is of huge relevance to *Journal* readers – clean growth.

The mission is to use new technologies and modern construction practices to halve, at least, the energy use of new buildings by 2030. The PM noted that heating and powering our buildings accounts for 40% of total UK energy use, and said: 'By making our buildings more energy efficient and embracing smart technologies, we can slash household energy bills, reduce demand for energy, and meet our targets for carbon reduction.'

May is probably not a *Journal* reader, but we have been arguing this case for some time. We should welcome this realisation in government.

The Challenge focuses on halving the energy use of all new buildings, but aims to halve the costs of achieving this in existing buildings too. This will be done by:

- Ensuring new buildings in Britain are safe, high quality, more efficient and use clean heating
- Innovating to make low energy, low carbon buildings cheaper to build



"The mission is to be a catalyst for new technologies and more productive methods"

- Driving lower carbon, lower cost and higher quality construction through innovative techniques
- Giving consumers more control over how they use energy through smart technologies
- Halving the cost of renovating existing buildings to a similar standard as new ones, while increasing quality and safety.

It is not just about UK buildings; the mission is to be a catalyst for new technologies and more productive methods, which can be exported to a large and growing global market for clean technologies. CIBSE supports this approach; we already work with universities doing world-leading research into low-temperature heating and cooling, which has led to the development of new products that can save energy, reduce costs for industry, reduce emissions and give 'UK plc' a competitive edge.

The government expects this challenge to drive innovation and higher standards in construction. It is one way of helping to meet the ambitious homebuilding targets, and is seen as a way of providing more jobs

and opportunity to 'millions of workers across the country'. It will be interesting to see how training and migration policy rise to this aspect of the challenge.

The Hackitt report is covered in detail on page 24, and it too sets out a challenging mission for government and industry – a new system of building and fire safety regulation for the life of buildings.

While Dame Judith is clear on the direction of travel, there is much detail to be developed, consulted on and delivered. It will need changes to primary legislation – such as the Building Act, which goes back almost as far as Harold Wilson – and to the way the industry plans, designs, delivers and operates buildings, and owners manage them.

Delivering that change, alongside the proposed Grand Challenge of halving energy use in buildings, will be difficult and demanding – but we really have no choice.

Not only do we owe a duty to the victims of the Grenfell Tower disaster to do all we can to prevent such an event happening again, we also have to cut our energy use and emissions if we are to be a competitive economy and live in comfortable and healthy homes.

References:

- 1 PM speech on science and modern Industrial Strategy [bit.ly/2lybl9E](https://www.gov.uk/government/speeches/pm-speech-on-science-and-modern-industrial-strategy)
- 2 Grand Challenge policy paper [bit.ly/2s4MxvA](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/684442/Grand_Challenge_policy_paper.pdf)



The world's first true ATS is here.

Introducing TruONE.

A critical breakthrough for critical power.

The all-new TruONE is the world's first true purpose-built automatic transfer switch, engineered to incorporate switch and controller in one seamless unit. Its self-contained design reduces the number of wires and connections, which speeds installation and minimizes the potential for connection failures, ensuring best-in-class reliability. Its predictive maintenance and modular components reduce downtime and service costs. And its optimum interface offers advanced connectivity and energy efficiency.

Unlike typical ATS solutions, TruONE allows safe emergency manual operation under load for immediate power restoration in the event of equipment malfunction. Performance tested beyond standard requirements, TruONE stands ready to ensure the steady delivery of critical power at all times.

Learn more. Contact your ABB representative or visit new.abb.com/uk/distribution-solutions



The circular economy: material advantages

How products are sourced, how they perform, and what happens to them, determines the impact of the built environment, says ECA's Paul Reeve

Building and infrastructure engineering services contribute hundreds of billions of pounds to the UK economy, and most of this value comes from the maintenance and operation of these services.

According to CIBSE figures, building engineering services can account for around a third of a building's whole-life environmental impacts. In terms of the products used, the impacts arise from: extracting and transporting raw materials; manufacturing, packaging and shipping; construction and installation; a typically overwhelming contribution from ongoing use, plus maintenance and upgrades; and, finally, material recovery and waste.

For electronic and electrical goods, the whole-life issues often centre on using and recovering strategic and precious metals, plus the embedded carbon in the products (CO₂ emissions resulting from the energy needed to create them) and, increasingly, what happens to the plastics that house all these products. Many plastics can be very difficult to separate and recover, yet they are now regularly cited as having environmental and other impacts.

Enter the circular economy – based on the premise that, when we increase the useful lifetime of these products, we also reduce the whole-life impacts, in a 'win-win' scenario.

Maximise value, minimise impact

The principles of the circular economy can be found in BS 8001, which enables a logical, but highly innovative, approach to finding optimal solutions to maximise whole-life economic, environmental and social value, while reducing the accompanying impacts.

The circular economy involves getting the very best out of product design, use and recovery, as well as examining the overall business model. The six guiding principles are: systems thinking; innovation; stewardship; collaboration; value optimisation; and transparency.

So, what would drive any of this to happen in our sector? It could be:

- Legislation – Ecodesign, WEEE
- Economic and commercial incentives/penalties (aiming to 'modify supply-chain behaviour')
- Standards – notably for Ecodesign



“When we increase the useful lifetime of products, we also reduce the whole-life impacts, in a win-win scenario”

- Client and supply-chain demand/ethical behaviours.

With the focus on optimising value, the circular economy has already attracted the attention of legislators and various UK buyers and suppliers.

Last, but not least, another driver will be the discovery of compelling business cases for the key players. These – and some examples of who might benefit – could arise from achieving:

- Legal compliance (for example WEEE, Ecodesign) – everyone
- Market advantage with clients – manufacturers, specifiers, service providers
- Reduced operational costs – the client, service providers
- Future-proofing – the client, manufacturer
- More persuasive pre-qualification questionnaires – the service provider.

In the circular economy, if great design isn't quite everything, it's close. As well as phasing out unsustainable materials, new product designs should aim for increased durability, adaptability, ease of disassembly and refurbishment, and recovery.

Increasingly, such products will need to be deployed via whole-life services, rather

than by simply selling or installation. After all, who has more interest in maintaining whole-life value than a whole-life service provider? And, in a truly circular economy, new and often unexpected business models can arise – for example, batteries are being sold or leased for second-hand use when their original design function is over.

We can look much harder at how we do business, and not just at what we buy, sell and install. Individual action is possible but seldom optimal – it will be much easier if we can increase cross-industry standardisation, notably to boost replacement and upgrading.

Various companies, including those in consumer electronics and engineering, already showcase good and best circular economy practice. We should now consider if our sector wants a 'free pass,' or do we want to improve economic, social and environmental value for ourselves and our customers? The means for achieving a more circular economy are out there, and where there is an industry will – and some solid business cases – there is usually a way.

Econoplate packaged plate heat exchangers



Econoplate C Range



Econoplate E Range



Econoplate Steam to Water

As the pioneers of packaged plate heat exchangers in the UK, Stokvis offers the ultimate in efficiency and quality in a fully comprehensive range of packaged units.

For further information or to receive a technical guide
tel: 0208 783 3050 or email: info@stokvisboilers.com

www.stokvisboilers.com

The regulatory system for high-rise buildings is set for a radical overhaul if the proposals in Dame Judith Hackitt's final report, into shortcomings in the building regulatory system in England, are put into practice.

Publication of the report draws to a conclusion her inquiry into failings in the Building Regulations and fire safety rules following the blaze in Grenfell Tower, a residential high-rise block in west London, in which 72 people died.

The former chair of the Health and Safety Executive sets out her proposals to change what she describes as the construction industry's 'race-to-the-bottom culture'. In it, Dame Judith proposes a radical rethink of the regulatory system in England – and of the management of higher-risk residential buildings during their operating life – in order to drive a change in culture, 'to ensure that people living in high-rise buildings are safe and have confidence in the safety of their building, both now and in the future'.

The report, *Building a Safer Future – Independent Review of Building Regulations and Fire Safety*, describes the current regulatory system for high-rise buildings as 'not fit for purpose' and in need of a 'radical rethink'. Dame Judith says issues underpinning the system's failure include: ignorance, misunderstanding and misinterpretation of

regulations and guidance; indifference to quality and safety, motivated by a drive for quick and cheap solutions; a lack of clarity on roles and ambiguity of where responsibility lies; and inadequate regulatory oversight and enforcement tools.

Her proposals to change the system are focused specifically on multi-occupancy, higher-risk residential buildings (HRRBs) of 10 storeys or more in height. However, the changes are expected to form a blueprint for a much wider reform of the system.

Hywel Davies, technical director of CIBSE, says: 'Dame Judith's terms of reference were to look at high-rise buildings where people sleep, but the very widespread industry view is that these changes probably ought to apply to almost all buildings, with the exception of two- and three-storey dwellings occupied by a single family.'

Davies describes the report as a 'once-in-a-generation call for fundamental change in the way we regulate the

A RADICAL RETHINK

Dame Judith Hackitt's review of Building Regulations and fire safety, in the wake of the Grenfell Tower fire, calls for a complete overhaul of how we construct and regulate buildings. **Andrew Pearson** looks at the implications for building services engineers



construction and operation of buildings, which seeks to address numerous flaws in the system that many in CIBSE and beyond have grappled with for years’.

At the heart of the report is the call for a new regulatory framework covering the design, construction and maintenance of high-rise residential buildings, which recognises that they are complex systems in which the actions of many different people can compromise the integrity of that system. (See panel, ‘Key recommendations affecting building services engineers’ on page 26.)

Davies describes the report as ‘sensible and says a lot of things that needed saying’; however, he believes there is ‘still a lot of detail to work out’.

It is not yet clear how the government will proceed to address the full package of recommendations, but the Secretary of State for Housing, Communities and Local Government, James Brokenshire, has said it is:

- Already consulting on restricting the use of desktop

studies as a means of assessing the fire performance of external cladding in lieu of an actual fire test. The consultation will seek views on whether desktop studies should be used at all and whether they are appropriate for construction products, wall systems, or for any other purpose

- Committed to consulting on a clarification of Approved Document B over the summer
- Planning to consult on banning the use of combustible materials in cladding systems on high-rise buildings.

‘Government has committed to work with industry to improve the user-friendliness of the overall suite of Building Regulations guidance – work on which CIBSE is already closely involved,’ says Davies.

There is also a call for everyone involved ‘to have their say on how we can achieve change in culture and practice’ by the end of July, he adds. This will be followed in the autumn by a further, more detailed, statement to parliament on how the proposed regulatory system is due to be implemented.

Davies says: ‘Once it is clear what this call entails, CIBSE will continue to contribute to the ongoing discussion.’

- Visit bit.ly/2KKbzXV to read the review



“The very widespread industry view is that these changes probably ought to apply to almost all buildings, with the exception of two- and three-storey dwellings occupied by a single family”
Hywel Davies

Key recommendations affecting building services engineers

- » ■ A clear model of risk ownership, with distinct responsibilities for the client, designer, contractor and owner, to demonstrate the delivery and maintenance of safe buildings. The project team will be held to account by a new Joint Competent Authority (JCA), made up of Local Authority Building Standards – the proposed new name for Local Authority Building Control – fire and rescue authorities, and the Health and Safety Executive. ‘It means the way building control operates will have to change,’ says Davies. ‘This new body will have powers during both construction and operation of the building.’
- A set of rigorous and demanding dutyholder roles and responsibilities, to ensure a stronger focus on safety during a building’s design, construction and refurbishment. These roles will be broadly aligned with the Construction (Design and Management) Regulations.
- A series of ‘gateway points’, from initial planning through to occupation of the building, that will have to be formally approved by the JCA before a scheme can move on to the next phase of work, or before a building can be occupied. The change-control process will also require permission from the JCA for significant amendments to the detailed plans signed off by the Authority. ‘It might also mean that, when a scheme is value engineered and there are changes to the original design, the amended design may need to be re-approved,’ explains Davies.
- Only the Local Authority Building Standards body can oversee a scheme’s compliance with regulations for HRRBs, to ensure regulatory oversight is independent from clients, designers and contractors. ‘A single enforcement regime for these buildings will replace the current market mechanism for building control, supported by rigorous and enhanced enforcement powers,’ says Davies.
- Penalties for those who – as Dame Judith Hackitt put it – ‘chose to game the system and place residents at risk’ will also be more serious.
- Moving towards a system where ownership of technical guidance rests with

the industry, with oversight provided by government. There are also proposals for a clearer package of regulations and guidance, which will be simpler to navigate, while reflecting the level of complexity of building work. The report calls for this guidance to be ‘truly outcomes based’ rather than based on prescriptive rules. It is an approach that acknowledges that ‘prescriptive regulation and guidance are not helpful in designing and building complex buildings, especially in an environment where building technology and practices continue to evolve, and will prevent those undertaking the work from taking responsibility for their actions’.

- Dame Judith acknowledges in the report that an outcomes-based framework ‘requires people who are part of the system to be competent, to think for themselves rather than blindly following guidance, and to understand their responsibilities to deliver and maintain safety and integrity throughout the life-cycle of a building’. Consequently, the report places demanding expectations around improved levels of competence, including the formation of an overarching body to provide oversight of competence requirements. This new approach will ‘reinforce the concept of delivering building safety as a system’ rather than a series of isolated objectives.
- In her report, Dame Judith calls for a more effective product-testing regime, with clearer labelling and traceability, because ‘the current process for testing and “certifying” products for use in construction is disjointed, confusing, unhelpful, and lacks any sort of transparency’. She also wants poor procurement practices to be tackled, to ensure high-safety, low-risk options are prioritised and full life-cycle cost is considered when a building is procured.
- A digital record from initial design intent through to construction, including any changes that occur during occupation, is also demanded by the report – effectively, producing a model similar to those created under BIM level 2. This model will create ‘a golden thread of information’ about each HRRB, which will be handed over to the owner. The information can then be used to demonstrate to the regulator the safety of the building throughout its life-cycle. ‘Dutyholders will have to present a safety case for approval at regular intervals during the life of the building,’ says Davies.
- Clearer rights for residents are also proposed, as well as responsibilities where resident activity can create risks that may affect others. **CJ**



**We're back and
turning up the heat!**



**Ormandy Rycroft
Engineering**



**A leading brand in the HVAC
industry since 1896**



Ormandy Rycroft Engineering
Duncombe Road, Bradford
West Yorkshire, BD8 9TB

Tel: 01274 490 911
Email: sales@ormandygroup.com
www.ormandygroup.com

Ormandy Rycroft Engineering is a division of Maloney Metalcraft Ltd, a subsidiary of Avingtrans plc.

HVAC2018

9-11 OCTOBER NEC

**AT THE HEART OF
THE HVAC INDUSTRY**

ATTEND

CPD accredited seminars about wellbeing

LEARN

about the latest H&S and building regulations

MEET

new and existing solution providers and suppliers

DISCOVER

10,000 innovative products and services

hvactive.co.uk



PART OF
UK CONSTRUCTION WEEK 2018



SUPPORTED BY

**REGISTER
FREE**

BE THE CHANGE

The built environment is on the brink of dramatic change, and CIBSE must be agile to keep up. **Liza Young** speaks to the Institution's new President about the year ahead

Construction in the UK must change, says new CIBSE President Stephen Lisk. 'As a body that exists for the public benefit, we are committed to being at the forefront of delivering that change.'

As well as technological and environmental shifts, we are in an era of political and economic upheaval as the UK nears Brexit.

Perhaps the biggest change for the construction sector, however, will be brought about by the publication of Dame Judith Hackitt's review into building regulations and fire safety, following the fire at Grenfell Tower last summer, says Lisk. The review – to which CIBSE contributed evidence – identified areas where change is needed, including regulations, roles and responsibilities, procurement and competence.

'We need to understand who, throughout a project, will ensure a building fulfils its purpose. Starting at design stage and right through construction – when alterations might affect the cost, design and safety – a record of any changes must be kept up to date so that, at the end, a competent person can confirm the original design intent was preserved and delivered,' explains Lisk.

That information needs to be handed over to those operating the building, preserving the 'golden thread' of information from construction into its operational life, he adds.

'Our members have the power to make a positive and significant impact,' says Lisk. 'Everything we do can make the built environment better – whether through the products we make; the projects we design; the buildings we manage, operate, maintain and refurbish; or the standards we contribute to.'

Seeing the light

As a lighter with almost 30 years' experience, Lisk has witnessed significant technological changes in the sector.

'We take LED lighting for granted now,' he says. 'When I was starting out, we had 10 or 12 lighting sources with different characteristics and performance.'

'Product design, and how it integrates with architecture, is another huge change. With improvements in LED, new optical design and different ways to control it, we can now reimagine how we light spaces.'

The important thing to remember, Lisk believes, is that lighting is for people. 'We've been doing performance-based lighting for 100 years; being able to quantify how much light someone needs to perform an activity is easy,' he says.

'But understanding how people react to light emotionally and how they feel in a space – whether it's children learning in a school or people working in an office – is a lot harder. And, as technology changes, we need to adapt our style of design.'

When lighting a space, you need to look at who is going to be in it, what they will be doing, and how long they will stay there. This should apply to all aspects of building services design, he adds.

The new CIBSE President started his career in his native New Zealand and studied illumination engineering at the Central Institute of Technology (CIT) in Wellington.

He later worked at a number of large European lighting companies, including Erco and iGuzzini, before starting his own lighting design and supply studio, One Eighty Light, where he has been for the past nine years.

His route into CIBSE was through the Society of Light and Lighting (SLL), which he joined after emigrating to the UK 18 years ago. In 2009 – the SLL's centenary year – Lisk became president of the society.

As well as working on the Imperial Tobacco HQ in Bristol and the Canadian Embassy in London, one of Lisk's most memorable projects was the Royal Junior High School, in Bath. 'We were called in to look at lighting, alongside the engineer, architect, and the client. Everybody started speaking in a technical way and, in the end, I asked the headteacher what she envisioned.'

'She said she saw open doors and lighting that looks like birds flying into the space. We used that to design a new concept. Lighting that connects



Did you know

The new CIBSE President started his career in his native New Zealand, where he studied illumination engineering at the CIT in Wellington

“Within CIBSE, we are a part of a much bigger picture and, if we want to move fast, we have to collaborate with others”



One Eighty Light worked on the lighting at the Imperial Tobacco HQ in Bristol

with people who use it is the best kind of lighting.’

Lisk says the process at One Eighty Light is highly collaborative – the firm works alongside architects, engineers and manufacturers. A key theme in his presidential address was that industry-wide collaboration is essential if CIBSE is to maintain its relevance and grow its reach.

‘Within CIBSE, we are a part of a much bigger picture and, if we want to move fast, we have to collaborate with others,’ he explains.

A changing CIBSE

‘We cannot stand still,’ emphasises Lisk. The world of professional engineering institutions is changing, following John Uff QC’s sector review last year, he adds, ‘and it doesn’t make rosy reading.’

