Co-operative Retail Services wanted its new headquarters building to be both energy efficient and humane. Have these green ambitions been realised, and did the chilled beams and displacement ventilation systems provide the promised improvements in occupant comfort?

BY THE PROBE TEAM

PHOTOGRAPHS: BILL BORDASS

PROBE 17: Co-operative Retail Services hq

Five years ago, chilled beams, displacement ventilation and ice thermal storage were thought to offer improvements in building energy consumption and occupant comfort. The headquarters building for Co-operative Retail Services (CRS) was one of the first to benefit from this type of thinking.

The building has been analysed in a previous issue of *Building Services Journal* – readers wanting to know U-values, loads, capacities and other design criteria should refer to that article[1]. Briefly, though, the crescent-shaped building curves south west through to north west, a sloping site allowing five storeys at the lower end of the slope (north west) and two storeys at the top end (south west).

The deep-plan floorplates are broken by three central atriums – most workstations are no more than a single 7·2 m grid from perimeter or atrium. A fourth atrium behind the main entrance provides vertical circulation to all floors. Open-plan office floor area is around 8000 m^2. Total treated floor area is 17 300 m^2.

Primary building services comprise conventional boilers, air handling units (ahus), hydraulic systems and packaged chillers operating in series with a 2900 kWh ice store.

The building currently accommodates some 930 staff – significantly higher than the design figure of 650 occupants. Hence, densities are as high as 5 m^2/person in parts of the main open-plan office.

Office areas at CRS are normally occupied between 08.00 h and 18.00 h on weekdays. The building is generally not occupied at weekends apart from the IT support desk and possibly the printroom, both of which are manned 24 h per day. Around 80% of CRS staff work on a flexitime basis.

Internal conditions in the offices are maintained using pressurised plenum displacement ventilation with perimeter chilled beams. Ventilation relies on 100% fresh air, fully conditioned with heat recovery in winter.

Office air conditioning is split into three vertical zones corresponding to the three main atriums, each of which has a separate ahu. Return air for each zone is extracted at high level in each atrium via a series of plate heat exchangers (complete with bypass dampers) in the double-height ahus.

The computer suites have a dedicated pair of roof-mounted, air-cooled chillers (390 kW total cooling), with free cooling coils designed to start operating at 9°C outside and provide full cooling below temperatures of 4°C. These serve a 24-h glycol/water circuit at 10°C, feeding 23 close-control air conditioning units in eight separate rooms.

All main plant is controlled using a building energy management system (bems) with terminals in the maintenance office and on the facilities manager's desk.

At present most of the heating, cooling and ventilation plant is timed to operate between 06.30 h and 18.30 h on weekdays only, with little or no energy management of availability according to season. Commendably, there are separate metered gas and water supplies to the kitchen, its plantroom and the restaurant.

Lighting design issues

Most windows are low-e, triple-glazed and incorporate mid-pane venetian blinds which can be manually tilted but not raised. Light transmission of the glass is about 30%.

Office lighting uses metal halide uplighters – typically 4 x 150 W (wall or column-mounted) and 4 x 100 W desk-mounted per 7·2 m square structural grid (19 W/m^2). Gear and control losses of some 15% from ballasts mounted in the floor plenum contribute a further 3 W/m^2. The total installed lighting load of 22 W/m^2 is much higher than the stipulated good practice[2] level of 12 W/m^2.

Spot measurements of desktop illuminance showed 350 lux, indicating a relatively poor lighting efficacy of 6 W/m^2/100 lux. A penalty is always inevitable for uplighting, but the acoustic ceiling finish here is particularly rough and absorbent.

A major complaint of the facilities team is the high cost of lamp replacement. Initial costs were £45 per halide lamp, but they have now found supplies at £25 each. The team usually has to replace 25-40 lamps per month.

Lighting in other areas of the building, such as entrance foyers, meeting areas and the restaurant/servery is predominantly from lv halogen lamps which are on for most of the time, regardless of daylight levels.

An automatic light switching system via riser cupboards and floor controllers can switch individual uplighters and up to four nearby desk-mounted uplighters, each in the centre of either two or four workstations.

