Assessing the whole cost

By John Staunton, Room Comfort Brand Manager for SAS International

In today's climate where reducing carbon emissions and energy usage, meeting amendments to the building regulations and achieving good room comfort are key considerations, it is unsurprising that alternative methods of providing cooling within non-domestic environments are being explored.

Chilled ceilings and beams, with low whole-life costs and energy consumptions, are emerging as a popular solution. Using water as a cooling medium, these systems offer an efficient way of cooling a building when compared to all-air, DX, VRF, VAV and fancoil systems. Requiring relatively modest cooling water temperatures of 14 to 17°C, natural cold water storage or free cooling from outside air can realise these temperatures throughout parts of the year, and when additional mechanical cooling is needed a higher chiller COP (Coefficient of Performance) can be achieved.

Peak power consumptions for chilled ceiling and beam systems have been shown to be about 20 W/m^2, while it ranges from about 50-70 W/m^2 for all-air, DX, VRF and fancoil systems (taken from The potential for reducing Carbon Emissions from Air Conditioning Systems in UK Office Buildings, Welsh School of Architecture, Cardiff University 2003). This reduction in energy consumption enviably leads to a lower energy cost over a system's life cycle; one which given rising energy prices is only going to make an increasing difference. However, this is only part of the life cycle cost story; initial capital outlay, asset replacement, and planned preventative maintenance costs also need to be considered.

A survey undertaken by Tony Cassidy of Cyril Sweett looked at the whole-life costs of chilled ceilings, fancoil, VRF and VAV systems in a new-build three storey office development with a gross internal floor area of 6500m^2 and operating over a 25 year period. It showed that chilled ceilings had the lowest whole-life costs, followed by fancoil units, VRF and then VAV systems. Chilled ceilings came in below VAV systems by a factor of 31% despite the fact that their initial capital costs worked out at about the same.

Chilled ceilings and beams systems are also very attractive in light of recent controversies over the aggressive effects of modern synthetic refrigerants used in air conditioning and the spread of Legionnaires Disease. Greater occupant comfort is also achieved as they generate for thermal storage - a natural process that has a cooling potential of up to 25W/m^2 according to the Concrete Centre.

While chilled ceilings allow lighting and other ceiling mounted services to be passive beams can achieve cooling outputs of up to 300W/linear metre, and chilled ceilings can produce cooling outputs in the range of 65 W/m^2.

Passive chilled beams and chilled ceilings must be used in conjunction with separate air

distribution systems. This makes these systems sensitive to the location of the fresh air supply and any heat sources, as well as any resistance to air flow. For this reason you may choose to install passive chilled beams at the perimeter of a building with a large percentage of glazing, as the thermal convection produced during the summer can enhance the cooling capacity of the beam; and a chilled ceiling throughout the rest of the building, where the cooling loads are lower.

Active beams offer an increased amount of control, as the level of induction of hot room air through the beam is managed by the flow of the fresh air supply. The induction ratio of a beam measures the amount of room air drawn through it in relation to the volume of fresh air introduced. As the air induced through the beam is cooled this process determines its cooling capacity. While a high induction ratio is often desirable it is not always required and the level should be determined by the requirements of the space. SAS active chilled beams can produce induction ratios of up to 4:1 (independently tested by Krantz).

The decision on which option to choose should be centred around the specific requirements of the building. The cooling load, minimum fresh air volume and level of control required are key factors to consider, as is the water supply system utilised and the spacing of the units.

In order to achieve the maximum energy savings possible, the inherent efficiency of the system employed and a wide range of other variables that affect the energy performance of cooling systems need to be considered. These include:

- Building design issues which influence the cooling load served.
- System design issues such as plant sizing.
- Operational regimes which include occupancy patterns, the use of control systems and the maintenance of individual buildings.

Addressing such key issues as these, in particular the relatively easy feat of assessing the all too prevalent over-sizing of plants and operation of systems outside occupancy hours will have a significant impact on energy use. They must be considered alongside the utilisation of alternative more efficient cooling systems in order to deliver the most cost effective occupant.

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also have fewer components and moving parts, ensuring minimal replacement part requirements and a greatly reduced maintenance regime. The survey goes on to say that overall running costs of chilled ceilings only make up around 20% of the total whole-life cycle cost, whereas VRF systems, with the cheapest initial capital cost outlay, actually accrue over 50% of their total from post installation running and maintenance costs.

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While not appropriate for every building, there is no reason why chilled ceiling or beam technology cannot be applied to most new and refurbished office developments, as well as within other environments such as schools, universities, airports, hospitals and libraries.

Chilled ceilings and beams, often specified as a design feature and enclosed in a metal casing, also offer all the fixed production, delivery and installation times you would expect from a prefabricated module, greatly reducing the risk of project overrun and on-site wastage. Chilled beams, can offer the added benefit of opening the concrete soffit up minimal air movement and remove the obtrusive noise generated by mechanical alternatives.

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Chilled ceilings use a combination of radiation and convection to achieve room and occupant cooling, while chilled beams rely on convection to cool the occupied space. There are two types of chilled beam: Passive chilled beams which utilise natural convection and active chilled beams which utilise mechanical convection that incorporates fresh air ventilation.

Active chilled beams can achieve cooling outputs of up to 500W/linear metre while