The review identified the ‘lost three million’ – the number of people working in engineering who are not associated with any professional institutions.

‘We have just over 44,000 people in our special interest groups, and only around a quarter are members,’ he says. ‘The rest want to share knowledge, and it helps us raise awareness of our work more widely.’

Lisk believes that some of CIBSE’s changes are long overdue. Next year, Professor Lynne Jack will be CIBSE’s first female President.

‘We are an institution that needs to be representative of its membership,’ Lisk says. ‘An imbalance in gender make-up is not exclusively a CIBSE thing – many institutions have a similar issue. We understand this needs to change, and we want to lead that change.’

Lisk says inclusion and diversity go hand in hand, and CIBSE’s new inclusivity panel has been set up to address this. But it’s not just about gender, race or sexual orientation – it’s also about diversity of opinion. ‘We want to foster an environment where people can have different views, because some of the questions we are asking do not have just one answer,’ he explains.

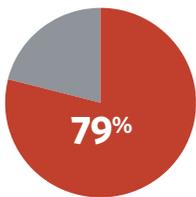
Lisk’s message to CIBSE members is that the Institution is agile and it ‘gets’ change. ‘Our guidance – accessible through the Knowledge Portal – and events, such as the Technical Symposium and Build2Perform Live, are available industry-wide and beyond,’ he says.

Building performance goes across every aspect of what CIBSE is doing and its 20,000 members affect it the most, he says. ‘Every time one of our members designs a building, they are directly affecting the people that use it. That positive impact is our driving goal – to make people’s lives better.’ **CJ**

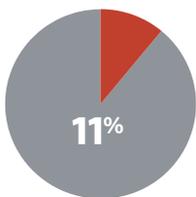
LONDON'S TUNNEL VISION

It carries five million passengers a day and is integral to the smooth running of the capital - but could the Tube also allow developers to tap a huge secondary heat source? **Andy Pearson** investigates

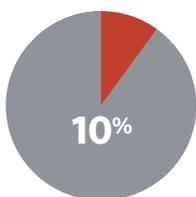
Heat emitted from trains



Proportion absorbed by tunnel walls



Amount pushed out of tunnels via draught relief shafts by piston effect



Share removed by mechanical ventilation

What would you do with 500GWh of heat a year? Transport for London (TfL) is looking to building services engineers and developers to provide it with some answers to this very question, because that is the quantity of heat produced in the tunnels and stations of the London Underground each year. And it is the amount of heat that TfL would like removed from the Tube to prevent it from getting any warmer and to make journeys more comfortable for the five million passengers a day that use the system.

Making use of this secondary heat will also help TfL to meet the London Mayor's objective, outlined in the draft Environment Strategy, to 'develop clean and smart integrated energy systems utilising local and renewable energy resources'.

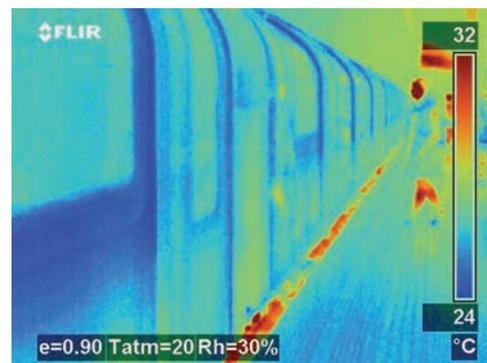
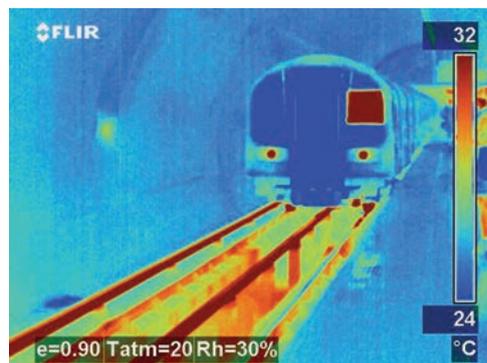
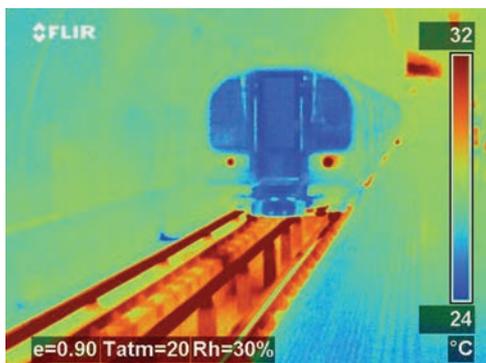
One way of achieving this is for building services engineers to come up with schemes to redirect this heat to nearby buildings and developments. 'TfL has been evaluating waste-heat utilisation at a number of locations; however, the next step is to engage with external stakeholders,' says Sharon Duffy FCIBSE, head of transport infrastructure engineering at TfL.

To understand how and where this heat is available, it is first necessary to know how it is created.

Keeping the London Underground cool in summer is a growing challenge, particularly on its deep tunnels serving the Piccadilly, Central, Northern and Jubilee lines. Many of these tunnels were constructed more than 150 years ago, through the thick layer of London Clay present beneath the city.

There are two types of tunnel on the Underground - 'deep Tube tunnels' and older 'sub-surface lines', which run just below street level in 'cut and cover' tunnels. Keeping sub-surface lines cool is less of a challenge; steam trains originally ran on some of these, so they are larger than the deep Tube tunnels and constructed with plenty of openings, through which smoke could escape. As a result, London Underground has been able to fit air conditioning units in its new S-stock trains on the sub-surface lines, because the openings allow waste heat to be vented away.

On deep Tube tunnels, however, London Underground is having to search for more creative cooling solutions. 'The kinematic envelope is so tight that there is not



Tube trains pulling into stations account for 50% of the heat generated on the London Underground, producing about 350kW each time



much space to put air conditioning on the train,' says Duffy. There are also very few openings through which to vent heat.

When the deep tunnels were first dug, cooling was not an issue; tunnel temperatures were a very temperate 14°C, the same as the surrounding ground. This fact was exploited by London Underground's marketing team in a 1926 poster, which had the banner 'It's cooler below' and the caption 'The Underground's the only spot for comfort when the days are hot' (see page 33).

These days, the reality is strikingly different, with some sections of the Central and Bakerloo line tunnels recording temperatures of more than 30°C (see heat map on page 32). 'The clay has acted as an effective heat sink, absorbing a lot of the heat generated by trains running year on year,' explains Duffy.

About 21% of the heat generated by the trains is aerodynamic drag and friction; a further 21% comes from the electric motors, drive and auxiliary systems, with about 2% generated by passengers. By far the largest proportion of heat, 50%, comes from the trains slowing down – the process of converting kinetic energy into heat simply by applying the brakes. 'A Tube train pulling into a station will give out about 350kW of heat,' says Duffy. (See thermal photos.)

The problem is only likely to get worse as London Underground upgrades the service. 'The more trains per hour we run, the more heat is generated – and the faster we run the trains, the more heat we generate,' explains Duffy.

London Underground uses regenerative braking to transfer about half of the energy back into electricity; however, this can only work where trains are braking and accelerating at the same time, on the same electricity substation loop. 'Regenerative braking has been enabled to minimise the heat generated in the tunnels, but the residual primary heat source remains the braking of trains,' says Duffy.

'With increasing service levels on all lines in recent years – and the ambition of TfL for this to continue – the amount of heat in the tunnels is expected to rise.'



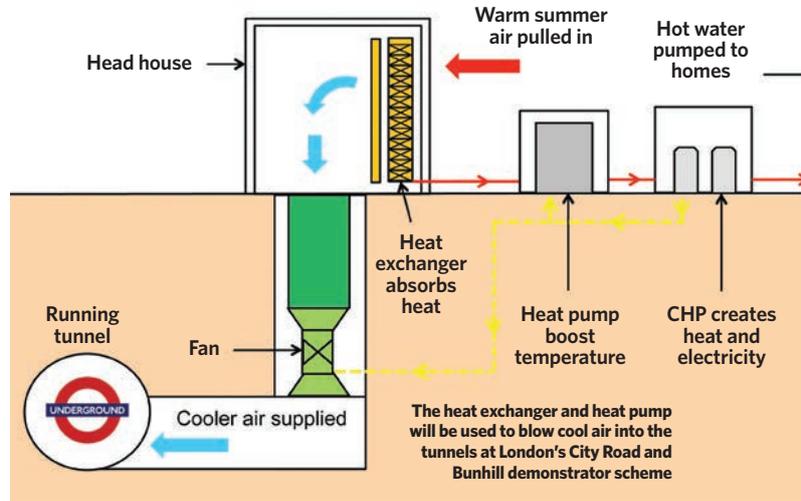
» Of the heat emitted by the trains, 79% is absorbed by the tunnel walls; 11% is pushed out of the tunnels through draught relief shafts by the train piston effect in the cylindrical tunnel; and the remaining 10% is removed by mechanical ventilation through dedicated ventilation shafts. 'We face a quandary between delivering the right passenger service and mitigating the increase in heat we generate,' Duffy says.

Removing the heat

TfL is taking steps to investigate how heat can be extracted from its tunnels and stations using a range of technologies. One solution is enhanced tunnel ventilation. In addition to draught relief shafts, deep Tube lines – such as the Victoria and Jubilee – have tunnel-ventilation systems. Generally, these comprise a large fan installed in a vertical, circular shaft connecting the tunnel to the surface. They were primarily installed as smoke vents, but on the Jubilee Line, in warm weather, the mid-tunnel vent fans are run at half speed to draw cool air into the tunnels through stations.

During the recent upgrade of the Victoria Line, the throughput of fresh air in stations has been doubled by upgrading the tunnel ventilation fans. 'Where we've got the facility for ventilation, we use it,' says Duffy.

On older lines, with very few ventilation shafts, it is virtually impossible to thread more shafts down through the capital's congested streets. 'Because parts of the system are 155 years old, some of our network



is not served by ventilation, which is why we need to look at station cooling systems,' explains Duffy.

At Oxford Circus, TfL has installed a simple chiller solution, using a roof-mounted air-cooled chiller to remove heat from an above-platform cooling coil. 'We're having to put in cooling systems at stations to enable line upgrades,' says Duffy.

At Green Park, TfL is using borehole water to remove heat from the station. Water is extracted at a temperature of about 13°C and passed through two heat exchangers before being re-injected into the ground. The first heat exchanger is used to remove heat from the station's cooling water circuit, which serves above-platform air handling units, raising the temperature of the borehole water by 8°C, to 21°C. 'There is an opportunity for someone to tap into the second heat exchanger to take this heat from the borehole water and return it to the aquifer at, say, 6°C,' says Duffy.

At the City Road and Bunhill demonstrator scheme, in north London, TfL is working in partnership with the Greater London Authority and Islington Borough Council on an EU Celsius Smart Cities-funded project. Currently under construction, it involves the installation of a heat exchanger to a Northern Line, mid-tunnel ventilation shaft. The shaft discharges 70m³/s of hot tunnel air straight into the atmosphere at approximately 25°C. In winter, the heat exchanger will recover heat from the discharged air, and this will then be piped through a primary water loop to a 1MW heat pump, where its temperature is increased.

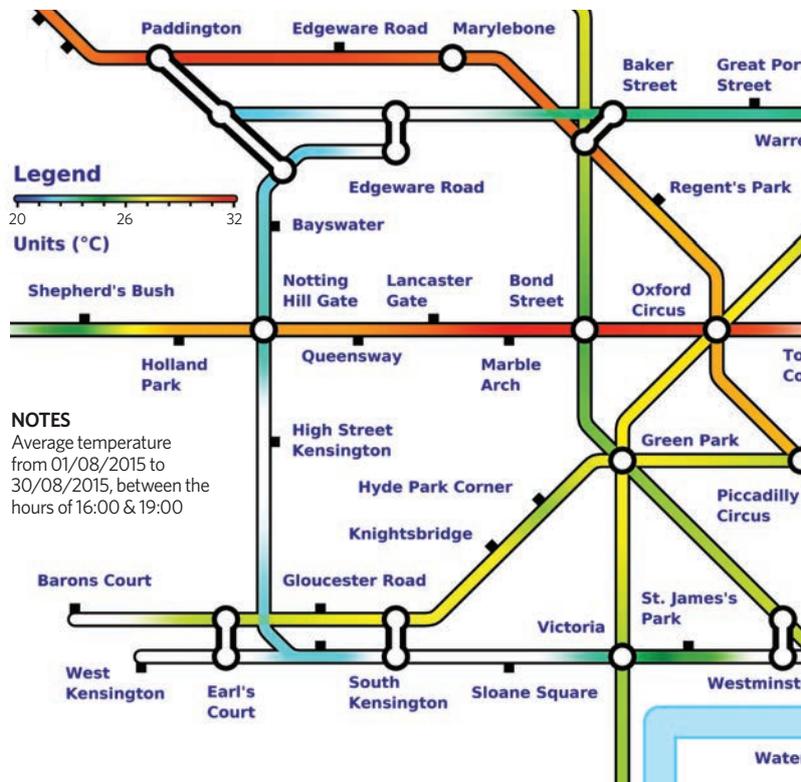
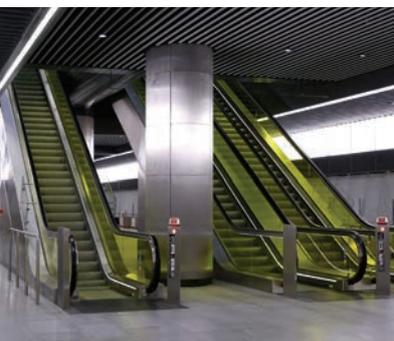
A secondary water loop will then transfer this heat to Islington council's existing Bunhill Heat and Power Network, which supplies 700

WHY CROSSRAIL WILL BE COOL

Crossrail is a new east-west railway line under construction beneath London. All of its subterranean stations have giant ventilation shafts at either end of the platforms, the primary purpose of which is smoke control. These shafts incorporate reversible fans that can move up to 300m³/s of air; however, they have been designed to operate at half speed to provide ventilation, and to cool the platforms by supplying air at one end and removing it from the other. There are also numerous mid-tunnel ventilation shafts for smoke control, which can be used to enhance tunnel and station cooling when required.

To limit the amount of brake-energy emitted as heat, trains approach stations up a gentle incline, to help slow them down. When the train pulls into the platform, under-platform extract removes heat from the brakes and drive motors. Air conditioned carriages ensure passengers remain comfortable during their journey. In addition, some Crossrail stations are surrounded by geothermal piles.

'By enabling heat to be removed from the geothermal piles to supply new over-station developments, we are future-proofing our infrastructure,' says Duffy. Some of these geothermal piles are close to existing London Underground infrastructure, so will help cool the ground around these too.



homes on an adjacent social housing development with low carbon heat and hot water. The heat recovered from the tunnel vent extension will supply an additional 450 homes with heat and hot water, saving up to 500 tonnes of carbon a year. In summer, the heat exchanger and heat pump will also be used to blow cool air into the tunnels.

‘The fan is bi-directional, so in the hotter summer months – when the air temperature outside exceeds the temperature in the tunnel – we can cool the warm summer air using the heat exchanger and heat pump while generating hot water for the homes,’ says Duffy.

The scheme aims to show that extracting airborne heat from the tunnels is feasible and worthwhile, and that it could help tackle fuel poverty, as well as reduce the cost of cooling for TfL and heating for the borough of Islington.

At Holborn, TfL is investigating the possibility of using a trigeneration system to supply cooling to the station, power to its traction substation, and heat, generated by the engine, to local commercial and residential developments. TfL is also involved with London South Bank University and University College London in the Luster project, to map where subterranean heat energy is potentially available in the capital. In addition to London Underground, the project is investigating heat resource from sewers and cable tunnels. ‘The map will enable people who are heat users to identify opportunities where the heat is available,’ says Duffy.

These examples show that it is technically feasible to use London Underground’s secondary heat sources – and, as far as TfL is concerned, these initiatives are just the start. ‘We’re interested to hear about all sorts of potentially disruptive technologies that could use TfL’s

secondary heat sources,’ says Duffy. ‘Tunnel temperatures don’t drop in the winter so – year round – there is an opportunity to take heat from the ground.’

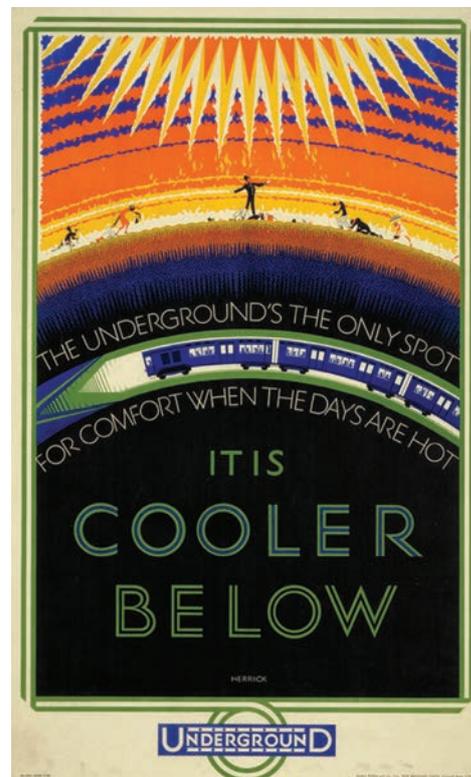
Wherever you are developing in central London, you are close to the Underground. Research by TfL has shown that heat-extraction rates are higher up to 24m from a Tube tunnel – which may result in developers viewing a scheme’s proximity to a line as a potential opportunity for free heat rather than an inconvenience, restricting what they can place in the ground, and where. ‘The key is for London Underground to be involved early in a development, so we can discuss the possibility of using heat,’ says Duffy.

TfL regards this as an opportunity and, potentially, a revenue source, and is keen to work in partnership with engineers and developers. ‘There are many technical, legal and commercial challenges to be faced with this pioneering new strategy and TfL recognises these,’ says Duffy.

‘But if the right partnerships can be developed, the prize of carbon savings, economic benefit and increased efficiency of systems is there to be won.’

■ If you have a scheme that might benefit from London Underground’s waste heat, get in touch with Sharon Duffy at Transport for London SharonDuffy@tfl.gov.uk

“By far the largest proportion of heat, 50%, comes from the trains slowing down – the process of converting kinetic energy into heat simply by applying the brakes”



A 1926 poster, encouraging people to use the Underground to stay cool

TAKING ROOT

A micro greens farm below Clapham is helping researchers understand the impact of plants on their surroundings. The University of Cambridge's **Rebecca Ward** reports on a project that aims to quantify the benefits

Beneath the busy streets of Clapham, in south-west London, an innovative and award-winning urban farm is thriving in energy efficient growing conditions, in tunnels 37m below street level. Growing Underground is an expanding business that is benefiting from a rewarding collaboration between industry and academia.

Launched in 2013, and located in former World War II air-raid shelters leased from Transport for London, Growing Underground uses hydroponic systems to produce sustainable, pesticide-free crops of micro greens and salad leaves.