At hourly intervals between 17.00 h and 00.00 h, a four-stage sequence of 'sweeps' begins to switch lighting off, beginning with one half of each switching module and ending with corridor and stairway lighting.

In practice it seems that, despite very low occupancy levels outside normal working hours, the activities of up to 20 people who are present means that the lighting 'sweeps' do not have the chance to switch off the corridor and stairwell lighting, which effectively runs for 24 h. Many office lights also seem to be on outside normal hours, not least due to the small number of cleaners present throughout the whole night who activate the passive infra-red detectors in offices and meeting areas.

Although lighting controls are intended to provide some daylight response, in practice the impact is small. Use of local switching in the open-plan offices is limited, owing to the long run-up and restrike times of the uplighters, added to the fact that one lamp serves several workstations.

Operational issues: cooling and ventilation

The displacement ventilation in the offices supplies fresh air at a total of 28 m^3/s (30 litres/s/person), at a specific fan power (for supply and extract combined) of 4 W/litre/s.

The design temperature for floor supply is 19°C. However, during the PROBE visits in July and August 1998, at outside temperatures of about 18°C the room temperatures were typically 23-25°C, while recorded temperatures at the supply diffusers were 20-23°C. Management reported that the offices were generally rather hot, particularly on the upper floors, where they had improved the cooling on warm days by opening the atrium rooflights.

Further investigation showed that air was coming off the supply plants at between 16-18°C, but was picking up some 3-5°C between there and the inlet to the room. The management blamed this on heat gains from the ballasts and controls for the metal halide office uplighters, which are located in the floor void. However, in a steady-state this would account for less than 1°C.

The ground floor offices at Co-operative Retail Services, viewed from an atrium. Due to the unreliable lighting control system, the metal halide uplighters tend to be on outside of normal office hours, contributing to an 'uplift' of 3-4°C to the supply air temperature in the first floor plenum.

Although many lights remain on after the ventilation goes off – hence storing up heat in the void – this appeared to account for only about half of the effect observed. The rest appeared to be related to the convective plumes of warm air from the uplighters and office equipment heating up the ceiling below, particularly overnight when (at present) a reported 70% of the computers stay on.

Each of the three ahus has a humidification capacity of 150 kg/h, with four-stage electrode boilers of 120 kW total capacity per ahu. During the PROBE visits in summer 1998, these were operating at typically 30% capacity. Sadly this is not unusual, but it was almost certainly unnecessary. The main reason for it was probably the elevated floor void temperatures, increasing the dew point of the required 40% rh supply set-point.

CO_2 emissions and electricity consumption data

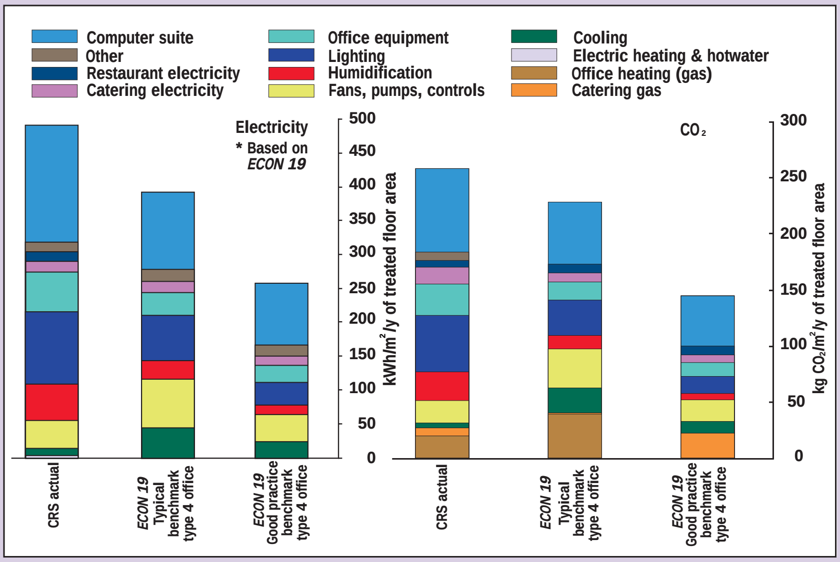


FIGURE 1: End-use energy breakdown at the Co-operative Retail Services headquarters building. The conversion factors are: gas – 0·2 kg CO_2/kWh and electricity – 0·52 kg CO_2/kWh.

