CHILLED CEILINGS & BEAMS

Chilled ceilings break through cooling barrier

THE 'HOLY GRAIL' OF 100 W/M^2 FOR A CHILLED CEILING IN AN OFFICE HAS BEEN PROVED FOR A CHILLED-CEILING SYSTEM BY INDEPENDENT TESTS. **GRAEME OWEN** AND **GREG KING** PROVIDE THE DETAILS.

The environmental and comfort benefits of installing a chilled-ceiling have been well documented over recent years. However, the relatively low levels of performance (in terms of cooling capacity) offered by traditional copper-pipe static cooling systems has tended to limit development of the concept to a small number of high-profile client-specified commercial buildings. For one chilled ceiling manufacturer, the 'holy grail' has been to produce a chilled ceiling system that has a cooling capacity over the active area of 100 W/m^2 at a 10 K Δ T (differential temperature).

A chilled ceiling was developed by Burgess Architectural Products Ltd and Hydroclima Ltd for testing in a 'generic' office scheme proposed by consulting engineer GW Building Services Consulting. The scheme is a representation of a typical 6600 m^2 speculative office development, and GW was looking for a chilled ceiling that could handle building occupancy loads of 50 W/m^2 with a chilled perimeter beam to offset solar gain of 120 W/m^2.

The ceiling arrangement proposed utilised 1280 mm square pivoting Megapanels on a 1500 mm modular grid arrangement. This meant that the active ceiling area had to provide a cooling capacity in excess of 70 W/m^2 whilst maintaining a water-supply temperature of 15°C with the room at a comfortable 24°C. The target cooling capacity was over 15% higher than the average for a typical chilled panel.

To achieve this performance, the manufacturer developed a novel type of heat exchanger. It consists of a flat aluminium plate (less than 5 mm thick) with integral titanium-lined waterways that are designed to spread the mass of water across the entire area of the plate, so promoting a highly efficient transfer of energy from the surface of the ceiling tile to the water. The principle seemed sound; in fact BSRIA tests carried out in accordance with DIN 4715 proved that the system could achieve 74 W/m^2 at a 7.5 K Δ T (and 100 W/m^2 at 10 K Δ T).

Table 1: Chilled-ceiling performance summary — normal conditions

Active area	10 m²
Total cooling effect	760 W
Cooling effect per square metre of active ceiling	76 W/m²
Differential temperature	6.6 K

Table 2: Chilled-ceiling performance summary — excessive conditions

Active area	10 m²
Total cooling effect	900 W
Cooling effect per square metre of active ceiling	90 W/m²
Differential temperature	8.2 K

The test room was constructed using 100 mm urethane insulation with steel-finish materials in a fabricated sheet form (manufacturers stated U-value of 0.19 W/m^{2}K). The test room was sufficiently airtight to prevent any ingress of ambient air. The test room was placed within an existing larger environmental chamber to minimise heat transfer through its surfaces.

AS-INSTALLED PERFORMANCE TEST

The DIN testing regime creates a rather artificial environment. The tests make no allowance for actual use in a working environment. More importantly, the tests take no account of the air movement generated by the ventilation system. As these variables are project-dependent, the only way to arrive at a truly representative performance is to test the specified environment. This requirement meant building a mock-up of the chilled ceiling as specified, with appropriate lighting, heat loads, solar gain, air delivery and air extraction.

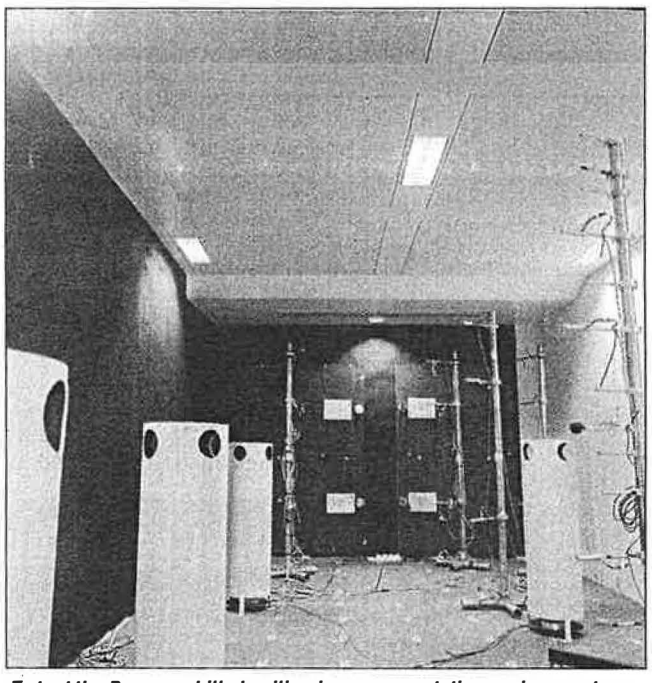
To provide additional guarantees of the performance of the chilled ceiling in a generic office environment, tests were carried out at BSRIA using a mock-up. The office was 7200 by 3400 mm and was provided with eight active elements. Fresh conditioned air was introduced at perimeter ceiling level and extracted through the light fittings. Representation of solar gain, people and equipment was made by introducing heating elements.