The aim is to bring edible crop production to the heart of the city and minimise the carbon impact of food transportation. Fennel, garlic, chives, pea shoots and coriander, among other plants, can be picked and on a restaurant plate within hours. Growing Underground – which sells its greens through Ocado, Marks & Spencer and Waitrose – aims to be carbon neutral, and was awarded the 2017 BBC *Farming Today* Future Food Award.

Urban farming is on the increase; rapid growth of the industry in Japan and South-East Asia has resulted in a rise of dedicated plant factories. This has been accompanied by a growing interest in biophilic design in the built environment.

Nature-based solutions – such as incorporating plants in and around buildings – are increasingly being applied to improve the urban landscape, as well our health and wellbeing. As these trends grow, however, it is important to be able to quantify the impact of plants, which can help improve air quality in terms of temperature, humidity and CO₂ levels, and contribute – in less tangible ways – to individual and community wellbeing.

Since 2015, a team from the University of Cambridge's Energy Efficient Cities initiative (EECi), led by Dr Ruchi Choudhary, has been collaborating with Growing Underground since 2015, building

on the success of an earlier project at the Royal Botanic Gardens in Kew. A retrofit study of the greenhouses there resulted in the development of a simulation model that incorporated the heat and mass transfer associated with plant transpiration into a dynamic energy simulation of the greenhouse structures.

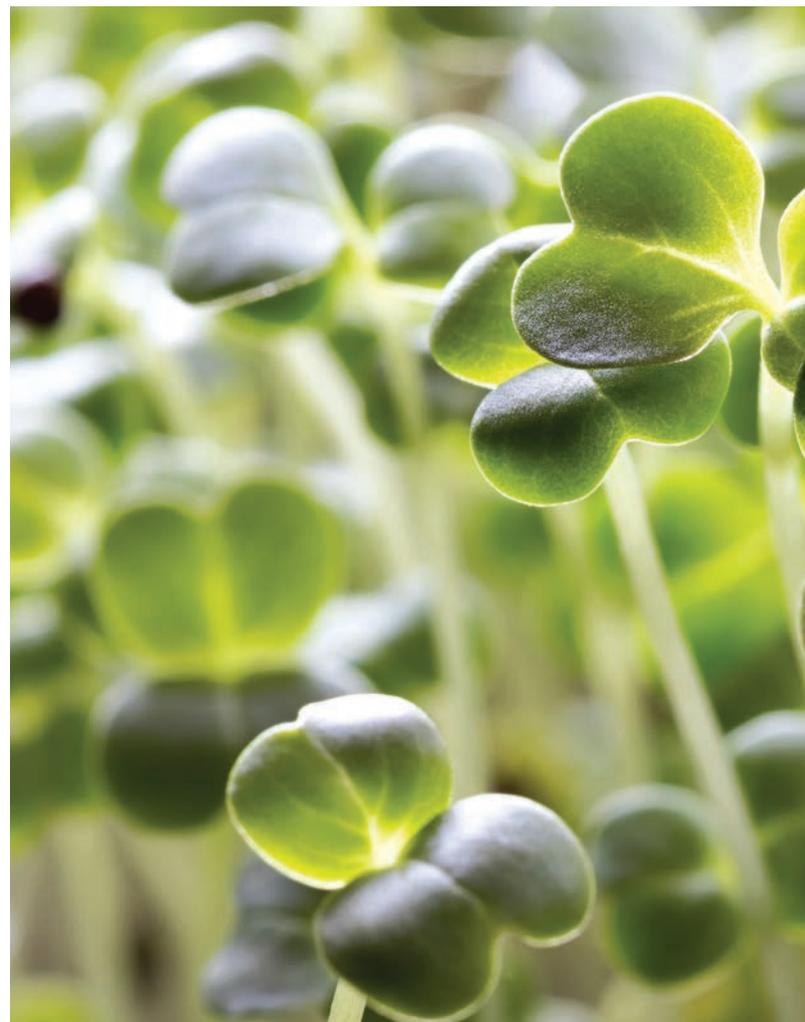
The initiative's collaboration with Growing Underground has presented an ideal opportunity to gather data on the impact of plants on air quality under controlled conditions, and for further development of the simulation tool. Since the link-up, a range of wireless instrumentation has been installed in the farm's tunnels to monitor temperature, humidity, CO₂, air velocity and light.

'Our monitoring is helping Growing Underground to optimise yield, while reducing energy consumption,' says Melanie Jans-Singh, EECi PhD student investigating the integration of urban farming in cities by reusing wasted resources. 'If, for example, there is a doubt about how the plants are growing at a certain spot, I can refer to the measurement of air velocity to identify the precise conditions. When the plants are growing better in one area than another, the instrumentation helps us to work out why.'



Win

Growing Underground was awarded the 2017 BBC *Farming Today* Future Food Award





Growing Underground is based in World War II air-raid shelters.



For the growers, access to real-time monitoring enables immediate action when conditions tend towards the sub-optimal. For example, environmental management of the tunnels depends on adequate ventilation via the installed extraction fans – and ventilation is a significant energy consumer at Growing Underground. The monitored data has allowed adjustments to be made that have cut consumption for ventilation without affecting yield.

The analysed data itself is also of value – it creates a ‘lifetime performance passport’, which is a rich source of information for the asset owners, present and future. Data collected from the instrumentation are also critical for informing a heat and mass transfer model of the tunnel developed at the university. This work was presented at the recent CIBSE Technical Symposium.

Environmental conditions result from complex 3D interactions between the plants and their surroundings, but the typically regular structure and layout of this farm means an appropriate approximation to consider heat and mass transfer is a one-dimensional slice, vertically through the greenhouse layers – for example, the floor, internal air, tray, growing medium, plants and roof.



Pea shoots, garlic, coriander, fennel and chives are grown at the urban farm

“The vision of the team at the University of Cambridge is to develop the tool as a means to simulate the impact of plants at the design stage for all types of building”

Plant transpiration contributes to the air temperature and relative humidity by taking heat from the air to enable evaporation of water from the leaf surface. This is included in the model, in addition to the more standard heat-exchange terms arising from conduction, convection and radiation, and mass exchange arising from evaporation from the growing medium and ventilation exchange.

Transpiration rates – and, therefore, cooling rates – are dependent on the leaf area index for the plants. This is the ratio of leaf area to planted area, and varies depending on the type of plant, growth stage and pruning or harvesting regimes employed. At the Clapham farm, it is a particularly difficult quantity to estimate because, at any one time, there are many different crops, all at different stages of growth.

The air’s temperature and moisture content is also critical, because transpiration is driven by the difference between the moisture content at the leaf surface and in the surrounding air. Even with a relatively simple 1D model, however, reasonable results can be obtained for prediction of internal temperature and relative humidity, given the external weather conditions.

Figure 1 shows how the model compares against monitored data for these two parameters. The blue and red points show the model results when the LED grow lights are off and on respectively, and can be compared with the monitored data points in green and pink.

The LED grow lights contribute the only heating to the tunnel. Interestingly, the tunnel location means it is feasible to have the lights switched on at night-time – when, typically, it is cooler outside – so helping to maintain stable temperatures.

Also shown in Figure 1 are the desired operational conditions. The growers keep temperatures above the minimum by altering ventilation rates and closing doors. These actions are not included in the model – hence the discrepancies between monitored and simulated temperatures for low external temperatures.

The simulation tool also includes a model of CO₂ exchange. Carbon dioxide levels have only a minor impact on transpiration rates, but are significant for plant growth and, so, critical for an urban farm. CO₂ exchange is a complex process, however, and appears to be very dependent on the type of plant; much lower CO₂ levels were observed in the farm than would be predicted by the model. Further research into this aspect is a priority for future studies. >>



» The model has the potential to be developed for use in building-energy simulation, to analyse the impact of plants on building internal environments, incorporating natural lighting and enabling quantification of the co-benefits between plants, buildings and the occupants.

The University of Cambridge team's vision is to develop the tool as a means to simulate the impact of plants at the design stage for all types of building. In the longer term, the EECi would like to identify the conditions required to turn a space into a greenhouse, to quantify the potential for re-use of derelict space within cities for urban farming, and to develop a metric for quantifying the benefits of plants.

Collaboration between business and academia benefits all stakeholders. Growing Underground is offering a case study for further research, and the EECi team is delivering data that will help the crops – and the company – to flourish. **C**

■ The EECi team is grateful for the support of Growing Underground.

■ **REBECCA WARD** is a research associate at the University of Cambridge Energy Efficient Cities initiative

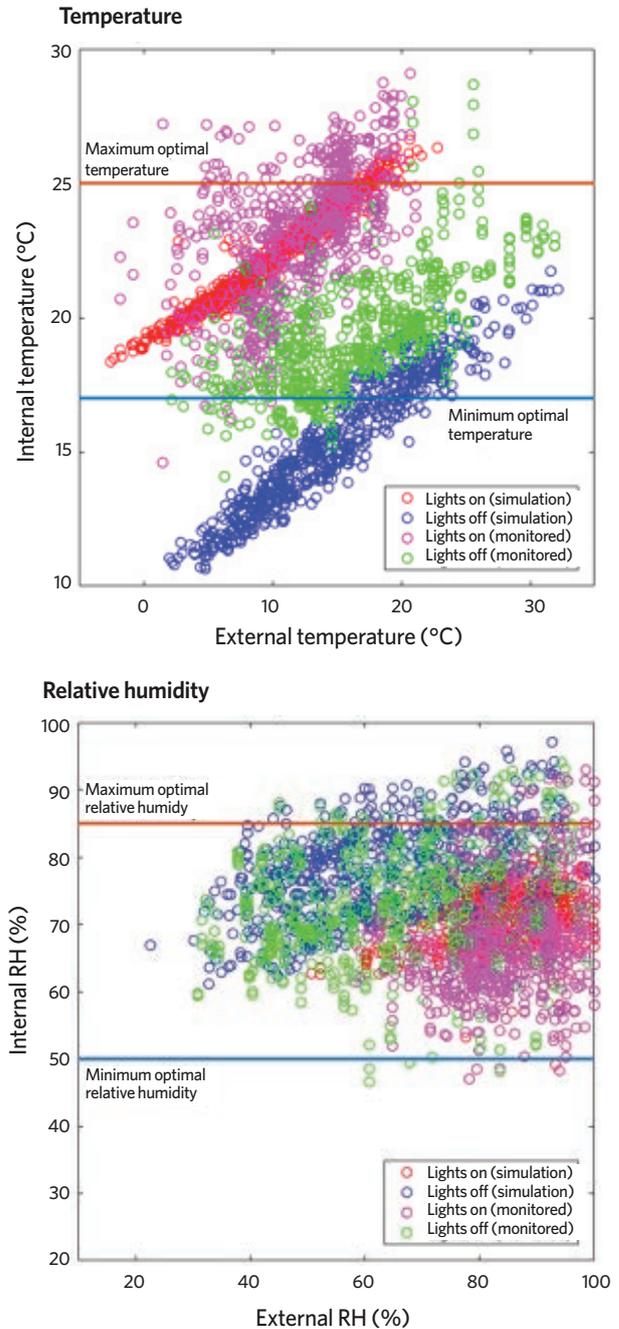


Figure 1: Internal temperature (a) and relative humidity (b) as a function of external conditions

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



VELOGRID
Velocity Averaging Sensor



P-Sensor

CMR CONTROLS Ltd

CMR are the inventors and manufacturers of both the P-Sensor and the Velogrid. The Velogrids are made to measure to fit any ductsize up to 3m x 3m and the P-Sensor has a keyboard to easily enter : duct height - width - density - magnification factor and the scaling in m/s - m³/s - m³/h - l/s. It can even work out the Air Change rate. And the BMS gets three linear volume signal outputs of 0..10V 4..20mA and an addressable Modbus rtu bus.

22 Repton Court Repton Close
Basildon Essex SS13 1LN GB
www.cmr-controls.com

Tel +44 (0) 1268 287222
Fax +44 (0) 1268 287099
sales@cmr-controls.com



CIBSE Certification approved by UKAS to certify to ISO 9001



What is ISO 9001?

ISO 9001 is the international standard that specifies requirements for a Quality Management System (QMS). The standard provides an internationally recognised framework to consistently provide products and services that meet customer and regulatory requirements.

Apply for ISO 9001 certification or transfer your existing UKAS accredited certification

Call +44 (0)20 8772 3614 or visit www.cibsecertification.co.uk/certification



DAIKIN APPLIED (UK) LTD
Technically better...

Daikin Applied are proud to launch the next generation of inverter driven air-cooled and water-cooled screw chiller series with refrigerant **R-1234ze(E)**.

The air-cooled chiller range (EWAH TZ-B series) is available from 130kW up to 830kW cooling capacity and the water-cooled chiller range (EWWH-VZ series) is available from 340kW up to 1600kW cooling capacity.

With efficiency ESEER figures above 5.5 (air cooled) and 8.5 (water cooled) the chillers are the most energy efficient inverter screw chillers on the market and compliant with Ecodesign Lot 21.

New Generation of HFO Air & Water Cooled Chillers



Contact us on: [0345 565 2700](tel:03455652700) to discuss all your Chiller, AHU or Service requirements.

www.daikinapplied.uk



Chiller CPD
now available

AHUs

CHILLERS

PROJECTS

SERVICE

TESTING THE WATER

Good engineering design and client-side control management are key to the successful containment of legionella bacteria. Aecom's **Richard Beattie**, Arup's **Damien Kane** and **Paul Nolan**, of Paul Nolan Water Hygiene, address legionella risk in domestic water services

Advances in technology, combined with the drive to conserve water through low-flush toilets and low-flow devices, mean current and reliable data on building water consumption must be obtained to ensure demand is assessed more accurately.

Without considering the implications of current practices – which reduce or limit building water consumption – demand and water-tank turnover rates can lead to stagnation of water in domestic installations, resulting in public health issues, including bacteria growth.

While bacteria may be in a viable but nonculturable (VBNC) state at low temperatures, they are capable of amplification in warmer water temperatures.

The sizing of all aspects of domestic water systems should, therefore, include an accurate estimation of the anticipated water consumption by the end users.

For legionella to proliferate, certain conditions are required, including:¹

- Water temperature in the system of between 20°C and 45°C
- Potential for water aerosols to be formed and become airborne
- Water being stored and/or recirculated
- Presence of deposits in the system, such as sludge, organic matter, rust, scale and nutrient
- Amoebae, which are known to cause retrograde contamination of legionella bacteria.

For legionella bacteria to amplify, ambient temperature and relative humidity (RH) need to be exact. Bacteria can proliferate in storage tanks, calorifiers, pipework and plant, filters, thermostatic mixer valves (TMVs) and particular types of fittings and materials.

All bacterium need a substrate – or food source. The common causes of contamination from hot- or cold-water systems are showers, taps, spray heads and spa baths. Other risk systems include humidifiers and air washers, car-wash lances, and horticultural misting systems.²

Water that is contaminated can pose a risk of infection if it can become an aerosol and airborne. Small particles can remain suspended in air for long periods and travel over considerable distances.² They are dry and contain no free moisture. Only bound water is present, which represents a small percentage of the total mass. When contaminated air is inhaled into the lungs, particles that are 5µm in diameter or less will be retained in the lungs because these

sizes are difficult to expel. The risk increases with duration of exposure, respiratory rate and number of legionellae in the air.²

A biofilm is any group of micro-organisms in which cells stick to each other and, often, to a surface. These adherent cells become embedded within a slimy, extracellular matrix that is composed of extracellular polymeric substances (EPS). This means legionella may be protected from normal water treatment methods.²

It is still possible, however, for biofilm to form that will support bacterial growth if water is circulated within a system. Water flowing or pumped into a water distribution system only causes shearing of biofilm – it does not remove it once it is established.

Pipework surfaces are not smooth, and biofilms will stick to them, so regular draw-off and water movement through the system – supported by automated flushing systems or via manual intervention by janitorial or facilities management (FM) staff – are important to minimise the risk.

Legionellae are only able to grow in water in the presence of other micro-organisms. They have also been shown to be associated with biofilm on surfaces in water systems, where they can grow in the protozoa grazing the biofilm.² In addition, evidence suggests they can grow outside protozoa, alongside – and supported by – other organisms within the biofilm.

Growth within protozoa – particularly with the potential for incorporation within



The range of water temperatures in a system that allow legionella to proliferate²

“A particle can remain suspended in air for prolonged periods of time and travel over considerable distances”

protozoal cysts – can protect legionellae from biocides, heat and drying. This enables them to survive under conditions that would otherwise be fatal, and to be transported within protozoa and cysts to more favourable environments, where they might grow.

The association with biofilms, as with other aquatic bacteria, offers legionellae a nutritional advantage and some protection against adverse environmental conditions – particularly biocides, which would kill them if they were simply suspended within the water column. Control of biofilm formation within water systems is of paramount importance for the control of legionellae.

Water-flow temperatures also have an influence on the water volume being used, particularly in relation to hot-water services. Hot-water temperatures need to be sufficiently low to mitigate scalding risk, but – as a result – can potentially encourage bacterial growth and the presence of legionella bacteria, stenotrophomonas and pseudomonads, including other waterborne, opportunistic pathogens.

The optimum legionella bacteria multiplication temperature is between 32°C and 42°C.² HSE L8¹ requires the temperature of domestic hot-water systems to be maintained above 50-60°C. It also advises that stored hot water is not below 60°C, with a recommended distribution temperature of no less than 50°C, and 55°C in healthcare premises, within one minute of running an outlet.³

Temperatures in excess of approximately 44°C³ may result in burns to the skin, so a conflict exists between storing hot water at 60°C and the risk of scalding. As a result, hot-water temperatures need to be controlled via thermostatic control devices – such as TMVs – or suitable warning signs need to be placed next to hot-water outlets. Better still, put a thermostatic mixing tap (TMT) on the wash hand basin, minimising pipe lengths from lowered, blended temperatures from a TMV to the outlets.

Identifying risk of infection

Empirical data suggests the ideal temperature for microbial growth and proliferation is 37°C. Below this, the rate of multiplication declines and can be considered marginal below 20°C.²

Certain groups of people are more susceptible, including: over 45-year-olds; smokers; alcoholics; diabetics; immune compromised; and those with cancer, respiratory or kidney disease.

HSG 274 states that all pipe branches to individual outlets should be capable of delivering cold water at a temperature close to the incoming water temperature within two minutes of running.

Management of legionella risks are described in the approved code of practice guidance document L8, *Legionnaires' disease: The control of legionella bacteria in water systems*¹, and HSG274 Part 2: *The control of legionella bacteria in hot and cold water systems*.³ The key actions are:

- Appointment of a 'responsible person' to be managerially responsible



- » ■ Identification and assessment of sources of risk, including the preparation of a risk-minimisation scheme for preventing and controlling the risk
- Implementation and management of the risk-minimisation scheme
- Record keeping and checking the actions taken are effective in preventing or controlling the risk.