In spite of the tendency for the offices to be on the warm side, there were also complaints of draughts, particularly from the floor diffusers: a problem which was probably aggravated by the increased occupation densities.

Initially, over 100 diffusers were moved while people were getting used to their new workstations. Since then, others have been relocated or covered-up. The situation is now reasonably stable unless furniture is moved.

The designers responded to a brief from the CRS, which required occupants to have control over their own area and local environment, including opening windows. However, in practice the management has discouraged their use, partly owing to conflict with the zone controls.

As usual where 500 mm square carpet tiles are applied over 600 mm square floor tiles, moving diffusers is complicated as each time up to four carpet tiles (at £36 each) have to be thrown away and replaced with new ones.

Office refrigeration system

A packaged twin-circuit, air-cooled chiller on the roof provides chilled water/glycol at 9·6°C flow, 14°C return. Ice storage is incorporated to provide capacity for peak cooling (during the night the chiller is reset to a flow temperature of -6°C), allowing the use of a smaller chiller, operating at higher load factors.

Constant-temperature chilled water serves the cooling coils in each main ahu and four plate heat exchangers for the chilled beam circuits at 14°C flow, 16°C return. The chiller is configured upstream of the ice store, ensuring that it can benefit from the greatest ΔT. It currently satisfies the baseload, with the ice store held in reserve for peak loads only.

When the building was nearing completion, the chiller and the chilled water batteries were upgraded to deal with the increased number of occupants. However, in spite of the problems with overheating, there seemed to be no shortage of chilling capacity.

A demand profile recorder installed on the chiller supply showed that it usually operated at between 25% and 50% of its capacity (in, admittedly, a cool summer): well within the rated 425 kW output of the ice store. Around 96% of chiller consumption occurred during the scheduled hours of 06.30 h-18.30 h, and it only came on at night in one thirty-minute period every other day – presumably to replenish the ice store's standing losses.

This suggests that it would be possible to reverse the priorities so that the ice store is charged at night and serves to provide the base load during the day – a change now being considered. It is estimated that this could save up to £5000 per annum, excluding any maximum demand charges which might also be avoided.

Unfortunately, to date the ice store has not been reliable, having sprung six leaks in its coils, the most recent this August. Although the CRS maintenance team can do the repairs, each leak is estimated to have cost £2000 in replacement glycol, and large amounts of staff time for drain-down, diagnosis, repair and system recommissioning.

The CRS facilities team and maintenance contractor suspect that leaks may have arisen because the plastic coils were kinked during installation, owing to limited clearances over the ice tanks.

Computer room air conditioning

Two ahus heat, cool, humidify and dehumidify the air to the computer suites. Their combined duty is 4·3 m^3/s at a specific fan power of 3·6 W/(litre/s). This equates to some 4 ac/h over the footprint of 1300 m^2, somewhat generous for a mostly unoccupied space.

As frequently happens today, the requirement for mainframe computers has reduced since the brief was written, and significant areas are now used for communications equipment, the electronics workshop, storage and the busy 24-h print room. Set-points are 20°C/50% rh in the computer rooms and 19°C/45% rh in the print room.

Of the computer room close control units inspected, 80% were running (20% on standby), 50% were dehumidifying and 20% were reheating, and their operating states seemed to be reasonably stable. As the internal latent gains in the spaces were small, it was likely that the dehumidifying duty was predominantly from the fresh air supply, suggesting that its dew point may not have been optimally set.

In addition, the dew points at the set-points above are 9·4°C and 7°C respectively, ie lower than that of the cooling coils at a chilled water flow temperature of 10°C. If so, the units appear to have been over-cooling in a forlorn attempt to dehumidify, only to then have to reheat using their 7 kW electric elements.

Energy and water consumption

The end-users find the bems comprehensive and easy to operate. Unfortunately, the trend-logging facilities had not been activated for any of the meters so no historic consumption profiles were available. These are now being set up by the bems supplier.

As a fully-air conditioned office, the most appropriate yardsticks to benchmark the total energy consumption of CRS are those in *ECON 19*[2] for a Type 4 office.