A visual representation of the resulting temperature and air velocity throughout the whole room is presented in the accompanying illustration. It shows a consistent environment and demonstrates that the room will achieve the desired occupancy comfort.

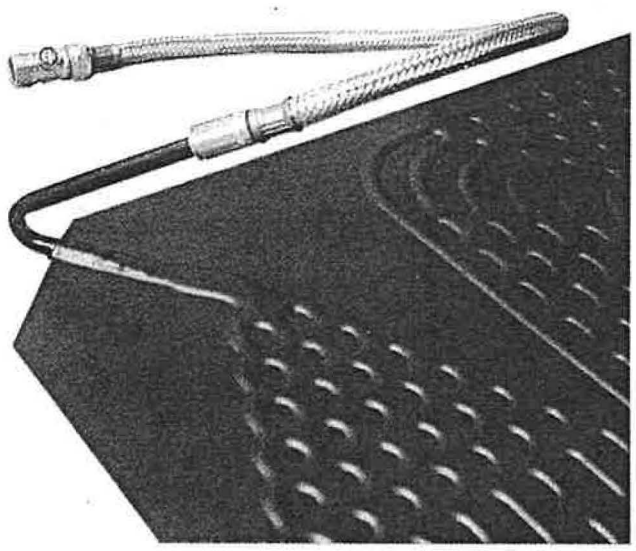
CONCLUSION

The chilled ceiling performance to two differential temperatures is shown in tables 1 and 2. These results neglect the cooling effect of the supply air.

The authors are with the Building Services Research & Information Association, Old Bracknell Lane West, Bracknell, Berks RG12 7AH.



To test the Burgess chilled ceiling in a representative environment, a full-scale mock-up was built, measuring 7.2 by 3.4 m.



The novel heat exchanger in this Burgess chilled-ceiling element is designed to promote efficient energy transfer from the surface of the ceiling tile to the circulating chilled water.

Combining cooling and light

Providing a stunning effect in the large open-plan areas of the new Cellular Operations Centre at Swindon are integrated service modules provided by SAS and combining chilled beams and indirect/direct lighting. This modern office building has a dramatic curved glass façade and provides its workforce with a comfortable and entertaining environment.

The passive chilled-beam units are 1700 mm long, 600 mm wide and 100 mm deep. The beams are above a 50%-open perforated central strip and provide over 340 W/m of cooling. T5 LG3 Category 2 luminaires are mounted within apertures on each side of the service module to provide 300 lux on the working plane. Coloured diffusion above the luminaire creates blue uplighting. The modules are positioned at 4.2 m centres across the floor-plate width.

Cellular Operations believes that the concept has made a significant contribution to reducing staff turnover.

Duncan Wisely, technical manager for chilled ceilings with SAS, says that the concept of offering a total solution from a single supplier is proving very popular and looks set to be used on a number of major developments.

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Chilled beams — and beyond

MULTI-SERVICE UNITS IS THE PHRASE OF THE DAY, AS CHILLED BEAMS FIND THEMSELVES COMBINED WITH OTHER SERVICES IN A CONCEPT THAT PROMISES TO HAVE A MAJOR EFFECT ON HOW SERVICES ARE PROVIDED AND PROJECTS MANAGED IN THE FUTURE.