Risk assessments are about compliance and vulnerability. They involve assessing compliance status using checklists, the response to which are either ‘yes’ – indicating compliance – or ‘no’, meaning non-compliance. The more non-compliant the conditions, the greater the likelihood that something could transpire.

When the risk has been assessed, it is necessary to minimise and control it – and the assessment must be reviewed regularly, as stated in HSE L8.

The record of the assessment is a living document that must be kept up to date. Arrangements should be made to review the assessment regularly – and, specifically, whenever there is reason to suspect it is no longer valid. An indication of when to review the assessment and what should be recorded^{2,3} may result from:

- Changes to the water system or its use



Good technical engineering design is one of the ways to reduce legionella bacteria



The temperature that domestic hot-water systems must be maintained above, according to HSE L8¹

“The ideal temperature for microbial growth and proliferation is 37°C. Below this, the rate of multiplication declines”

- Changes to the use of the building in which the water system is installed
- The availability of new information about risks or control measures
- The results of checks, indicating that control measures are no longer effective
- Changes to key personnel
- A case of Legionnaires’ disease/legionellosis associated with the system.

When the assessment indicates there is a reasonably foreseeable risk from a water system, exposure has to be avoided so far as is reasonably practicable.

Where this is not practicable, a written scheme for controlling the risk from exposure should be implemented and properly managed. The scheme should specify measures to be taken to ensure it remains effective.

Summary

It is becoming increasingly difficult to size cold- and hot-water systems because more low-flow devices and mixing valves are being incorporated.

Even though outbreaks of Legionnaires’ disease are infrequent they are potentially life threatening, and may be avoidable through engineering design and operational-side maintenance and management.

Successful control of legionella bacteria is a combination of good technical engineering design and client-side control management. One of the key considerations should be to review the sizing guides/methodologies to account for modern practices. This will require more research, data analysis and sharing of raw, live, consumption data from actual buildings. **CJ**

- The issues and mitigation measures highlighted in this article have been compiled through the experience of multiple engineers from many consultancies over several years, and in no way reflect projects at Aecom or Arup.

■ **RICHARD BEATTIE** is a senior engineer at Aecom Edinburgh, **DAMIEN KANE** is a senior engineer at Arup Glasgow, and **PAUL NOLAN** is an authorising engineer at Paul Nolan Water Hygiene

References:

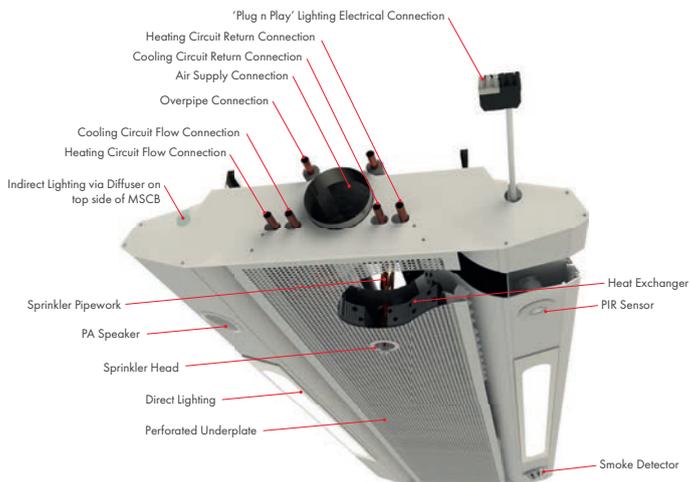
- 1 UK Health and Safety Executive, Approved Code of Practice and Guidance, *The control of legionella bacteria in water systems*, L8, fourth edition (Health and Safety Executive Books, 2013).
- 2 CIBSE, TM13, 2013, *Minimising the risk of Legionnaires’ disease*, The Chartered Institution of Building Services Engineers, London. See www.cibse.org/knowledge
- 3 UK Health and Safety Executive, HSG 274 Part 2: *The control of Legionella bacteria in hot- and cold-water systems* (Health and Safety Executive Books, 2014).

Multi-Service Chilled Beams

Multi Service Chilled Beam (MSCB) units can utilise either **passive or active beam technologies**. They provide visually stunning yet **100% functional building services** which are **100% pre-fabricated off site** in a controlled factory environment, thus significantly reducing the site installation programme. All services are **100% factory tested and delivered 'Plug n Play'** to reduce on-site commissioning time.

Key Benefits

- Ideal where floor-to-slab height is minimal
- Low running costs - minimal maintenance requirements
- Delivers many services in a single unit - so reducing costs
- Optimum levels of occupancy thermal comfort
- Beam aesthetic can be customised to client requirements



Design Options

The following building services can be integrated within Frenger MSCB's:

- | | | |
|-------------------|--------------------|-------------------------------|
| • Cooling | • Heating | • Electrical Compartmentation |
| • Up-lighting | • Direct lighting | • Emergency Lighting |
| • Control valves | • Sprinklers | • Acoustic insulation |
| • Smoke detectors | • Lighting sensors | • Distribution Ductwork |
| • Fresh Air | • PA / VA Speakers | • Distribution water pipes |

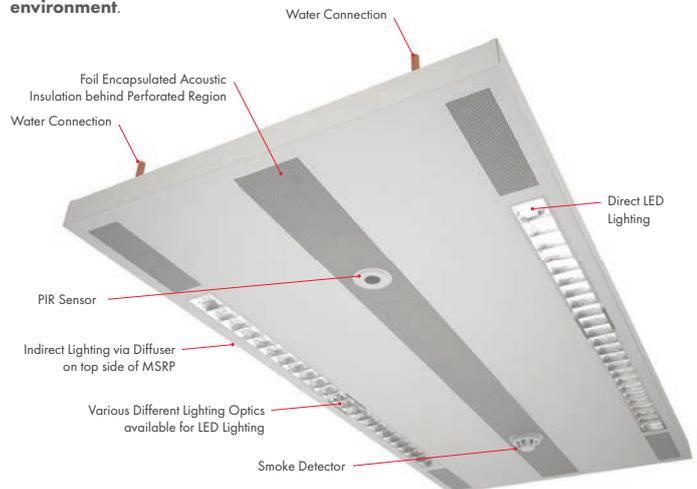
There are several aspects of a "Chilled Beam System" that promotes a more energy efficient operation than other air based HVAC solutions.

Chilled water is distributed to the chilled beams above dew point, typically at 14-17°C to avoid the risk of condensation, whereas other HVAC solutions operate below dew point, typically at 6-12°C.

Multi-Service Radiant Panels

Using a combination of **Radiant Panel and MSCB technology**, Frenger's Acoustic, Lighting and Heating Rafts, otherwise known as **Multi Service Radiant Panels (MSRP's)** are a free hanging radiant heating panel which may also have options of **lighting and/or acoustic sound absorbing properties**.

An ideal solution for schools, youth centres and universities, other services can also be incorporated such as apertures for sprinkler heads, compartment trunking for other electrical services, apertures for PA and VA speakers plus lighting control, PIR, Photocells and other building services which are **100% pre-fabricated off site in a controlled factory environment**.



Design Options

The following building services can be integrated within Frenger MSRP's:

- | | | |
|-----------------------|-----------------------|-------------------------------|
| • Heating | • Direct LED lighting | • LED Up-lighting |
| • Acoustic insulation | • Sprinklers | • Emergency LED Lighting |
| • Control valves | • Smoke detectors | • Electrical Compartmentation |
| • Lighting sensors | • PA / VA Speakers | • Distribution water pipes |

For further information on MSCBs and MSRPs or to learn about our other product ranges please visit www.frenger.co.uk

FRENGER[®]

systems





**YOUNG
ENGINEERS
AWARDS
2018**

CIBSE Graduate of the Year 2018



**ENTER
NOW**

Tell us your story...

The annual CIBSE ASHRAE Group Graduate of the Year Award is one of the industry's most sought after accolades. The competition is open to anyone that has graduated in a building services related discipline, within the last two years.

Winners receive

The first prize includes a trip to the ASHRAE Winter Conference in Atlanta. Two runners up will receive generous cash bursaries, with other finalists receiving cash prizes.

For more information visit:
cibse.org/graduate-of-the-year

Email completed entry forms by Wednesday
1st August 2018 to yea@cibse.org

www.cibse.org/yea



Supported by:



Sponsored by:



Chartered Institution of Building Services Engineers
222 Balham High Road, London, SW12 9BS
CIBSE is a registered Charity No. 278104

It is a common trait of specifiers to stick with what they know. Faced with the challenge of balancing increasingly stringent efficiency targets with ever-squeezed project budgets, it is inevitable that some systems within the building will be repackaged again and again within new project specifications, because they work at the right cost, without impacting efficiency. But what if there is a better solution? What if this inertia is preventing cost savings, installation efficiencies or enhanced performance from being achieved?

One such example is the soil and waste drainage system – clearly a critical part of any building, and one in which failure could be costly, disruptive and unpleasant for property owners, operators and users. Despite continued innovation and development of materials, however, many specifiers will stick to the ones they used in the previous project.

Each material comes with advantages and disadvantages, especially when considered for specific applications. Before I explore the merits of four in more detail, however, it is important to consider the demands of drainage pipes and how this will affect specification.

Effective drainage specification

Obvious considerations, such as lifespan of the pipe, encompass both the material and installation costs. Flexibility of installation, acoustic performance – how well the pipe can dampen the noise of flushing water or waste as it passes through – and joints and fittings are also important. Depending on the material choice, pipes can be connected using mechanical clamps, push fitting, solvent welding, butt welding or electrofusion welding.

We must also consider the smoothness of the pipe bore and the hydrophobicity of the inner pipe – how well it repels water and, so, avoids blockages. For metallic pipes, we have to factor in susceptibility to corrosion, including whether any coatings will be required.

Once the material is agreed, individual product standards must be adhered to and products must be installed in line with BS EN12056-2 and Building Regulations Part H.

Let's examine in more detail four material options for soil and waste drainage systems: cast iron and high-density polyethylene (HDPE), commonly used for higher specification projects, then polyvinyl chloride (PVC) and enhanced polypropylene composite, offering a lower cost alternative.

Cast-iron credentials

Cast iron – an alloy of iron and carbon – offers good acoustic performance, but is more expensive to purchase and install compared to plastic alternatives.

As an iron-based material, it is also susceptible to corrosion; modern cast-iron pipes have more advanced coatings, but many older buildings are, inevitably, facing corrosion issues after 40 or 50 years of service from their original drainage systems.

Most significantly, cast-iron pipes are more likely to build up depositions than a plastic pipe because of the roughness of the pipe bore. A new cast-iron pipe would typically offer a roughness value – the relative roughness of a pipe against the size of its diameter – of 0.26mm, compared with 0.0015mm or below for plastic alternatives.

Through decades of constant use, this surface roughness gradually worsens and deposits start to cling to pitting in the pipe bore. Even with regular cleaning and maintenance, this can lead to serious blockages and clogging with cast iron, and this will eventually cause leaks if left untreated. >>

The demands of drainage pipes affect the specification of materials

WATER WAYS

Is inertia holding us back when it comes to material selection for drainage pipes and fittings? Geberit's Jonathan Briafield weighs up the choices

» **A shift towards HDPE**

Offering a viable alternative to cast iron, HDPE is an increasingly popular material for drainage pipes and fittings in commercial buildings. It combines the lightweight flexibility and installation benefits of plastic pipes with the robust, durable properties required for commercial applications.

Although HDPE is not the lowest cost material, the initial investment can often be outweighed by reduced maintenance costs and an extended system life-cycle – not to mention the peace of mind that comes with a strong and reliable welded solution.

HDPE pipes have a smooth bore, which is maintained throughout their lifetime, helping to repel any waste that might attach to the inside – and they are reasonably hydrophobic. The inside of a HDPE pipe can often be cleaned thoroughly simply by flushing the toilet or running the tap.

It is also a chemically inert material and insensitive to high water temperatures. It is able to withstand hot water up to 90°C – and even boiling water – unlike PVC which has an upper limit of 75°C. This is particularly important in applications such as hospitals because of the nature of the waste disposed of through the drainage system.

PVC – the old favourite

Currently, around 75 per cent of soil and waste pipes and fittings sold in the UK are made from PVC, which is lightweight, incredibly cost-effective and easy to attach to walls. Like any plastic pipe it has a smooth bore, so is less likely than cast iron to experience clogging from a buildup of deposits.

Unlike cast iron, PVC does not offer strong acoustic performance, so lagging is often required, adding time and cost.

PVC is also a relatively brittle material, particularly in cold weather. It is not

uncommon with commercial applications for PVC drainage to be installed, only to be damaged later by subsequent contractors. This can add unforeseen project cost.

Enhanced polypropylene composite

The fourth option is relatively new to the UK market. Enhanced polypropylene composite is a proven material, used for many years on the continent and now finally delivering benefits to UK specifiers, engineers and installers too.

Offering strong acoustic performance because of its enhanced structure, this is a more robust material than PVC, so does not become brittle at low temperatures and reduces the need to fit twice in the event of damage by other trades.

Crucially, it is comparable in price to PVC pipes and fittings, which makes it a competitive choice for acoustically sensitive applications. Enhanced polypropylene may offer an opportunity to deliver overall project cost savings – compared to lagged PVC – by reducing or removing the need for lagging on some projects.

In addition to the installation and performance merits of each material, it is also important to consider the fragility of pipes when clearing blockages. New cast-iron pipes, for example, will be able to withstand high-pressure water jetting and any reasonable use of tools inside the pipe, but we have seen many examples where the pipe wall has fractured or fittings have blown in ageing cast-iron systems as a result of careless unblocking maintenance. Plastic pipes, such as HDPE, PP or PVC, do not corrode over time and, with welded fittings, there is no reason why they should be compromised by pressure washing – although PVC pipes will remain brittle, especially in colder weather.

Ultimately, the choice of material will come down to a number of factors, but new materials should not be ruled out because of inertia. Products continue to evolve and – with learnings from the European market too – efficiencies and enhancements can be achieved. **C**

JONATHAN BRIAFIELD is senior product manager at Geberit



Top: Butt welding HDPE pipes using a hot plate; Bottom: Corroded cast-iron pipework

AIR MASTER[®] SMART VENTILATION UNITS

- ✓ Draught-free
- ✓ Low dB(A)
- ✓ Low CO₂
- ✓ Smart control

SAV SYSTEMS
www.sav-systems.com/smart



Celeste

Energy efficient low profile surface or suspended LED luminaire ideal for educational applications

- **'Corona' backlit effect** with an 80/20 front/back distribution
- **Robust construction** suitable for **stairways** and **corridors**
- Offers **50,000 hours** operational life with **no maintenance**
- Digital **dimnable**, integral sensors and **emergency** variants
- **Colour** insert accessories for backlight accent and decorative trim bezels

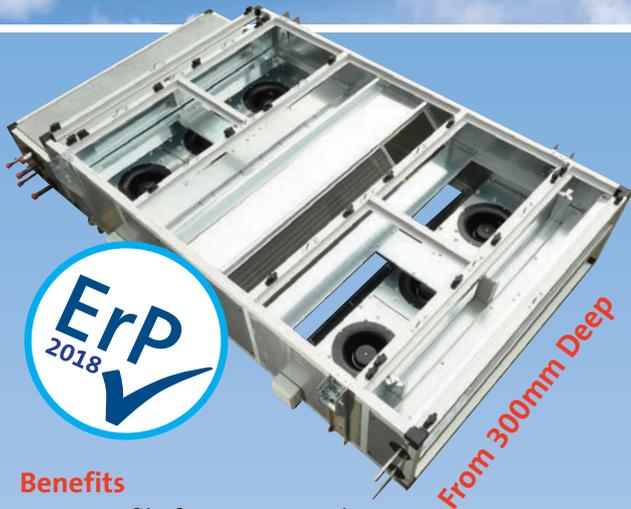


AIR HANDLERS LTD

PVHRU

Max Quiet

Packaged Void Heat Reclaim Unit



Benefits

- Low profile from 300mm deep.
- Up to 90% Heat Recovery efficiency.
- Outperforms ErP 2018.
- Heating Coil options. LPHW or electric.
- Cooling coil options chilled water or DX.
- Heat pump coil options.
- TM52 compliant.
- On board controls available.
- Filtration to F7.
- Summer by pass facility.
- High sound reduction casework tested to BS EN ISO 10140-2 (2010) UKAS certified.
- High performance backward curved centrifugal fans with low specific fan power.
- Meets BB101 and BB93 Feb 2015.
- Bottom access.



University of
Salford
MANCHESTER

Acoustic Testing Laboratory
College of Science & Technology

Air Handlers Northern Ltd.
Alfred Procter House
Bute Street, Salford
Manchester M50 1DU

Tel: 0161 745 8888
Fax: 0161 725 9900
sales@airhandlers.net
www.airhandlers.net

Engineering Solutions

SPONSORED FEATURE

It's our choice, is it not?

Connect your assets with open protocols to boost performance and profits.

With the right control and monitoring technology, users can collect and analyse HVACR operating data from across their building or estate. Giving both service providers and end-user organisations the opportunity to achieve heightened



performance and safety compliance, while protecting assets and reducing operating costs. Typically manufacturers that produce building automation equipment limit which protocols their equipment will conform to, which means that users of this equipment are committing to not just the solution, but the protocol used to support it. Companies who produce proprietary protocol systems, typically do not disclose their technical information and as such customers are forced to acquire all of the required components from the supplier. Arguably, proprietary protocols, lock customers in and take away their freedom of choice, and the option to expand their system with alternate suppliers.

Open protocol systems offer a higher degree of flexibility; customers can choose from a variety of different suppliers for a solution that best matches not just their technical requirement, but their financial needs also. Presenting the option to incorporate existing assets, through integration with third-party systems, or assets that they choose to purchase from other suppliers.

Through the adoption and implementation of IP, XML, plus optional plug-in connectivity with BACnet™ and Modbus®, amongst other protocols, RDM products can communicate across open protocols and non-proprietary networking communications.

Furthermore, RDM does not charge an annual maintenance or license fee for any of our protocol activations. The licence is for the life of the hardware, and the majority of our hardware products are backed with a best in class five year warranty. Giving our customers the freedom to make their own choices underpins our ethos.

Visit www.resourcedm.com/blog/openprotocols to read the full blog and to learn more about our open protocol solutions.



Resource Data Management

■ GRAEME ROSS is Group Head of BEMS at Resource Data Management.

Passengers can breathe easy at Bristol Airport

Internal components treated with coating to resist corrosion

To ensure a high-quality indoor environment, four high-specification, large-capacity air handling units (AHUs) have been installed at Bristol Airport's upgraded West Terminal by Ciat UK.

Airtech units include active carbon filters to maintain good air quality.

The units also include silicon-sealed plate heat exchangers for heat recovery to capture energy from exhaust air and return it to the building, saving running costs and reducing carbon emissions, says the firm.