Energy consumption: gas

Between July 1997 and June 1998 actual total gas consumption was 2045 MWh or 118 kWh/m^2, comprising 1510 MWh (87 kWh/m^2) for office heating and toilet hws and 535 MWh (31 kWh/m^2) used by the catering kitchen for food preparation as well as heating of the restaurant block. Due to billing errors the cost of gas consumption is not available.

Normalised for standard weather conditions of 2462 degree days (the current estimate for the West Pennines is 1960), the non-catering gas consumption is found to be 138 kWh/m^2/y. The total normalised gas consumption is 146 kWh/m^2/y.

This is above the *ECON 19* good practice benchmark of 114 kWh/m^2, but lower than the typical consumption of 210 kWh/m^2 (figure 1), and about half as much as the two previous Type 4 offices studied under PROBE (which have full fresh air underfloor systems but no heat recovery). Overall, gas consumption levels at the CRS could be improved upon considering the high fabric insulation and internal gains, together with heat recovery.

Energy consumption: electricity

Total unit consumption in the 12 months from June 1997 to May 1998 was 7800 MWh, or 451 kWh/m^2/y at a cost of £345 000. This compares to an *ECON 19* good practice benchmark of 234 kWh/m^2/y, and a typical consumption level of 358 kWh/m^2/y. Reducing electricity consumption by 20% to typical benchmarks might save some £70 000/y.

The CRS hq is on a day/night tariff and billing data indicates that 5835 MWh (940 kW average) was consumed in the day period (07.00 h to 00.00 h) compared to 1965 MWh (770 kW average) during the seven night hours – a very high base load.

Billing data shows that maximum demand has increased from around 900 kVA in July 1996 to 1550 kVA in June 1998. An analysis of sample half-hourly consumption data by the PROBE Team confirms a minimum deep slumber load of 500 kW, which can be clearly identified during winter weekend days and nights. During weekday nights (winter and summer), the load is typically double this (at between 900-1000 kW), confirming that a good proportion of lighting or plant is still running in spite of being scheduled to be switched off.

Comparison of the profiles between normal and bank holiday weekdays suggests that the additional load due to occupancy is just 400 kW, giving a typical occupied demand of about 1400 kW (winter and summer).

Under current operation there is no clearly identifiable time for peak annual consumption. As so often happens, the hourly peak tends to be around lunchtime, when high catering and office loads coincide.

DESIGNERS' RESPONSE TO THE FEEDBACK STUDY

The PROBE study of the Co-operative Retail Services building has been most useful in detailing some of Hoare Lea & Partners views on the building's performance, *writes Alan Wood*.

Immediate improvements to the building's performance could be achieved by eradicating the build-up of heat caused by the electric lighting and office computers being left on outside working hours. However, it is clear that the building's current occupancy levels have exceeded the original design parameters. This will inevitably have an impact on the summertime comfort levels.

The chilled beam system was actually designed to deal with this eventuality, and a review of the potential need is currently under discussion with the client.

In parallel with this, the original design intent of introducing cool, night-time air to floor plenums in order to maximise the potential thermal inertia of the exposed slabs and soffits should be implemented.

The PROBE findings indicate that, at present, the building's energy inefficiency is primarily associated with electricity consumption, gas consumption being some 33% lower than a typical building. The *ECON 19* figures referred to also relate to a 1998 document not available during the design period in 1991-92.

It is therefore interesting to note the advances in energy targets, as the building performs notably better against original 1992 benchmarks.

An uplighter scheme will inevitably have a lower efficiency than direct lighting. However, this must be balanced against the pleasant visual ambience and low levels of glare that the lighting installation has achieved.

The major factors contributing to present inefficiencies are those which are common to summertime comfort (ie the lighting and computers being left on). Energy consumption will be reduced if these two items are attended to, which consulting engineer Hoare Lea & Partners estimates would result in a saving of around £40 000/y.

We are pleased to note that the occupant surveys rated the building 'good' for overall comfort and 'extremely' good for providing an odour-free environment. Both issues are commensurate with the key objectives of a chilled beam and displacement ventilation system.

Alan Wood MCIBSE is a partner at Hoare Lea & Partners Consulting Engineers (Manchester).

