Capital Cost

The following data has been developed from an original cost analysis carried out by Mott Green Wall for the Building Services Journal, May 2001.

CHILLED CEILINGS AND BEAMS – COST COMPARISON			
	Fan coil unit	**Passive chilled beam**	**Active chilled beam**
	£/m2 (gifa)	**£/m2 (gifa)**	**£/m2 (gifa)**
Shell and core: all figures in terms of gross internal floor area (gifa)			
Disposal installation – condensate drainage	1.2		
Heat source – gas-fired boilers, gas supply, twin walled stainless steel flues	6.5	6.5	6.5
LTHW installation			
Pipework distribution in plantrooms and risers, pumps, pressurisation unit, water treatment, insulation	7	7	7
CHW Installation			
Roof mounted, air-cooled packaged chiller plant, pipework distribution in plantrooms and risers, pumps, pressurisation unit, water treatment, insulation	25	23	23
Air handling plant			
Supply/extract air handling plant, ductwork to plantrooms/risers, insulation	19	19	23.1
Electrical installation – allowance for electrical supplies to mechanical plant	3.9	3.9	3.9
Controls installation			
Head end supervisor, motor control centres, outstations, sensors, controls and all power and controls wiring	13.7	13.9	13.9
Total shell and core cost	**76.3**	**77.4**	**77.4**
	£/m2 (nia)	**£/m2 (nia)**	**£/m2 (nia)**
Category A fit out all figures expressed in terms of net internal area (nia), based on a net:gross efficiency of 75%			
Floor finishes – extra over for:			
350mm raised floor void, including cavity barriers, for displacement ventilation		4	
Seals to form airtight plenum		5	
Forming holes in raised floor tiles and fixing free issue supply air diffusers		0.6	
Dust sealing to underfloor plenum		1	
Ceiling finishes – extra over for:			
Cost of perforated metal suspended ceiling suitable for passive beam installation		4	
Disposal installation – condensate drainage	5.6		
1) LTHW Installation			
LTHW Distribution, pipework, insulation, connections to fan coil units	17.5		
LTHW Distribution, pipework, insulation, connections to active beams			17.5
Perimeter heating, pipework, insulation, trench heating installation		26.6	
2) CHW installation			
Chilled water distribution to office areas at high level, pipework, insulation, connections to chilled elements		29	29
Chilled water distribution pipework, insulation, connections to fan coil units	26.5		
Passive chilled beams, flexible connections, shut off couplings		42	
Active chilled beams, flexible connections, shut off couplings			45
Ceiling mounted four pipe fan coil units	32.1		
3) Air handling			
Supply and extract ductwork, insulation grilles and diffusers	47.2		
Supply and extract ductwork, insulation, extract grilles			35
Extract only ductwork and grilles		27.2	
Supply only floor grilles		12.5	
4) BEMS installation			
Sensors, control valves, power, control and network wiring	12	14	14.5
Total Category A fit out cost	**140.9**	**165.9**	**141**

The following exclusions apply to the costs shown in the table: inflation beyond second quarter 2001; general builder's work; main Contractor's preliminaries, attendances, overheads and profit; professional fees and prescribed fees; contingency and design reserves; tax allowances, vat.

This analysis shows that a passive chilled beam solution is slightly more expensive than a high quality fan coil unit or active chilled beam solution. Most of the difference is associated with the installation of a raised floor to supply the ventilation air requirement. This cost can be reduced if ceiling-mounted supply air grilles are used, and mitigated if a raised floor is required in any event for the other two solutions.
The cost of controls and valves assumes “zone” control for both of the chilled beam solutions, and not control to individual beams.

Where a passive chilled beam solution is used it is assumed that the beams themselves are painted black to preclude the necessity to paint out the soffit. A ceiling system perforated to 35% maximum should be used for the same reason.

Running Cost / Energy Use

There are several aspects of an active chilled beam system that promoted a more energy efficient operation than air based systems such as fan coil units and VAV.

Typically the chilled water is distributed to the chilled beams at 14-17^{o}C to minimise the risk of condensation, whereas fan coil units operate typically at 6-12^{o}C.

Elevated chilled water temperatures offer two principal benefits in terms of energy efficiency:

- By operating the chiller plant at elevated temperatures its co-efficient of performance (COP) is increased and energy consumption reduced. The efficiency of the compressor can be increased by using a dry cooling system (inlet water 14^{o}C instead of 7^{o}C) with a percentage increase in COP of typically 22%.

- Elevated temperatures enable a significant increase in the opportunity to avail free cooling from sources such as outdoor air or ground water heat sinks. That is an annual increase from 800 hours to 2000 hours for a 12 hour day an 2100 to 5200 hours for 24 hour operation.

Fan coil unit ad VAV systems rely on a fan assisted cooling distribution; that is each fan coil unit incorporates a fan. Chilled beam systems utilise a centralised fan that delivers just enough air to meet respiratory requirements (or a little more in the case of some active chilled beam systems); with a consequent reduction in capital cost, electricity consumption and maintenance cost.

To deliver 100 W/m2 cooling:

	Fan Coil Unit	Passive Chilled Beam	Active Chilled Beam	VAV System (12°C supply air)	Displacement System (18°C supply air)
Approximate Air Volume Required (l/s/m2)	1.2 (minimum fresh air)	1.2 (minimum fresh air)	1.2 (minimum fresh air)	8.0	14

Maintenance Costs

There are no moving parts in chilled beams and therefore maintenance requirements are very low. An active chilled beam will require the cleaning of the batteries - using a vacuum cleaner and brush attachment - at intervals of 3-4 years (more frequently in healthcare environments where there is lint in the air). A finned tube passive beam will have similar cleaning intervals, however Frenger's Carat radiant/convective passive beam requires cleaning every 4-5 years by simply wiping the surfaces with a damp cloth. The chilled beam itself requires no further maintenance and can be expected to last the life of the building; however water quality must be appropriate and associated control valves and flexible hoses will require more frequent inspection/replacement.

The maintenance and replacement cost illustration below is taken from REHVA's Chilled Beam Application Guidebook issued 2005:

Fan Coil in 300 rooms, 20-year life cycle:		**(Euro)**
Filter Change:	25 Euro/filter twice a year	300,000
	15 min to replace @ 20 Euro / Hour	60,000
Cleaning of condensation System:	3 times / year @ 15 min	90,000
Motor Replacement:	200 Euro / Motor	60,000
	2 Hour work @ 20 Euro / Hour	12,000
Fan Coil Replacement:	1000 Euro / unit	150,000
Total:		**672,000**

Chilled Beam in 300 rooms, 20-year life cycle:		
Cleaning of chilled beam:	Once every 5 years	
	15 minutes @ 20 Euro / Hour	6,000
Total:		**6,000**

Difference in maintenance and replacement cost
660,000