Adam Hardacre, sales manager at Ciat UK, said: 'The Airtech range is fully modular and provides a number of options to meet specific requirements for almost any commercial and industrial application.'

The AHUs, all Eurovent certified, are designed in accordance with EN 13053, and meet the strict requirements of the EN 1886 performance standard for thermal bridging, mechanical strength, casing air leakage, filter bypass leakage, and mechanical safety requirements for fans.

The extension to the airport's West Terminal is part of a long-term strategic development programme to upgrade the site's infrastructure and transform



the airport experience for passengers. This latest phase offers a more spacious security search and arrivals area to cut waiting times.

The AHUs were supplied by Air Systems SW, and installed by mechanical services contractor Whitehead Building Services. The consultants were Amber Management, acting for the client, and McCann and Partners, who supported the mechanical services contractor.

This project follows the installation of four heat pumps and one AHU at the airport's East Terminal. After a 14-month construction project, the new 9,000m² facility is now fully operational.

The units are equipped with a heat recovery system to capture energy from exhaust air

Weatherite debuts WispAir AHUs

Using selection and quotation software, integrated with an interface programme that links design, purchasing and manufacturing processes, Weatherite's new WispAir range of standard/modular AHUs combines a rapid quotation turnaround with fast-track delivery.

'Lead times are getting shorter and there will always be increasing pressure on costs. The challenge for us was to design, build and deliver energy-efficient, fully compliant AHUs that meet the client's requirements within the shortest possible time,' said Steve Cartledge, sales director at Weatherite.

The range covers typical airflow rates from 0.3m³/s to 35m³/s, and offers an extensive selection of configurations to suit each individual application. It can even supply units in multiple sections or as a flat-pack solution.

Fully ErP compliant, the range uses high-efficiency fans and motors, and incorporates heat-recovery technology, said the firm.



Carrier chillers offer real-time data access

A new generation of air-cooled liquid chillers has been developed by Carrier.

According to the firm, the 30KAV Aquaforce Vision chiller with Greenspeed intelligence combines energy efficiency, intelligent controls, connectivity and real-time data access, to ensure end users can manage their buildings for optimum comfort.

The combination of variable speed drives with screw compressors offers stability and a wide operating range of positive displacement compression, said Carrier.

Its operating range means the 30KAV can function in temperatures from -20°C to 55°C. This is not generally available with variable-speed centrifugal compressors, said the firm. The range is available with options for free-cooling, partial and full heat recovery, and low-temperature brine cooling.

Stackable modular chiller launched by Aermec



Aermec MD
Paul Lawrence

Aermec UK has launched a stackable water-cooled modular chiller that enables cooling capacities to be increased over time to suit changing requirements.

The WWM chiller has been engineered to deliver energy efficiencies and flexibility through its modular design, said the firm.

Suitable for indoor installation for medium-to-large air conditioning applications in residential and commercial buildings, the chiller offers dual-circuit units, reversible water side with hermetic scroll compressors, and a plate heat exchanger to transfer heat between the geothermal source and the internal system.

Located in a drawer that slides out from the front, the refrigerant components can be easily reached for service and maintenance.

Paul Lawrence, MD at Aermec UK, said: 'The WWM offers a streamlined and flexible solution for all installers and building owners.'

A maximum of 32 chillers can be linked together hydraulically, and each module has its own electrical panel and control logic, so it can be operated and controlled as an individual chiller. The modular concept also offers component redundancy, claimed Aermec, which said work can be carried out on a module without affecting other units.



Adiabatic air inlet cooling

EcoMESH is a unique, patented mesh and water spray system that improves the performance of Air Cooled Chillers, Dry Coolers and Refrigeration plants whilst reducing energy consumption worldwide.

save

energy, time & money

Reduce electrical running costs by up to **44%**

additional EcoMESH benefits

Retrofitted to any model, make and size of air conditioning and refrigeration unit

Minimal water consumption, **79% less water** than any other wet system

Protection against snow and sand storms and provides additional shading properties

No water softeners or chemical treatment plant required

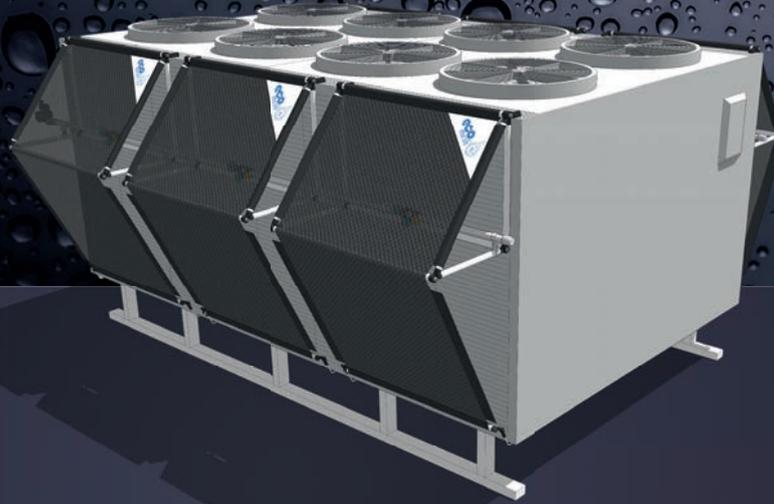
No still water reservoir design **eliminates health risk**

Extends compressor **reliability and life**

Typical **payback period 21 weeks** from installation, no more than 1 cooling season

Ideal as part of your **environmental solution**

Maintenance free, with no need for replacement nozzles or meshes



Do your air cooled chillers / condensers cut out on really warm days?

Muck and grime, creating maintenance and reliability issues?

Do you replace/overhaul your compressors every few years?

Concerned about energy usage of your cooling equipment?

EcoMESH is the answer!



Any make/model of Air Cooled Chiller, Rooftop unit or Air Cooled unit

info@ecomesh.eu | www.ecomesh.eu

The refrigerant threat to VRF

A new breed of chillers may come onto the market if VRF manufacturers cannot develop safer refrigerants, says Klima-Therm's Tim Mitchell

Variable refrigerant flow (VRF) air conditioning systems are one of the great success stories of the modern building services industry. Introduced in the 1980s, the approach – based on direct expansion (DX) of refrigerant piped around a building in a distributed system – has progressively displaced other, more conventional methods of cooling and heating buildings as its range of application has grown.

The introduction of larger capacities, easily multiplexed systems, extended pipe runs and intelligent controls have enabled VRF systems to continue making inroads into the medium and larger end of the chiller and fan coil market. At the other end of the scale, the development of compact VRF-style systems has begun to replace standard splits and multi-split air conditioning in smaller projects.

However, existing and emerging downsides to VRF technology are raising concerns about its future development and application.

An Achilles' heel of VRF is the risk associated with circulating large quantities of refrigerant around a building. EN378 places strict limits on the maximum concentration of refrigerants allowed in an occupied space. With some large projects requiring substantial volumes of refrigerant, this continues to be a concern. Mitigation and compliance depends on project-specific system design and technical safety additions, such as leak detection, to meet the requirements.

The phase-out of R22, because of its ozone depletion potential (ODP), led to the adoption of a new generation of, supposedly, more environmentally acceptable HFC-based refrigerants. While having zero ODP, these compounds were soon identified as having global warming potential (GWP), directly implicating them in climate change. Accordingly, legislators switched focus to target and restrict the use of high-GWP substances.

Recent changes to the F-Gas regulations introduced strict quotas on the sale of high-GWP refrigerants over the next decade or so. R410A, the refrigerant on which the current generation of VRF air conditioning systems operates, is classed as a high-GWP substance – and is now firmly in the crosshairs of the F-Gas phase-down.

The quota system is now beginning to bite, leading to serious shortages in the availability of R410A. This has coincided with a worldwide shortage in manufacturing capacity for R125, a key component of the refrigerant, which has exacerbated the supply problem. The combined effect has been sharp increases in the cost of R410A.



“There does not appear to be a non-flammable, low-GWP refrigerant to replace R410A”

Many manufacturers have responded to the curtailment of R410A supplies by introducing a lower-GWP alternative, R32 – itself a component of R410A – for use in small split and multi-split air conditioning systems. However, unlike R410A, which is classified as A1 (non-toxic and non-flammable), R32 is classified as an A2L refrigerant, which means it is flammable in certain circumstances.

When handled correctly by competent technicians, it is considered safe to use in smaller DX air conditioning systems because of the relatively small volumes of refrigerant involved. It is not considered suitable for use in VRF systems, however, because of the larger quantities involved, and the fact it is distributed through the occupied space of a building. VRV systems almost always require larger refrigerant charges than the limit allowed for A2L refrigerants in EN378: 2016.

At present, there does not appear to be a non-flammable, low-GWP refrigerant, suitable for use in VRF air conditioning, that can replace R410A. There are no available hydrofluoro-olefin (HFO)

alternatives. As a result, there appears to be a question mark over the future of VRF air conditioning, at least in the form in which we know it.

Some manufacturers have developed a hybrid technology approach to VRF; the DX refrigerant section is confined to outside the building, while a heat exchanger transfers heating and cooling to a non-DX coolant circuit inside. This reduces the refrigerant charge and overcomes the risk of releasing refrigerant into occupied spaces.

Unless a solution is found soon, the industry may return to more conventional approaches that have been overlooked because of the inexorable rise of VRF.

Chiller-based systems have developed significantly in recent years. By coupling modern chillers and heat pumps with high-performance, inverter-controlled pumps and motors, energy efficiency has been transformed. One of the major forms of VRF applicable in the UK climate – the three-pipe heat recovery option – is now being replicated with air-source hybrid heat pumps. This uses a so-called ‘polyvalent’ approach to deliver ‘free’ low-temperature hot water or chilled water around buildings as the by-product of cooling or heating elsewhere in the system. Alongside reductions in energy consumption, the rise of oil-less, compressor-based systems has added savings in servicing costs, low power draw on start-up and reduced size.

Despite the modest cost premium these technologies carry, it is conceivable that their time has come.

TIM MITCHELL
is sales director at
Klima-Therm

CATALYST FOR CHANGE

Electrostatic precipitators can stop PM2.5 dust particles from entering buildings, but could create dangerous levels of ozone. Catalysts in AHUs may be the answer, says Staffordshire University's **Derek Wardle**

Fine dust particles of diameters 2.5 microns (designated PM2.5) and less have harmful effects on people's respiratory systems when inhaled. Ultrafine particles of 0.1 microns can pass into the blood system, which carries them to the heart and around the body. Particles also become permanently embedded in the lungs, reducing their capacity and making it more difficult to breathe. Analyses have shown traces of heavy metals and organic carcinogens form part of the total distribution of these particulates.

According to a 2013 report, *Clean Air London*, the quality of air in urban areas can be worse inside buildings than outside. The most common forms of pollution at and above molecular level are fine and ultrafine particulate matter, for example \leq PM2.5, including particulates emitted from traffic exhausts, power stations and bio-aerosols. Without filtration, more than 50% of indoor air pollution comes from outside.

A study conducted by the EU air quality and emissions policy committee concluded: 'As buildings become virtually "airtight" to improve energy efficiency, it becomes increasingly important to install efficient air-filtration devices as a minimum requirement and as part of their ventilation systems.'

An efficient and reliable method of preventing particulate matter from entering (and leaving) non-residential buildings must be sought. There are viable choices, such as fabric filtration, cyclonic separation and electrostatic precipitation. This article focuses on electrostatic precipitators (ESPs), which all



operate in much the same way. Incoming PM receives an electrostatic charge, which causes it to migrate to one or more oppositely charged or grounded collecting surfaces. The PM builds up on the collecting surface, where it remains until removed by mechanical means, such as rapping, where vibrations imparted to the electrodes remove the collected particles. During removal, the 'caked' PM falls into storage hoppers, although a significant amount becomes re-entrained in the gas flow. In single-section ESPs, re-entrained particles are carried through to the atmosphere. To meet specified emission targets, some precipitators are built with two or more sections aligned in series. Each section reduces re-entrainment until the specification is met.

The layer of ozone surrounding the Earth in the stratosphere is beneficial to life because it absorbs harmful ultra-violet radiation emitted from the sun. Unfortunately, ozone is also found in the troposphere, from ground level upwards, where it is harmful to life above certain concentrations. Ozone is a powerful oxidant that reacts with the body's internal tissues – even short-term exposure can cause shortness of breath and chest pain. According to Reiser *et al* and Witschi, long-term exposure can lead to severe respiratory discomfort and, possibly, lung cancer.

Another property of ozone to be considered, especially in the built environment, is its half-life. The work of McClurkin *et al* indicates that, in closed environments, this is dependent on air circulation, temperature and humidity, and may be much longer (up to 24 hours) than indicated previously in published data (30-40 minutes). ESPs, operating at high voltages, produce ozone to unacceptable levels that

ESPs, operating at high voltages, produce ozone to unacceptable levels that must not be distributed throughout a building



must not be distributed throughout a building. Ozone generation occurs as a result of the coronal discharge at the electrodes during particle charging. As health, safety and environmental protection pressures grow, the necessity to contain and destroy ozone at – or close to – any source intensifies. This summary discusses one method by which ozone is degraded within an ESP system.

A catalyst for change

There is no reason why ESPs should not become a standard part of an air handling unit if a catalyst is introduced that removes ozone. The collection efficiency of these devices across a broad range of particle sizes is high and, unlike fabric or mat-type filters, the pressure drop

Figure 1: Cross-section of the new ESP design, including a catalyst and ozone sensor

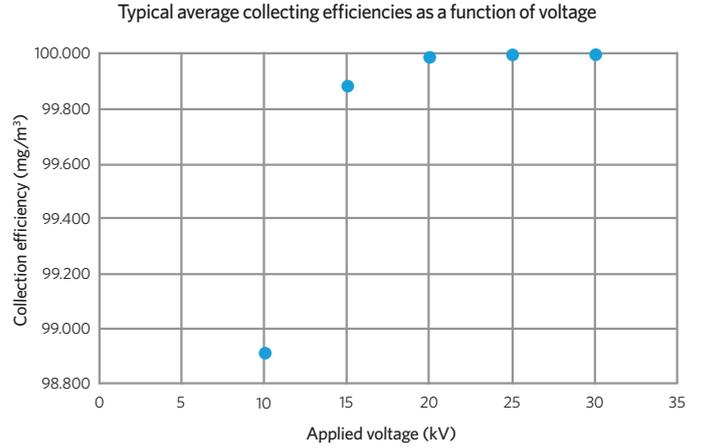
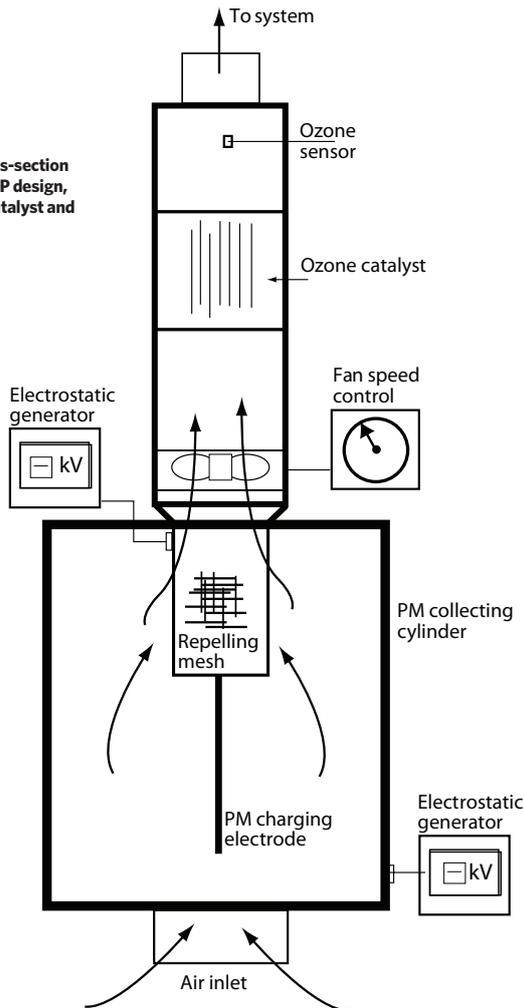


Figure 2: Variation of collection efficiency with applied voltage

across them is low and remains constant, offering considerable savings in running costs.

Figure 1 is a cross-section through a new design of precipitator that is being researched and developed by the author, which addresses the perennial problem of re-entrainment. Dust particles are charged on entry by the centrally located ‘wire’ electrode; these then migrate towards the oppositely charged or grounded collecting cylinder, where they slowly build up into a cake, which is routinely removed. An additional feature of this design is the fine, stainless steel mesh cylinder, which is sealed round the exit aperture and given the same charge as the particles. This causes a repelling action that forces the particles towards the collecting cylinder, but allows the uncharged, cleaner air to pass through. This considerably increases the overall collecting efficiency of the device (see Figure 2).

Ozone degradation by adsorption using a catalyst

In catalytic decomposition, the atomic structure of a molecule can be changed without the catalyst undergoing chemical

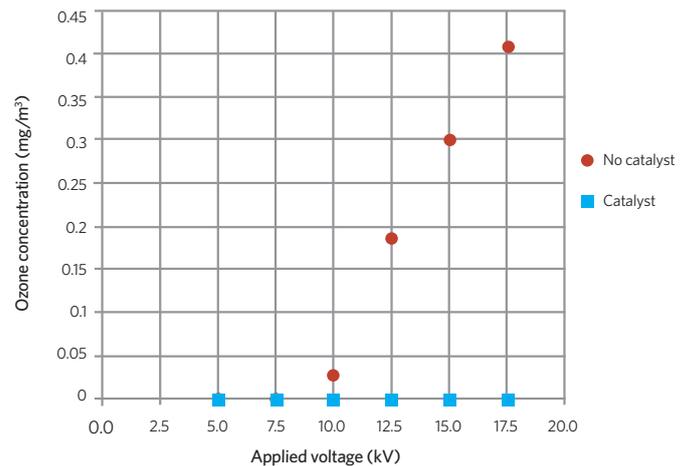


Figure 3: Ozone concentrations with and without catalyst

» change. With ozone, this is achieved by the transient adsorption of the loosely bonded oxygen atoms in its molecules. Desorption takes place rapidly, leaving spaces on the catalyst's surface for a continuous adsorptive/desorptive process.

The catalyst material chosen during tests was fine manganese dioxide (MnO₂) powder, which does not pose a threat to health and safety, or damage the environment. Figure 3 shows the rise in ozone production as the applied voltage increases with no catalyst, and that there was no detectable ozone when the catalyst was in place. From the ESPs inlet to outlet, there is negligible pressure drop when using an ozone catalyst. This remains constant because there is no interruption to the airflow.

The American ceramic ozone catalyst tested indicated a pressure drop across of 50Pa at an air velocity of 2.5m·s⁻¹. The author has designed a catalyst that, it is hoped, will match – or improve on – this performance.