Half-hourly data from the electricity supplier provides a useful insight into the CRS building's diurnal behaviour. The information suggests that many systems must be operating under automatic time signals or overrides, quite independent of the main occupied period of the building.

End-use energy breakdown

Electricity consumption has been calculated using the normal PROBE reconciliation technique to arrive at the completed energy breakdown for the major end-uses.

The building has a large staff restaurant which has its own plant, including a dedicated ahu and perimeter chilled beams. Gas and water have separately billed supplies, and even electricity to the kitchen is sub-metered. The catering electricity figure comes in at 16 kWh/m^2/y. This is close to the 'good' and 'typical' benchmarks of 13 and 15 kWh/m^2/y respectively.

Fans, pumps and controls account for 44 kWh/m^2/y, with fans alone accounting for 30 kWh/m^2/y. The installed fan power of 117 kW of the main ahus, equivalent to 4 W/litre/s, is not the most efficient. Time control restricts the fans and the heating and cooling pumps to 12 h/weekday, or 3000 h/y. According to *ECON 19*, this is a tight schedule for a headquarters building. Despite the relatively high specific fan power, the fan energy consumption compares favourably with good practice benchmarks.

At 100 kWh/m^2/y, main office lighting is considerably higher than typical (60 kWh/m^2/y) and over three times that of good practice. This reflects the relatively inefficient installation (22 W/m^2) combined with the unmanageable controls which cause much of the lighting to stay on during the night.

At 54 kWh/m^2/y, the figure for office equipment is considerably higher than even the typical benchmark value (32 kWh/m^2/y), due mainly to the organisation's habit of leaving desktop equipment, copiers and printers on standby 24 h/day. PROBE Team measurements suggest that the typical desktop machine uses about 125 W in normal use, but only drops to 110 W in screen-save mode.

Around 700 pcs stay on overnight. In addition to the considerable cost (£12 000/y), this also helps to warm the building structure, contributing to the overheating problem. This is particularly evident on a Monday morning when there has been no ventilation at all over the weekend period.

The refrigeration system consumption of 13 kWh/m^2/y compares well with the benchmark values of 21-41 kWh/m^2/y. However, it seems that more cooling is required to achieve improved summer comfort, suggesting considerable under use. During PROBE Team visits, space temperatures were quite high, even though it was only 19°C outside and the cooling system was operating at only 25% of the available capacity.

The computer suite consumption (157 kWh/m^2/y) is made up from a load of 60 kWh/m^2/y for the actual equipment, including the losses from the interruptible power supply and 11 kWh/m^2/y for the lighting, which mostly seems to be on 24 h/day. The remaining 86 kWh/m^2/y (120% of the equipment load) is for the air conditioning.

For efficient computer suite air conditioning, the energy consumption would normally be expected to be 60-80% of the annual energy consumption by the computer equipment. In this case the high consumption is related to:

☐ the small load-factor on the system, causing proportionately higher consumption for air and water transport systems, which are sized for peak capacity;
☐ the high fresh air change rate of 4 ac/h;
☐ seemingly wasteful humidity control, whereby many of the air conditioning units were dehumidifying and then reheating.

The estimated humidification load for the offices of 48 kWh/m^2/y is considerably higher than typical for an office of this type, though not dissimilar to the other Type 4 offices studied under PROBE. The installed office humidification capacity is 360 kW (21 W/m^2).

As mentioned above, the main reason for this appeared to be the floor void temperatures of 20-23°C, as against 19°C design, hence increasing the dew point necessary to maintain the 40% rh setting. In addition, it appeared that the humidifiers were sometimes putting back moisture which had been removed at the cooling coil.

Water consumption

Calculated from monthly readings, water consumption at the CRS shows that the office supply consumed 10 000 m^3 and the kitchen supply 1750 m^3 during the year March 1997 to February 1998.

This equates to a water usage of nearly 13 m^3/person/y, more than the 10 m^3 benchmark for an efficient office, but half that of the 25 m^3 for an inefficient one[4].

The occupant survey

Building Use Studies (BUS) carried out an occupant survey to provide information on occupants' opinions about how well the building is performing. Questionnaires were completed by 127 office staff – a 98% response rate and a 14% sample of all staff.