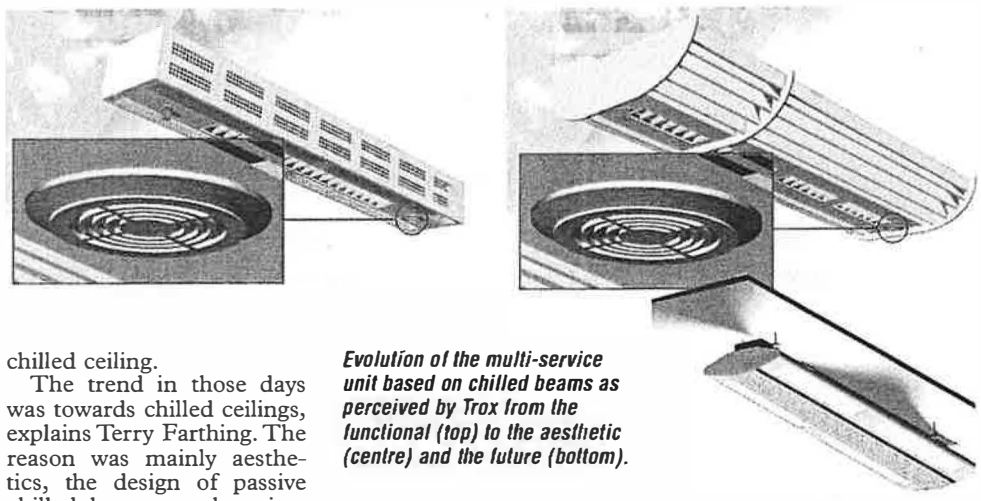
The market for chilled beams in the UK is undergoing a massive step change in the UK, believes Terry Farthing, sales director of Trox UK.

The change is quite recent, certainly since the start of this year, but heralds a new era in the approach to the way services are provided in buildings and projects are managed.

New buildings now in the construction and design phases are showing the way, and Terry Farthing believes that innovative approaches that are so readily being accepted in new projects have important implications for office buildings of the 1960s that are in desperate need of upgrading to suit 21st-century ways of doing business — or the expensive alternative of demolition and replacement.

SHORT HISTORY

The position today is firmly built on a history of the use of chilled ceilings and beams in the UK — a history that is very short. The first major UK project using chilled beams was the Department of Trade & Industry in Victoria Street, London. Built in 1994, it incorporates 28 000 m² of chilled ceiling.



Evolution of the multi-service unit based on chilled beams as perceived by Trox from the functional (top) to the aesthetic (centre) and the future (bottom).

The trend in those days was towards chilled ceilings, explains Terry Farthing. The reason was mainly aesthetics, the design of passive chilled beams at that time being extremely 'agricultural'. Chilled ceilings prospered, but their development was hampered by their limited cooling capacity. Chilled ceilings achieve their cooling effect by radiant means, compared with convection from chilled beams.

One solution was to install chilled beams above perforated suspended ceilings to handle the higher cooling loads in the perimeter area of a building with chilled ceilings in central zones. The ceiling tiles below the chilled beams required a free surface of 50%. Point North in Birmingham was one of the first examples.

Another technique devised to overcome the unaesthetic appearance of chilled beams was to incorporate them in suspended ceilings, and there are many installations with active chilled beams incorporated in the ceiling design.

Despite concerns about condensation on chilled surfaces expressed in the early 1990s, Terry Farthing knows of very few installations where condensations has been a problem. He refers to work carried out by the Building Services Research & Information Association on pipes carrying cold water. The work revealed that such pipes could be operated 2 K below the dewpoint before misting occurred — and then only after a couple of hours.

Chilled beams, both active and passive, are highly convective, reducing the likelihood of condensation. Acceptable operating conditions in a space with a temperature of 22 to 24°C are a chilled-water flow temperature of 14°C and a return temperature of 17°C.

FEATURE

Landmark projects in the latter part of the 1990s began to make a feature of chilled beams, fixing them to the slab and leaving them exposed. The beams also incorporated lighting for the first time.

One example is the headquarters of Barclaycard at Northampton, one of the first multi-service beam projects Trox was involved in. Modules containing passive chilled beams and lighting within the same casing are suspended from the building slab at 1.5 m centres. Air enters the beam from above, is cooled, and discharged from the sides. The project has 15 000 m of these beams based on a Scandinavian type of design.

Lloyds Registry of Shipping in London follows a similar approach, with modules incorporating passive chilled beams and lighting fixed to the underside of the building slab.