The efficiency of ESPs can be as high as any other system given the right design for each application. By incorporating a catalyst, it is possible to control ozone that is drawn into

ALTERNATIVE METHODS

Two methods of ozone degradation found to be problematic by the author

Reduce ESP charging voltages

Experimentally, this approach was found to adversely affect the PM collecting efficiency of the test unit because the highest collecting efficiency is achieved when the voltages are at levels just before electric field breakdown. By reducing the voltage, this method becomes a trade-off between maximum ozone reduction and maximum PM collecting efficiency. ESPs should be working at peak particulate collection performance, which would not necessarily be the case with this method.

By absorption

This method was only researched briefly. Chemicals such as bromine, iodine and chlorine all react with, and destabilise, ozone. Conceptually, chemical degradation works, as proven by the depletion of ozone in the stratosphere. However, this method would not be conducive to good engineering practice in the troposphere because the nature of these potentially harmful chemicals as the methods of employment may not meet health and safety guidelines. In addition, the process is absorption, so the chemicals are subject to degradation, giving them a limited best-performance lifespan.

and produced by ESPs operating at ambient temperature (~20°C) and pressure (1 bar). □

■ **DEREK WARDLE** is a PhD researcher at Staffordshire University

References:

- 1 Witschi, H, Ozone, Nitrogen Dioxide and Lung Cancer: A Review of Some Recent Issues and Problems, *Toxicology* 48 (1988), 1-20
- 2 J D McClurkin, D E Maier, Half-life time of ozone as a function of air conditions and movement, *Startseite* 425, Julius Kühn Archiv (2010)

TACKLING NOX IN THE CITY

Trimbox - breathing life back into the urban environment

Titon's award winning Trimbox NO₂ Filter is designed to reduce nitrogen dioxide emissions in a home as part of a MVHR system. By protecting against NO₂ and other pollutants from diesel exhaust fumes, the product helps create a healthy indoor environment for occupants.

- Clean filtered air
- Reduces pollutants (including sulphur dioxide, hydrogen sulphide, hydrogen chloride and chlorine)
- Ideal for multi-storey buildings
- Third party tested for both NO₂ and acoustic reductions

www.titon.co.uk

EcoAir Box goes to great lengths in the Pods

Project: The Pods – Scunthorpe Academy



Construction of The Pods in Scunthorpe is part of an initiative by North Lincolnshire Council to kick-start the regeneration of the town. The high quality leisure facilities will help reinvigorate the area, providing a focal point for sport and recreation in Scunthorpe.

The winning building design was chosen by a specialist panel and via public consultation as part of a RIBA led international competition. It features an unusual interlinked geodesic dome structure which will be covered with a variety of materials including sedum, glass, metal, timber and plastic to complement and extend the external landscape whilst creating a series of unified internal spaces.

The key objective of the design team was to create a 'gentle but bold vision of how an important and active facility can work in harmony with its landscape'.

The Pods were crowned the most sustainable building/development of the year at the Property Industry Awards

The building envelope comprises glass and steel for the entrance dome (reception and café), timber for the small pool and fitness areas, sedum for the main pool and membrane for the sports hall. It is thought to be the first time in the UK that timber framed pods and sedum roofs have

been used in a major leisure facility. The roof structure for the pods is supported by an engineered timber glulam frame comprising hundreds of interlinked bespoke roof cassettes. A central structural spine links a series of individual shells accommodating wet and dry sports facilities including an eight lane, 25 metre swimming pool; separate training pool; state-of-the-art gym; dance studio; crèche and a six court sports hall. The structure will enable the internal layout to change and adapt over time according to demand.

The facility aims to achieve an energy performance rating of 22 which is a category A 0-25

EcoAir Box in Bromsgrove supplied their CRS2 10000S packaged heat recovery unit to control the humidity and airflow to the main pool and learner pool areas. The system provided air volume of 4.0 m³/s at an incredible 80% efficiency through a single composite plate heat exchanger. This solution was the most energy efficient and cost effective with ensuring comfortable bathing and keeping the fabric of the building intact. With the pool areas being the most costly part of the building in energy, we would not have been able to achieve the energy performance criteria without the aid of this form of heat recovery.



British manufacturing at its best



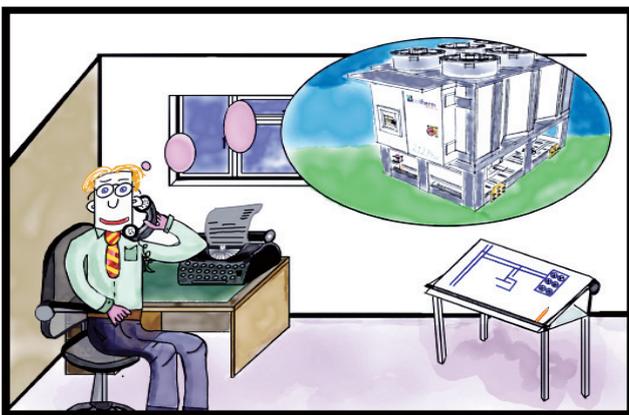
TED IS A CONSULTANT WITH A CHALLENGE!
HE HAS A CLIENT WHO IS FORWARD THINKING, SHE WANTS A SUPER EFFICIENT, QUIET, COMPACT AIR COOLED CHILLER FOR HER NEW BUILDING.



AT THE DRAWING BOARD TED IS STRUGGLING TO FIND A SOLUTION.
ALL THE QUIET CHILLERS ARE LARGE, AND COMPACT ONES ARE NOISY!
TED IS STRESSED.....!



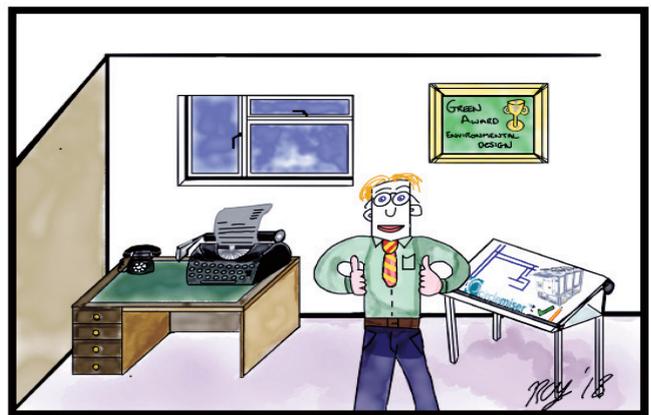
TED KNOWS WHO HE CAN RELY ON TO ASSIST HIM IN FINDING THE SOLUTION TO THE TOUGHEST COOLING CHALLENGES.
TED CALLS COOL-THERM....



WHILST ON THE PHONE TO COOL-THERM THEY EXPLAIN TO TED ABOUT CIRCLEMISER FROM GEOCLIMA.

IT'S A CHILLER WHICH HAS INNOVATIVE ROUND BAM CONDENSER COILS, WHICH INCREASES SURFACE AREA, WITHOUT ENLARGING THE CHILLERS' FOOTPRINT.

TED BREATHES A SIGH OF RELIEF.....



CIRCLEMISER IS THE MOST EFFICIENT INNOVATIVE AIR COOLED TURBOCOR CHILLER AVAILABLE TODAY!

WITH EERS TOPPING 3.8:1 (@ 6-12-35°C) ACROSS THE RANGE, AND OPTIMISED TO OPERATE ON R1234ze FROM THE GROUND UP.

IT HASN'T WON AN AWARD YET, BUT TED THINKS IT SHOULD!

INNOVATIVE CONCEPT - BESPOKE DESIGN - EXCEPTIONAL PRODUCT

**PIONEERS IN HIGH EFFICIENCY,
INTEGRATED COOLING SOLUTIONS.**



www.cooltherm.co.uk

enquiries@cooltherm.co.uk

T:0117 961 0006



Continuing professional development (CPD) is the regular maintenance, improvement and broadening of your knowledge and skills, to maintain professional competence. It is a requirement of CIBSE and other professional bodies.

This *Journal* CPD programme can be used to meet your CPD requirements. Study the module and answer the questions on the final page. Each successfully completed module is equivalent to 1.5 hours of CPD.

Modules are also available at www.cibsejournal.com/cpd

Improving the performance of vapour compression air-cooled chillers

This module explores the application of a novel condenser design that can improve the effectiveness of systems without increasing the equipment footprint

Air conditioning, chiller and component manufacturers actively strive to improve equipment efficiency, particularly through compressor developments. Advantages can also be gained from increasing the effective heat rejection surface area of air-cooled condensers – this article will consider the application of a novel condenser design that can improve system effectiveness while not expanding the equipment footprint.

The thermodynamics of the refrigerant vapour compression cycle

The pressure-enthalpy diagram (also known as a Mollier diagram) offers a convenient way of showing the thermodynamic properties of a refrigerant, and the basic vapour compression refrigeration cycle, as shown in green in Figure 1.

In real systems, the four principal processes – compression, condensation, expansion, and evaporation – also experience pressure loss from the components, plus heat losses and gains from the ambient air, and the compression process would not be ideal, so would be more like the real cycle shown in Figure 1.

The lower the enthalpy of the refrigerant at entry to the evaporator, the greater potential there is to supply useful cooling.

Coefficient of performance (COP) and energy efficiency ratio (EER)

The simple coefficient of performance (COP) for a given vapour compression cycle is calculated by the cooling power delivered through the evaporation process divided by the work added during the compression process, as in Figure 1. In this example, the cycle has a COP of $(395-250)/(430-395) = 4.1$. The COP is an instantaneous measurement of the refrigeration system's thermodynamic performance. The energy efficiency ratio (EER) is commonly used by practitioners – and in standards – as a measure of the practical energy efficiency of a refrigeration cooling cycle, and provides a ratio of useful cooling energy to (typically) electrical input energy. In SI units, this is a dimensionless ratio and is lower than the cooling COP, as it accounts

for such items as motor and drive efficiencies, pressure and thermal losses. The seasonal EER (SEER) offers a standardised indication of the cooling performance accounting for application and operating conditions (there is a UK version of SEER¹, as used in compliance assessment, and the European ESEER², which apply slightly different load profiles and weightings). In heat pump applications, the term COP – together with the seasonal COP (SCOP²) – is typically used to indicate the ratio of useful heating to electrical power input.

Chiller manufacturers have been focusing on reducing compression energy by developing more efficient compressor technologies – notably through the development of magnetic-bearing compressors equipped with variable-speed drives – and this has significantly improved the efficiency of the system. However, there are other elements of the cycle that can be optimised to improve its efficiency further by increasing the evaporation potential without using more compression energy. A key component is the condenser, which can be readily optimised to increase system efficiency at a lower cost than adopting



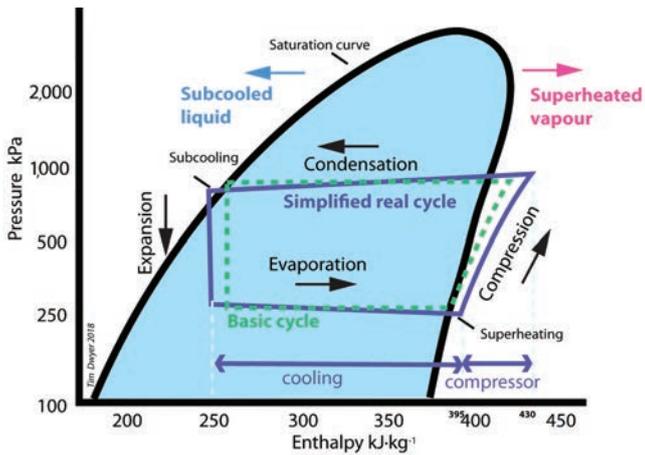


Figure 1: A refrigeration cycle plotted on a Mollier diagram for a typical synthetic refrigerant

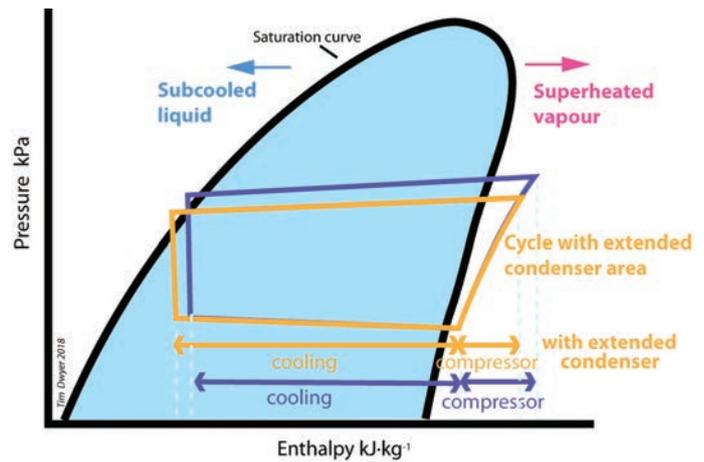


Figure 2: Applying an extended condenser

» some of the more advanced compressor technologies and improved monitoring and control. Advanced technologies can be combined with such optimisation to improve performance further.

Extending the condenser process provides a greater cooling potential in the evaporating process (as shown in Figure 2), so increasing the COP and the EER. This can be achieved by reducing the condensing temperature – which will be practically limited by the ambient conditions – while still ensuring that there is an appropriate amount of refrigerant sub-cooling (typically approximately 5K) as the refrigerant liquid leaves the condenser. In many cases, there is an opportunity to achieve this by increasing the effective heat rejection area of the condenser.

Increasing the condenser heat rejection area

When considering a traditional tube and fin air-side heat exchanger, the surface area-to-volume ratio can be increased by several techniques:

- Reducing the diameter of the tubes in the coil block and boosting the number of tubes will increase the amount of heat exchange. This works well but raises the cost and weight of the coil block.
- Increasing the number of fins per length of tube will also improve heat exchange, but this will have adverse effects:
 - The air-side pressure drop of the coil block grows and requires more fan power to move the same amount of air
 - The coil can trap more debris, therefore reducing airflow and limiting heat transfer
 - It will increase the cost and weight of the coil block
- Reducing the thickness of the tube wall to increase coil U value – although this weakens the structure of the coil and makes it more prone to damage

- Selecting different materials with improved thermal conductivity will improve a coil's heat exchange performance – for example, copper has a greater thermal conductivity than aluminium, therefore coils with copper tubes and fins offer greater levels of performance. However, copper is around three times the price of aluminium.

An increasingly common alternative is the plate fin heat exchanger (Figure 3). They were originally developed in the aircraft industry in the early 1960s and offer a bigger surface area to volume ratio, while cutting weight, increasing structural strength, and reducing air-side pressure drop. Although initially prohibitively expensive for general applications, production costs fell as they were more widely adopted by the chemical and automotive industries to meet the requirement for robust, highly efficient coils for use in the aggressive environments. Subsequently, these have been applied by the chiller and air conditioning industry, often referred to as brazed aluminium microchannel (BAM) coils. Microchannel heat exchangers provide high refrigerant convective heat transfer coefficients and a greater wetted surface to volume than conventional heat exchangers. Microchannels can, however, also potentially increase the pressure drop associated with the smaller flow passage – although this can normally be resolved by a careful design ensuring sufficient cross-sectional flow area. In addition, the flow-length inside microchannel heat exchangers are typically much shorter for a given duty, which will reduce their overall pressure drop.³ An additional advantage of this type of heat exchanger is that there is typically 70% less refrigerant volume in the heat exchanger, and the air-side static pressure resistance through the coil is half that of a traditional tube and fin heat exchanger. The single-cast aluminium structure also makes the coil comparatively strong.

Until recently, large chiller condenser coil configurations (and specifically BAM coils) were limited to linear, flat coil designs, generally arranged in a 'straight', 'W' or 'V' section configuration (as shown in Figure 4). Tube and fin condenser coil designs have been limited either to being straight or curved with long radius bends, as often

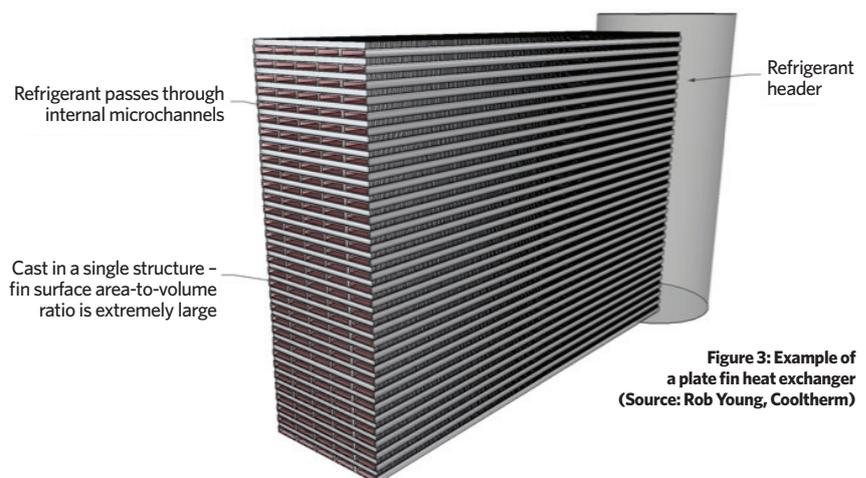


Figure 3: Example of a plate fin heat exchanger (Source: Rob Young, Cooltherm)

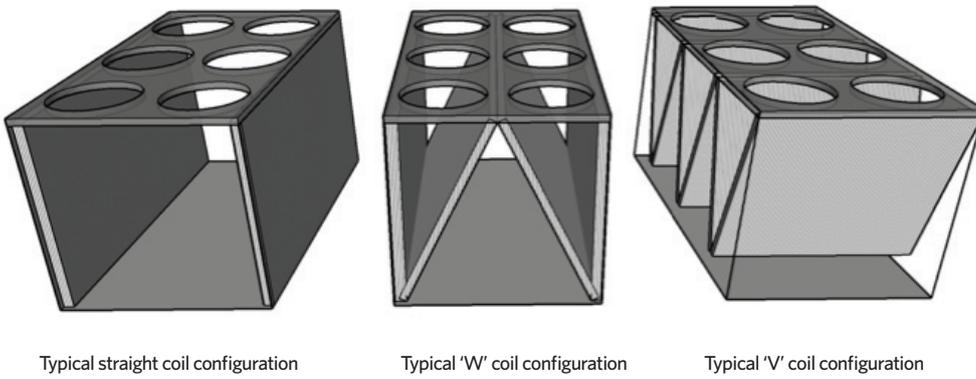


Figure 4: Common condenser coil configurations (Source: Rob Young, Cooltherm)

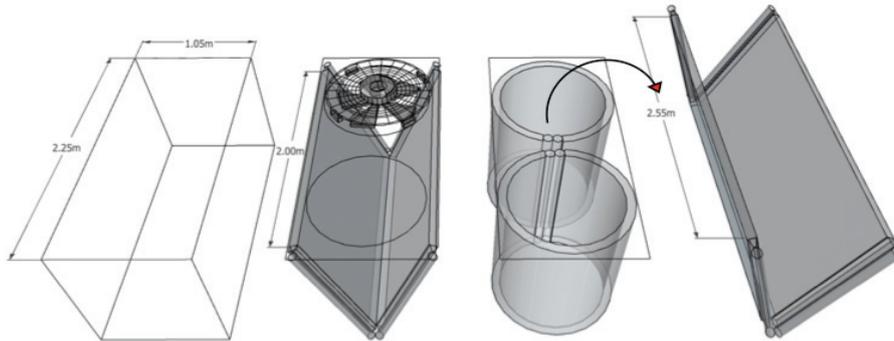


Figure 5: Example comparison of applying circular designs (Source: Rob Young, Cooltherm)

found on small split DX air conditioning systems, with the condenser face on two or three sides of the unit. A curved tube and fin condenser is difficult and expensive for larger systems (such as industrial water chillers), so until now curved coils have only typically been found on small systems.