This project went several stages further than Barclaycard by incorporating into the beam modules fire sprinklers, IT cabling, alarms and emergency lighting. The underside of the modules also incorporates a small area of radiant-cooling surface to help meet a very high cooling demand.

Installed at 3 m centres, the Lloyds modules achieve a cooling capacity of 380 W/m, or about 130 W/m² of floor area.

MOTIVATION

'The concept of integrated modules was also used in the Satellite 2 building at Stansted, but with a different motivation,' says Terry Farthing. This is a very long and narrow building, and the objective of the British Airports Authority was to speed up the project time by maximising the amount of work carried out in the fac-

Total solution for Royal College of Nursing

Active cooled beams are providing both cooling and ventilation for the refurbished listed Royal College of Nursing in Central London. Project designer R. W. Gregory & Partners selected Halton's CBF active beams to provide a comfortable environment with low energy consumption and significantly reduced maintenance costs.

For aesthetic reasons, architects EPR required the lighting to be combined with the beams. Halton and Thorn Lighting jointly developed the fully integrated curved-face service module that would span offices and cross partitions.

The modules incorporate Thorn's fully recessed uplights using T5 technology actuated by passive infra-red sensors within them. The curved panels of the units are specially designed to provide a visual glow effect of light through the perforations.

Construction of a full-scale prototype on site enabled M&E services to be co-ordinated prior to the contract. Particular attention was given to the design of the interface between lights, beams and the profiled cover sections.

All the required M&E services are hidden within a service bulkhead located on the internal façade. The lighting and curved covers were fitted to the CBF beams by Thorn as a final fix — after the beams had been installed and connected — to reduce risk of damage to the decorative features and maintain the high levels of detail required for this project. MESL installed the beams.

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Lighting and cooling using active cooled beams are combined in these fittings specially produced by Halton and Thorn Lighting for the refurbishment of the Royal College of Nursing in London.

tories of its suppliers so as to minimise the time required on site.

The modules for the Stansted project provide both heating and lighting and were produced in sections 10 m long. Special arrangements were made to handle them when they were delivered to site. Once these unprecedentedly long modules had been fixed in position, only plumbing connections and plug-in connections for lighting were required. Labour-cost savings of £100 000 are said to have been achieved.

A new concept was being born — the multi-service unit — with the potential to transform the provision of services in larger buildings. Built in a factory under controlled conditions, they can incorporate cooling using chilled beams, lighting, air diffusion, alarms, emergency lighting and provision cables for power, data and telecoms.

The design of these multi-service units brings together a wide range of expertise. Trox, for example works with Thorn Lighting.

Once delivered to site to a carefully planned schedule, multi-service units are quickly fixed to the underside of the structural slab — eliminating the cost of a suspended ceiling.

Readily accepted

Terry Farthing tells us that they are being readily accepted by architects, who value the ability to stamp their own mark on a building with their own case design, which adds very little to the overall cost.

'Production, not construction' is how Terry Farthing dubs the concept, and he is full of the benefits to developers and clients. Among them are lower capital cost, lower running cost and lower installed cost. The construction process is also shortened, since much work is done off site. Fixing multi-service units to the slab dispenses with the suspended ceiling, reducing slab-to-slab spacing — and hence building cost. In an old-style building with limited slab-to-slab height that is being refurbished, the saving in height is critical in making it possible to install modern high-spec services.

Multi-service units could typically be just 350 mm deep or, even, 300 mm.

If a multi-service unit incorporates an active chilled beam, the height of the floor void can be reduced since no additional ventilation is required.

Enormous potential

Just as vital as the effect on buildings themselves is the enormous potential for improved and simplified project planning, explains managing director David Leatherbarow. Computer-aided design and manufacture makes it a routine job to customise *every* unit for a project and schedule delivery precisely to requirements.

This is single-source responsibility with several pluses. Integrated services are delivered to site and require merely fixing to the ceiling slab and final electrical, plumbing and air connections made. The principal constraint is transportation and access to site. At Stansted Airport, the multi-service units were a massive 10 m long.

Both David Leatherbarrow and Terry Farthing are full of enthusiasm for this rapidly developing concept — as is the Trox factory at Thetford.

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Chilled beams provide the flexible refurbishment solution for Shell Mex House

A high-capacity passive cooling system based on Klima-Therm chilled beams serves the newly refurbished Shell Mex House and Cecil Chambers buildings on the Strand in London.