Circular BAM coils

BAM condenser coils are robust, and the cast-metal construction allows them to be shaped more easily than traditional coils, so they can be manufactured with tight radius bend configurations. This has recently allowed the creation of completely circular large-scale condenser coils, that – compared with traditional ones – can increase the chiller output by allowing a larger coil face area to be installed in the same frame dimensions. Linear BAM condenser coils are typically applied across the width of the chiller in a ‘V’ configuration (as in Figure 4), with the most common

large-scale chiller width being 2.25m (limited by truck trailer widths), which typically limits a condenser coil width to approximately 2m.

Employing a circular design allows more coil to fit into the same frame. Each coil is 27% longer and, for example, almost 10% more coil face area is gained over the previous most efficient use of space in the ‘W’ condenser coil configuration (as shown in Figure 5 and Table 1).

This offers the opportunity to cut the chiller footprint for the same capacity. It also assists in compensating for the general industry practice of moving away from cooling towers, which tend to be more compact than air-cooled chillers per kW of cooling.

Real-world application and performance

The availability of circular format condensers has allowed the recent development of a circular BAM condenser coil machine that also employs a compressor with magnetic-bearings. The comparison in Table 2 is for two systems where only the condenser is different. The core system has a flooded evaporator, charged with HFO R1234ze refrigerant, employing a Turbocor TT310 compressor and 800mm EC condenser fans.

The comparison indicates that the system employing the circular BAM condenser shows improvements across all aspects, with a 5% improvement in the seasonal EER and a 15% improvement at conditions relating to 50% full load and a typical UK ambient temperature of 15°C. So, taking an example application with an average cooling load of 150kW, occupied 12 hours a day, five days a week, 52 weeks of the year, a system employing a circular BAM condenser could reduce operational energy use by 3.7MWh. This would also save more than a tonne of associated CO₂ emissions (based on the ESEER figures).

By applying generously sized and appropriately configured air-condenser coil formations within the same chiller frame – regardless of coil type and compression – the amount of energy a chiller consumes can be reduced. If this is done within the same – or smaller – chiller footprint, these energy savings can be achieved with little increase in the initial chiller cost. If the cooling load is maintained but the air-side heat rejection surface area increases, then less fan power is needed to reject the energy and, consequently, noise can also be reduced.

© Tim Dwyer, 2018.

■ With thanks to Robert Young for his contributions to this article.

■ Turn to page 58 for references.

	Chiller length	Chiller width	No. coil blocks	Coil length	Coil 1 height	Coil 2 height	Area m ²
Straight ‘W’ coil	4.4m	2.25m	4	4m	1.21m	1.6m	22.48
Circular coil	4.4m	2.1m	8	2.5m	1.21m		24.69
Additional coil face area							2.21m ²
Increase in coil face area							9.8%

Table 1: Comparison of the effective area linear ‘W’ configuration, and circular, BAM condenser coils (Source: Rob Young, Cooltherm)

Condenser type	Dimensions, mm	Peak duty cooling 12°C to 7°C at 35°C ambient temperature	Noise level, dBA @ 10m	EER	ESEER	EER at 50% duty and 15°C ambient temperature	Condenser airflow, m ³ ·h ⁻¹
Standard linear BAM	4,510 (L) 2,250 (W) 2,540 (H)	334kW	61	3.641	6.039	8.633	165,100
Extended circular BAM	4,510 (L) 2,100 (W) 2,500 (H)	345kW	60	3.823	6.349	9.979	170,000

Table 2: Comparison of linear and extended circular BAM condensers for example refrigeration system (Source: Performance data – Geoclima and Rob Young, Cooltherm)



» Module 128

June 2018

1. Which one of these would be most likely to provide the most suitable performance rating to assess practical installations of proposed air-cooled chillers for UK compliance?

- A COP
- B EER
- C ESEER
- D SCOP
- E SEER

2. What is not specifically noted in the article as increasing system effectiveness?

- A Improved monitoring and control
- B Increased condenser area
- C Increased evaporator area
- D Magnetic bearing compressors
- E Variable speed drives

3. Which one of these was not discussed as being a method of increasing the effective surface-area-to-volume ratio for a traditional tube and fin air-side heat exchanger?

- A Increasing the number of fins per length of tube
- B Reducing the thickness of the fin material
- C Reducing the thickness of the tube wall
- D Reducing the diameter of the tubes in the coil block and increasing the number of tubes
- E Selecting different materials

4. What does the acronym BAM stand for in this application?

- A Bolted aluminium microchannel
- B Braced aluminium microchannel
- C Branded aluminium microchannel
- D Brassed aluminium microchannel
- E Brazed aluminium microchannel

5. In the example comparison of the system with the linear and circular BAM, what improvement was gained when comparing the EER at 50% duty and 15°C ambient temperature?

- A 5%
- B 10%
- C 15%
- D 25%
- E 50%

Name (please print)

Job title

Organisation

Address

.....

.....

Postcode

Email

Are you a member of CIBSE? If so, please state your membership number:

The CIBSE Journal CPD Programme

If you would like to receive information about Cooltherm, the sponsor of this CPD module, please tick here:

By entering your details above, you agree that CIBSE may contact you with information about CPD and other training or professional development programmes, and about membership of CIBSE, if you are not a member.

Go to www.cibsejournal.com/cpd to complete this questionnaire online. You will receive notification by email of successful completion, which can be used to validate your CPD records. Alternatively, fill in this page and post it to: N Hurley, CIBSE, 222 Balham High Road, London, SW12 9BS

References:

- 1 *Non-Domestic Building Services Compliance Guide: 2013 Edition.*
- 2 BS EN 14825: 2016 *Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling.*
- 3 Wanh, H, Performance enhancement of a thermally activated cooling system using microchannel heat exchangers, *Applied Thermal Engineering*, Volume 31, Issues 14-15, October 2011, pages 2,951-2,962.



✓ Grundfos Pump School enrolling now



The Grundfos Pump School has re-opened its doors and is now offering 11 courses on topics relating to a wide range of applications, including fire, dosing and wastewater.

Two new courses have been introduced to the curriculum this year, and these are aimed at people working with pump solutions in industrial and building services applications.

The one-day courses - which include the chance to get 'hands on' with various pumps - are already proving very popular, so early online booking is recommended.

A range of dates and venues are available for the remainder of 2018.

For more details on the many options available - or to book courses - visit www.grundfos.co.uk, and click on 'Training' link and then 'Pump School'.

■ Call 01525 850000 or email grundfos-uk@sales.grundfos.com

Hoval boilers upgrade for Mylnes Court, Edinburgh >

In a boiler upgrade at Mylnes Court, University of Edinburgh, ageing Hoval boilers have been replaced with the company's high-efficiency SR Plus and UltraGas boilers. The new boilers were specified by Enright Engineering Consultants and installed by contractors Taylor and Fraser.

The Mylnes Court complex includes three halls of residence and housing for 176 postgraduate students in self-catered flats. A central boiler house provides space heating, domestic hot water and pre-heating of ventilation air in air handling units.

■ Call 01636 672711, email marketing@hoval.co.uk or visit www.hoval.co.uk



✓ Luceco lights Ark Byron Primary Academy

Luceco and Hull-based Rawfield Electrical Contractors have completed the supply and installation of more than 400 energy-saving LED luminaires at Ark Byron Primary Academy's new school at The Vale, London.

LED 600x600 LuxPanels were installed throughout the building, in the classrooms, assembly and recreational areas, corridors, and the library. LuxPanel - like the IP65 Climate LED luminaire used in the plant and storage areas - requires no maintenance over its lifetime, with more than 50,000 hours of operational life. Climate Extra has a market-leading efficacy of 140lm/cW with increased performance for improved energy efficiency.

Platinum downlight luminaires, offering potential running-cost savings of up to 80% over traditional lamped fittings, were installed in various areas, including the toilets. Offering 50,000 hours of maintenance-free life, Platinum has an impressive efficacy of 135lm/cW. Versatile IP65-rated LED Atlas luminaires were used on stairwells internally and externally.

■ Call 01952 238100, email uk_sales@luceco.com or visit www.luceco.com



✓ And the winner is... Waterloo

Waterloo Air Products has been crowned Manufacturer of the Year at the Kent Invicta Chamber Business Awards 2018.

The Aylesford-based company picked up its prize at a ceremony in Canterbury Cathedral Lodge on 22 March.

'We couldn't be happier,' said John Tiernan, operations director at Waterloo, which makes air terminal devices. 'Winning an award is always good, but to win one for manufacturing is the best it can be.'

■ Call 01622 711500 or email enquiry@waterloo.co.uk



✓ Care home receives heating upgrade from Elco

Elco Heating Solutions has supplied five Thision L EVO 120kW boilers to Westhaven House care home in Weymouth, Dorset. The installation was part of a complete refurbishment of the heating and hot-water system.

Two ageing atmospheric boilers and two direct gas-fired water heaters were replaced by a floor-mounted cascade system of five Thision L EVO boilers and two 500L Gemini calorifiers. Elco also supplied a weather compensation kit.

The new boilers ensure ultra-low NOx performance of 40mg/kWh, reduced CO₂ emissions and considerable annual gas savings.

■ Visit www.elco.co.uk or follow @elco_uk on Twitter

Energy-related Products (ErP) – we are ready ✓

Under the Energy-related Products (ErP) directive, the minimum seasonal efficiency for warm air heaters is now 72% and, for radiant heaters, 74%. These criteria apply to new installations and when replacing products.

In addition to ErP-compliant heating products, Nortek offers Airmix, a high-induction air distribution system. It evenly distributes conditioned air (heating, cooling or ventilation) at low air velocities and noise levels, virtually eliminating excess heat stratification and the need for air recirculation fans.

■ Call 01384 489700 or visit www.nortekhvac.com



Rinnai Infinity's Solo is just the ticket if gas services limited ✓

Rinnai Infinity's Solo range of recirculatory water heaters is perfect for sites where limited gas services dictate the use and application of water heating systems. Its combination of continuous flow units with insulated stainless steel storage cylinders, for pre-heated hot water, allows for periods of peak-hour use.

The range has 35kW, 37kW and 54kW heat engines, ensuring sites with a smaller gas meter can use this technology. The larger model will also act as a high-efficiency alternative to gas-fired storage appliances.

The cylinders have heat-loss figures as low as 1.41kWh per day, and the life expectancy of stainless steel is far greater than that of a glass-lined equivalent.

■ Visit www.rinnaiuk.com



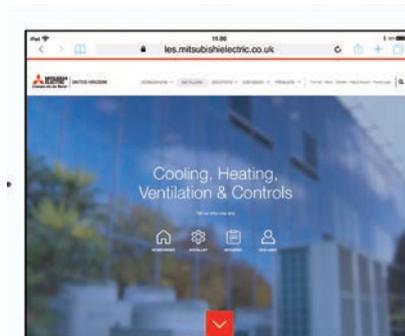
Mikrofill at Parkstone Yacht Club ✓

Parkstone Yacht Club, in Poole, was established in 1895 and is on the north shore of the second-largest natural harbour in the world.

Building services consultancy Hoare Lea selected Mikrofill equipment to cover the club's low pressure hot water (LPHW) and hot water supply (HWS) demands. This included three Ethos 110kW stainless steel condensing boilers for heating and indirect LPHW to three 500L Extreme HWS loading systems. The installation was carried out by long-standing Poole-based contractor Rentec.

The Extreme is a domestic hot water generator that combines the advantages of an instantaneous hot water heater and a storage system. The efficiency of the Ethos 110kW boilers is maximised while providing indirect LPHW to the cylinder, as the Extreme is designed to operate at a Δt of 30K. Based on a prioritised input of 110kW at 80°C, each Extreme 500 will produce more than 2,350L·hr⁻¹ and 800L in a 10-minute period at 60°C.

■ Call 03452 606020 or visit www.mikrofill.com



Mitsubishi Electric's new website enhances the customer journey

Mitsubishi Electric has launched a new website to improve customers' access to information, with a seamless, modern design that will tailor content to visitors.

'Our website has served us really well, but we wanted to make our products and information even easier to access,' said Deane Flint, UK branch vice-president at Mitsubishi Electric. 'So we've looked at every aspect and developed a new site that is stylish and really easy to navigate.'

The website has content relevant to installers, specifiers, corporate end users and homeowners, and will intuitively present focused information to visitors, making navigation easier and everything more accessible.

Installers will be able to browse a vast selection of tools and apps to aid design, commissioning and installation. Specifiers, meanwhile, will be able to download CPD-accredited guides to the latest construction legislation, as well as find information on the latest class-leading HVAC solutions.

■ Visit les.mitsubishielectric.co.uk

Thermal Dynamics helps boost SKH productivity and quality ✓

Latvian firm SKH specialises in the manufacture and construction of industrial buildings, storage tanks, pipelines, thermal insulation of buildings, and general building and construction.

It recently decided to improve the productivity and quality of a large cutting table by retrofitting it with Thermal Dynamics' iCNC Performance CNC controller and Auto-Cut 200XT plasma cutting system. The installation, by Riga-based CNC Baltic SIA Cutting & Welding, took place on site, over two weeks.

New lifters for the plasma and gas torches were fitted, bearings on the portal were changed, and new wiring harnesses were installed.

■ Call 01257 261755 or email automation@thermal-dynamics.com





George Clarke becomes Ecodan brand ambassador

Mitsubishi Electric has announced an association with TV presenter, architect, lecturer and writer George Clarke to help promote Ecodan air source heat pumps.

Best known for the Channel 4 programmes *George Clarke's Amazing Spaces*, *The Home Show* and *Restoration Man*, Clarke is a passionate advocate of design excellence and high levels of quality in the construction industry.

In addition to his TV work, he is creative director of George Clarke + Partners, and has set up the charity Ministry of Building Innovation and Education (MOBIE). Its aim is to inspire new generations into the building profession to 'fundamentally transform' the way we think about, design and construct homes, and to bridge the skills gap.

'For us, George is a perfect fit with Ecodan because he is such an inspiring pioneer and a real advocate of the need to build quality into the homes that the nation desperately needs,' said Donald Daw, commercial director at Mitsubishi Electric Living Environment Systems.

Visit www.mobiehomefutures.org

Canadian consulting firm seeking investor or buyer

Are you interested in an exciting opportunity of leveraging the Canadian marketplace to expand or diversify your business?

We are a well-established, successful, profitable Canadian consulting firm with a proven 10-year track record. Our expertise includes market-leading technical knowledge and business acumen to achieve growth targets, resulting in increased overall profitability.

We are seeking investors or buyers who are interested in helping expand our company's business.

Email offers1@shaw.ca



Open protocols and energy management as standard in DMTouch

DMTouch, the powerful control system front-end from building controls and remote monitoring specialist Resource Data Management, allows users to communicate across open protocols to incorporate existing infrastructure. With built-in energy-monitoring features, it can also facilitate due diligence at a local level, without the need for additional software solutions. The time taken by users to interrogate and analyse data is reduced dramatically, while user experience and interactions are heightened, simplifying the overall energy management process.

Visit www.resourcedm.com or email hello@resourcedm.com

Viessmann boilers take centre stage at Hull New Theatre

Heating systems manufacturer Viessmann is in the limelight at Hull New Theatre, which re-opened at the end of 2017 after an extensive refurbishment.

The company has overhauled the heating system, supplying three Vitocrossal 200 boilers to heat the theatre space and ensure comfort for actors and audiences.

Specified by G&H Building Services, the Viessmann system was selected as the ideal solution to meet the capacity, cost-efficiency, environmental and noise requirements of the project.

Visit www.viessmann.co.uk



Evinox expands its team of CIBSE-certified heat network consultants

Evinox has added to its CIBSE-certified technical and design team, with design engineer Arturs Kokins (pictured) becoming the latest from the company to complete the CIBSE Heat Networks Code of Practice course.

The CIBSE heat network qualification is recognised across the industry, and covers a broad spectrum of considerations for communal and district heating systems. It demonstrates the depth of knowledge Evinox can offer to its customers in the design of heat network systems.

Kokins joined Evinox in early 2017 as a graduate engineer, with an MEng (Hons) mechanical engineering degree. He has since developed his skills and gained valuable experience working on key projects, including managing bespoke testing with BSRIA for a large development in London, where Evinox is supplying heating and cooling units. He was also involved in Evinox successfully completing testing under the new BESA UK Standard for heat interface units (HIUs), for which the Evinox ModuSat (XR) HIU achieved excellent results. Evinox is currently one of only five manufacturers to have officially published its results on the BESA website, something of which the company is very proud.

Evinox offers developers, consultants and specifiers a broad range of design support services for district and communal heating projects, including: HIU sizing and selection; hydraulic system guidance and advice; and complete plantroom system and distribution pipework design, where required.

Call 01372 722277 or visit www.evinoxenergy.co.uk or www.evinoxresidential.co.uk



Hydra-Cell: reducing the cost of precision metering and dosing

Hydra-Cell pumps, with multiple hydraulically balanced diaphragms in a single pump head, work at high speed, delivering a small volume from each cell, but at high frequency. As a result, they can be physically smaller in relation to flow capability and, so, less expensive to acquire and operate. Hydra-Cell pumps are exceptionally energy efficient - 80% and above - and require no expensive seal maintenance. Robust in construction and reliable in operation, Hydra-Cell pumps enjoy a long service life with exceptionally low life-cycle costs.

■ Visit www.hydra-cell.eu



AET underfloor air conditioning fit-out at Hanover Street

Underfloor air conditioning specialists AET Flexible Space has completed a Cat-B fit-out of the first floor at 11-12 Hanover Street, London, for incoming tenant Quadreal.

The system is the CAM-C, with underfloor supply air and return air. Each floor is, effectively, one zone, with a single CAM downflow unit supplying conditioned air to the underfloor plenum. This air is supplied into the workspace via fan terminal units, which are recessed into the floor plenum. About 80 standard-size TU4 fan tiles are located over the building's five floors.