Both buildings in the 13-storey 50 830 m² project commenced as speculative prime office refurbishment. However, their rapid letting within the initial-construction phase required a high degree of flexibility to allow the needs of incoming tenants to be accommodated. The chilled-beam system allows cooling loads to be met and layouts accommodated within the original design concept.

Principal contractor StructureTone (UK) and services designer Norman Disney & Young awarded Klima-Therm a £1.25 million contract for the design, supply and installation of passive chilled beams for both buildings. The Grade 2 6110 m² Cecil Chambers building was one of the most prestigious hotels in London when it was built in 1892. Shell Mex House, also Grade 2 listed, provides 44 720 m² of floor area and was built in 1933 in the original gardens of Cecil Chambers. Both buildings required different architectural cooling solutions to meet the needs of the retained listed plaster work interior of Cecil Chambers and a typical large-floor-plate office area in Shell Mex House.

The design solution for Cecil Chambers was an exposed suspended cooling-and-lighting module incorporating chilled beams and intelligent T5 lighting, giving both direct and indirect lighting. Cooling capacities of 100 to 200 W/m² are achieved from a chilled-water supply of 15°C and lighting levels of 400 lux.

The solution for Shell Mex House required concealed chilled beams above a metal tile celling with a free area of 39%. Cooling outputs of 110 to 130 W/m² are achieved from chilled water at 15°C. The cooling performance was laboratory tested to confirm the predicted derating of the lower-free-area tiles, which Klima-Therm states is a key factor in the application knowhow of a passive chilled-beam system. The design also has a gap around the perimeter of the celling to capture the warm-air plume created at the window blind by the solar-heating effect to increase the capacity of the chilled beam and separate the perimeter zone.

In both buildings, fresh air is supplied and extracted at high level in a conventional manner for ventilation and to provide some primary cooling.

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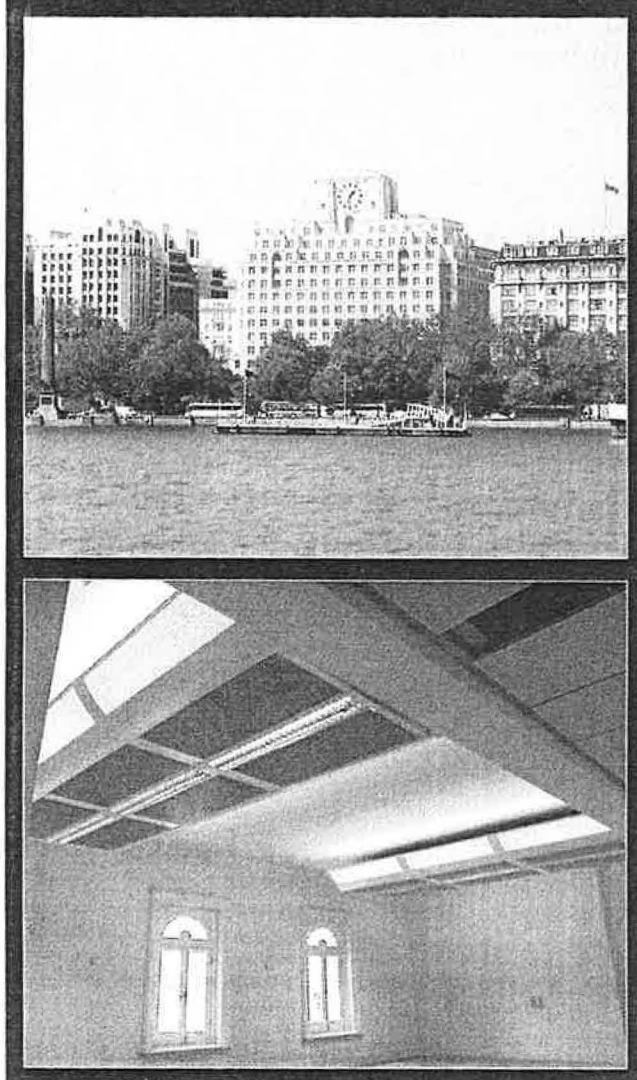

Klima-Therm high-capacity passive cooling systems have been used in the refurbishment of the Grade 2 listed Shell Mex House (top) and Cecil Chambers (bottom) in London.