■ Call 01342 310 400 or email aet@flexiblespace.com



Riello extends RX premix burner range

Building on the tried and tested RX range of premix packaged burners, with outputs up to 1,500kW, Riello has extended the offering. It now has variants up to a 3MW model, while still achieving NOx levels of less than 30mg/kWh and very low noise output. Riello RX premix burners' unique design includes a patented woven-wire gauze 'sock' covering the combustion head cylinder. The technology enables high turndown ratios of up to 8:1, while control options include progressive two-stage operation and fully modulating via 0-10V or 4-20mA.

■ Visit www.rielloburners.co.uk



DIRECTORY Your guide to building services suppliers

Tel: 020 7880 6217 Email: callum.nagle@redactive.co.uk

Air Handling



Manufacturer of high quality bespoke AHU's.
Specialists in refurbishment and site assembly projects.
Rapid delivery service available.

Aircraft Air Handling Ltd
Unit 20, Moorfield Ind Est,
Cotes Heath, Stafford, ST21 6QY
Tel: 01782 791545 Fax: 01782 791283

Email: info@aircraftairhandling.com Web: www.aircraftairhandling.com

Energy Efficiency

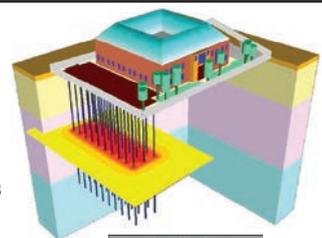


Ground Source Heat Pump Installations

Meeting Renewables Targets

Tel: 02392 450889
Fax: 02392 471319

www.groenholland.co.uk



Air Conditioning



For total solutions in air-conditioning

E: info@clivet-uk.co.uk
W: www.clivet.com
T: 01489 572238
W: www.versatemp.co.uk

Heating & Hot Water Specialists



- BESPOKE SYSTEM DESIGN
- COMBINED HEAT & POWER
- HEATING & HOT WATER
- PACKAGED PLANT SOLUTIONS
- MAINTENANCE & SERVICE PLANS

T: 01252 551 540
W: <https://advenco.co/>
E: enquiries@advenco.co/



To advertise here, contact Callum Nagle on 020 7880 6217 or email: callum.nagle@redactive.co.uk



conrad consulting
technical recruitment specialists

Trusted recruitment advisors bringing candidates and organisations together to build outstanding careers

Principal Mechanical Engineer - Manchester

£42k to £47k plus benefits

The client we are currently working with has asked us to find them a dynamic Principal Mechanical Design Engineer for their Manchester office. This company has been operating for over a Century and is at the forefront when it comes to M&E design. The successful Principal Mechanical Engineer will have brilliant technical design skills as well as site-based knowledge and can expect an excellent package in return.

For further information please contact
Kye Nessling on 01728 726 125

Principal Electrical Design Engineer - London, St Paul's

£60k to £65k plus benefits

Principal level engineer required for forward thinking multi-disciplinary consultancy. Possessing excellent commercial sector experience, you will lead and manage successful projects. Degree qualified candidates will possess a minimum of 15 years design experience within a consultancy or contractor environment. An unrivalled benefits package is available at this level.

For further information please contact
Martin Bell on 01728 726 135

Design Manager (Critical Systems) - London (EC4)

£55k to £60k plus excellent benefits package

Design manager required for top multi-disciplinary consultancy to sit within their Critical Systems Team. Working on UK and international projects, candidates will need expert experience in managing complex projects and feel comfortable leading design teams. Project experience should include complex data centres and critical systems. Candidates should be CEEng or working towards.

For further information please contact
Martin Bell on 01728 726 135

Principal Mechanical Engineer - Bury St Edmunds

Up to £50k plus benefits

Are you currently looking for an opportunity to work with a longstanding and highly renowned multidisciplinary Consultancy as a Principal Mechanical Engineer? Our client is looking for an experienced engineer to join them in their Suffolk office. The successful candidate will have extensive design experience within a consultancy environment, with management skills and client facing expertise. You can expect a generous package as a valued member of this exciting company.

For further information please contact
Kye Nessling on 01728 726 125

We have opportunities nationally at all levels; if you are looking for your next strategic career move call us to make this a reality for you

Senior Electrical Engineer - Winchester

£40k to £50k plus benefits

Are you an innovative Senior Electrical Engineer looking for a new role with one of the country's leading multidisciplinary consultancies? Our client is on the lookout for a talented Senior Electrical Engineer for their Winchester Office. The successful candidate will lead teams of engineers and handle multiple projects at one time. You will be an expert when it comes to the design of Electrical Systems buildings and can expect a healthy salary in return.

For further information please contact
Kye Nessling on 01728 726 125

Senior Mechanical DE (Hotel Specialist) - London EC1

£50k to £60k plus benefits

A specialist in the hotel, residential and commercial sectors would like to add a senior mechanical design engineer to their MEP design team of 16, sitting within a larger multi-disciplinary office. The consultancy is known for their well-publicised UK and international workload. Transforming the built environment, the consultancy led the way in sustainable design. Ideal candidate will have a minimum of 10 years mechanical design experience within building services and can work with minimum supervision.

For further information please contact
Martin Bell on 01728 726 135

Senior Mechanical Engineer - Nottingham

£38k to £45k plus benefits

Our client has been operating for over 15 years and is currently on the lookout of for an accomplished Senior Mechanical Design Engineer in their Nottingham based office, to help with their ever-increasing workload. The successful candidate will have experience in a variety of industries and have extensive experience in the design of Mechanical systems within buildings.

For further information please contact
Kye Nessling on 01728 726 125

Find all jobs at
conradconsulting.co.uk

London 0203 890 7336
Suffolk 01728 726 120
Leeds 0113 457 0079

Edinburgh 0131 240 1260
Manchester 0161 209 3246
Birmingham 0121 698 2085

b-a-r beeby anderson recruitment

For further information and to apply, please call us on **+44 (0)203 176 2666** or email **cv@b-a-r.com**

Building Services Director

London £100k + package

Internationally renowned consultancy is seeking a passionate and talented Director dealing with UK/global clients and reporting directly to the board. With an innovative mindset you should be capable of pushing boundaries in order to deliver exceptional solutions on iconic projects. My client offers a dynamic environment, flexibility, travel, and exposure to cutting edge schemes. Ref: 4979

Senior Mechanical Engineer

London £45k - £55k + bens

Working across a rich and diverse portfolio of projects ranging from art & leisure, scientific, urban developments, commercial and heritage schemes. This award-winning and highly regarded consultancy have built an enviable team of talented engineers in London and are recognised for their innovative and pioneering approach to projects across the globe. Ref: 4639

Senior Electrical Engineer

London £45k - £55k + bens

An opportunity has arisen at a medium sized and well-established MEP design consultancy that boast impressive & diverse portfolio of projects in: residential, commercial, retail, historical, and healthcare sectors. There is ample opportunity for a candidate with the right technical expertise, commercial acumen, and client facing abilities. to progress to Principal and beyond in this rapidly growing business Ref: 4971

Electrical Engineer

London £40p/h

We have a requirement for an electrical engineer on a contract basis. You will provide design from conception through to completion on some of the UK's most iconic projects. The work is predominantly HV & LV and the contract will run for approximately 12 months+. Similar experience is essential. Immediate start. Ref: 4960

Mechanical Engineer

London £40p/h

We have a requirement for a mechanical engineer to work on a contract basis. You will provide design from conception through to completion on some of the UK's most iconic projects. The work is predominantly conceptual and detailed design on large HVAC systems coupled with client liaison. Successful candidates must be degree qualified. Ref: 4958

Technical Manager (Mechanical)

Central London £60k - £75k + bens

This is an exciting opening to work on some of London's flagship projects ranging from £30 - £80 million pounds, with a specific focus on large scale mixed use projects. You will be acting as Mechanical Technical Manager liaising directly with in house design teams and external stakeholders. Ref: 4976

Thinking of your future

www.b-a-r.com

Society of Public Health Engineers (SoPHE)

Young Engineers Award 2018

For the past few years, Caminos de Agua has been working to develop a media-based filtration system to remove arsenic and fluoride from groundwater. To do so, they have developed low-cost technical filtration media made of cow bone char for fluoride removal and is now working to develop a similar media for arsenic. Both media are granular and are sieved to a standard 8 x 30 mesh.

The Problem

When bought new, the filtration system components are quite expensive. To keep costs low, they plan to design a gravity driven system and, based on the different filtration media's properties, each will have a different sized container. The media will have to be changed every 3 to 6 months and therefore the cartridges will need to be opened quite regularly.

The Challenge

Design a refillable cartridge that is openable with commonly available, reasonably priced tools. These containers need to be refillable, air and water-tight, and cannot allow the media to exit with the water. They also need to connect, in-line, with commonly-available parts, to other filter cartridges.

Submissions

Form a team of up to 3 people aged 18-35. Demonstrate your idea with a two to five-minute video or a poster. Please refer to the SoPHE website.

The Award

The finalists will be invited to the annual SoPHE dinner where the award will be announced.



Image © Caminos de Agua

In association with Engineers Without Borders
www.cibse.org/sophe





CIBSE YEN chairs and vice-chairs at the YEN Global Conference in Dubai last October

Andrew Saville

YEN at heart

The CIBSE Young Engineers Network started in 2006, with help from mentor Andrew Saville. He shares how, and why, the network was formed

Since 2006, Andrew Saville has taken on the role of mentoring CIBSE's young engineers, through the Young Engineers Network (YEN). For his work with the network, he was awarded a CIBSE Honorary Fellowship.

Saville started his career as a design engineer in 1971, working for W A Troake and Partners. He went on to the Haden Carrier Group as senior design engineer before moving to the Bank of England property services and security division, where he spent more than 16 years, becoming technical support manager. He then set up his own consultancy and became a partner at Armville Consultancy.

As a CIBSE Fellow and CIBSE Silver Medal recipient, Saville has been an active member of CIBSE since 1976. He was a Council member for 12 years, and has been a member of the Trustee Board since 2014. He is also past chair and secretary of the Home Counties North East (HCNE) Region.

He has co-authored several publications including CIBSE Guide M *Maintenance Engineering and Management* and CIBSE Knowledge Series *Managing Building Services*.

Q How and why did you become involved in the YEN at CIBSE?

A In November 2005, during my chairmanship of HCNE Region, young engineer Michael Norton asked me if CIBSE could have a young engineers' group. That was some challenge; Special Interest Groups (SIG) are discipline-related, whereas a young engineers' group would be age-related. After Michael gathered 14 of his colleagues from South Bank University, now LSBU, I contacted CIBSE HQ and, in 2006, these same young engineers met three delegates from the CIBSE board. Each prepared a two-minute presentation on why CIBSE should have a young engineers' SIG. They believed passionately that CIBSE young engineers should have a greater voice in the building services industry. In September, we received a response from the Board: 'Don't form a group, form a network.' After discovering that there were already young engineers' groups in Scotland and Hong Kong, the London group proposed that all three might amalgamate, and YEN was born.

Q How can the industry encourage and motivate young engineers?

A Young engineers should be encouraged and motivated at work and at college. Employers should see YEN activities as a source of CPD and ensure individuals feel part of the greater building services engineering family, rather than simply

confined to their workplaces, engineering silos, following traditionally – and often slowly – in the footsteps of older, more experienced engineers. Young engineers should be allowed to go to conferences, leave their workplace in time to get to external CPD events, get time off for studying and revision before exams. Some employers have always offered such facilities but, now, the most up-to-date employment practices are showcased widely each October in the Employer of the Year awards.

Q How do established companies benefit from young engineers?

A Young engineers need training and need to understand how the industry works. However, for their part, they are enthusiastic, energetic, very clever, keen to assimilate new information and they think outside the box. They should be supported as they get used to employment in the industry. All young engineers should be given the chance to work in – or visit for a period – a consultancy, a contractor and/or a manufacturer, which is not their normal employment. They should be given a chance to appreciate the big picture. Industry work experience is practised by some more progressive employers, but to a very limited extent.

Q What do you as a mentor?

A Mentoring is two-way. It involves support and enlightenment, but also listening. A pilot mentoring scheme is currently being managed and assessed from CIBSE HQ.

Q How do you promote building services engineering in schools?

A Many students in schools and further education colleges know little about engineering as a technically advanced subject, and the best people to explain building services with enthusiasm, in the classroom or at careers events, are our YEN members. Those of us who have spent 20 years or more in the industry are best employed talking to parents or teachers.

Q What have you learned from young engineers?

A They are appreciative of the support and guidance of older and more experienced engineers, and, yet, they are our industry's best representatives.

■ **ANDREW SAVILLE** is a partner at Armville Consultancy and CIBSE YEN mentor

NATIONAL EVENTS AND CONFERENCES

Society of Light and Lighting: LightBytes 7 June, London

Continuing the 2017-18 SLL Lighting Knowledge Series 'LightBytes'. The day includes peer-reviewed, bitesize presentations focusing on four key areas: Design, Build, Specify and Future. Speakers will include Lee Thomas and Nick Van Tromp, from Fagerhult, Steve Shackleton, from Zumtobel Group, Helen Loomes, from Trilux, and Roger Sexton, from Xicato.
www.cibse.org/sll

CIBSE TRAINING

For details, visit www.cibse.org/training or call 020 8772 3640
Energy monitoring and targeting
4 June, London

Low carbon consultant design training 5-6 June, London

Heat networks code of practice 6-7 June, Manchester

High voltage (11kv) distribution and protection 8 June, London

Building services one-day overview 8 June, London

The importance of energy efficient buildings 11 June, London

ISO 50001: 2001 Energy management system 11-13 June, London

Low carbon consultant building operations 12-14 June, Manchester

Understanding and application of psychrometric charts 13 June, London

Practical approach to LV fault analysis 15 June, London

Air conditioning and cooling systems 15 June, London

Complying with ESOS: the ISO50001 standards explained 19 June, London

Mechanical services explained 19-21 June, London

Variable flow water system design 20 June, London

Energy efficiency building regulations 21 June, Manchester

Lighting: legislation and energy efficiency 21 June, London

Practical controls for HVAC systems 22 June, London

Energy strategy reports 22 June, London

Electrical services explained 27-29 June, London

Standby diesel generator 27 June, London

Building services explained 27-29 June, London

Introduction to combined heat and power (CHP) 29 June, London

CIBSE GROUPS, SOCIETIES AND REGIONS

For more information about these events, visit: www.cibse.org/events

SLL and South West: Lighting for architectural and media façades based on LG6 7 June, Bristol

Focusing more specifically on lighting building façades and media installations.

YEPG: Carbon Bite Night 2 – integrated building design – parametric modelling 7 June, London

An interactive discussion and presentations, on second Carbon Bite Nights series.

SOPHE AGM and SoPHE Young Engineers Award winner presentation 12 June, London

AGM, preceded by presentation from the 2017 SoPHE Young Engineers Award winner.

South West: Future-proofing cities 12 June, Bristol

An evening of networking and an opportunity to play Atkins' future-proofing cities game. How do the scenarios posed affect the future of your city?

SFE: City walk 12 June, London

Popular annual city walk, focusing on building façades.

SLL & South West: Light and health part 3 13 June, Bristol

With speaker Henrik Clausen, director at Fagerhult Lighting Academy, exploring the concept, studies and practicalities of the biological and emotional impacts of light on the human body.

YEN London: CPD, pub and grub: Fire! Are you up to date? 13 June, London

Lee Thompson, of Senseco, will give an update on BS5839 and an overview of fire suppression.

Intelligent Buildings Group: Multisensory design 13 June, London

Seminar showing how multisensory design can be achieved in practice to create healthy spaces.

South West: SoPHE – Fire-safety engineering perspectives 19 June, Bristol

Fire-strategy design lies with the fire engineer consultant, and fire-systems design lies with the MEP engineer – speakers from the two camps will run through design regulations relevant to their role and best practices.

South West: TM60 – Good practice in the design of homes 21 June, Bristol

Presentations by Ashley Bateson, Homes for the Future Group chair, and Tom Lelyveld, lead author of TM60.

ANZ: Annual cocktail function and awards 21 June, Sydney

Evening reception and ANZ Young Engineers Awards, hosted at the Westpac Long Gallery at the Australian Museum, Sydney.

ILEVE AGM and technical day 27 June, Buxton

The Institute of Local Exhaust Ventilation Engineers AGM, and technical day.

East Anglia: Summer social 29 June, Horning

Summer social aboard the Southern Comfort Mississippi Steam Paddle Boat, on the Norfolk Broads.

HIGHLIGHTS



Alastair Hayden will give his presentation before the SoPHE AGM on 12 June



Ashley Bateson will speak at the South West event on 21 June

Facilities Show

19-21 June, ExCel London

Returning to ExCel for its fifth year, the 2018 Facilities Show will offer the latest solutions, newest products and services, as well as expert knowledge. The show continues to grow, attracting facilities management (FM) professionals from all sectors – including suppliers, advisers and specialists – who can network with more than 300 exhibitors. This year, the show's seminar stream includes inspirational speakers Ruby Wax, Nicky Moffat and Sir Clive Woodward.

Visit the CIBSE Facilities Management Group on Stand S950 and catch up on all the latest FM news, events and services that CIBSE has to offer. Geoff Prudence, chair of the group, will also be presenting the 'Leadership: The opportunity' session in the Facilities Management Theatre, from 1-1.30pm on 21 June.

Vice-chair David Stevens will be presenting two sessions in the same theatre: 'Delivering top-class FM on a budget' (3-3.40pm, 19 June), and 'FM in 2025: The people and skills needed to drive FM in the future' (12-12.45pm, 21 June).

To register, visit www.facilitiesshow.com



Geoff Prudence

Perform » Reward » Celebrate



CIBSE BUILDING PERFORMANCE AWARDS 2019

OPEN FOR ENTRIES SOON »»»»

Recognising the people, products and projects that demonstrate engineering excellence in the built environment

ENTER NOW

Entry deadline:
Friday 14 September 2018

Winners announced:
Tuesday 12 February 2019

Sponsorship enquiries please contact jim.folley@redactive.co.uk or 020 7324 2786

For more information please visit:

cibse.org/BPA

 [@CIBSEAwards](https://twitter.com/CIBSEAwards)
[#BPA2019](https://twitter.com/CIBSEAwards)

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.

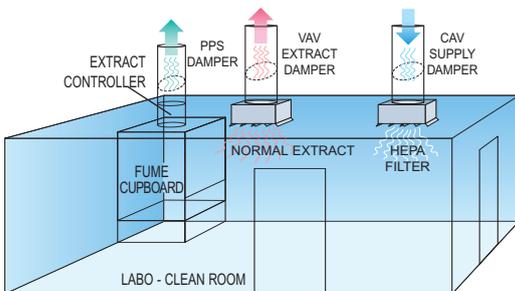


DPM PRESSURE SENSOR

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

A Division of C. M. RICHTER (EUROPE) LTD

22 Repton Court, Repton Close,
Basildon, Essex SS13 1LN. GB
Website: <http://www.cmr.co.uk>

Tel: +44 (0)1268 287222
Fax: +44 (0)1268 287099
E-mail: sales@cmr.co.uk