Background information shows that occupants' working practices are very typical for

Results from the occupant satisfaction survey

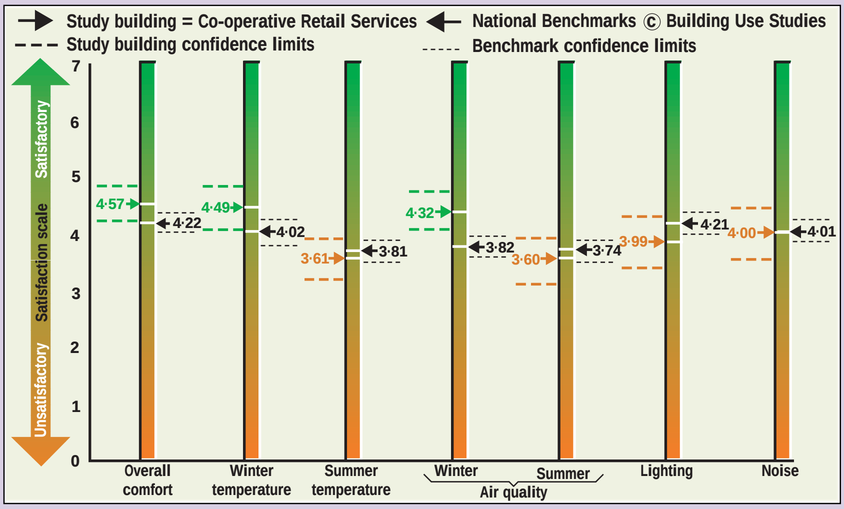


FIGURE 2: Overall satisfaction with comfort conditions at the Co-operative Retail Services headquarters.

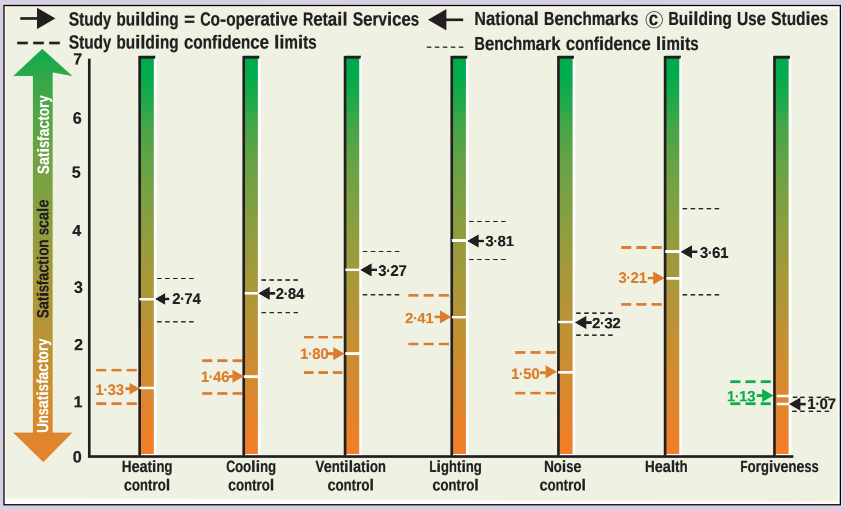


FIGURE 3: Occupant satisfaction with the building's health, management and control strategies.

buildings within the BUS data set: most people spend just over 8 h / day for five days per week in the building, with 7 h at their desk, 5·5 h of which are at a pc. Eleven percent of staff spend less than five days a week in the building, twice as many as the norm of 5%, suggesting more part-time staff than typical.

The occupants are relatively young (50% under 30-years old) and more are women (67% compared with the 50% norm). A quarter of staff had worked in the building for less than a year, and 58% had been at their present workstation for less than a year – a slightly higher churn rate than the norm. One third of staff have a window seat, considerably lower than the norm of 61%.

On overall performance, the CRS performs slightly better than average in the BUS dataset. As figure 2 shows, the most notable findings are good ratings for overall comfort (despite lower results for summertime conditions), high scores for design and needs (top 10% of BUS dataset), a surprisingly low score for health and a high forgiveness or tolerance of faults by occupants.

The CRS hq achieves better comfort in winter than summer for both temperature and air quality. Interestingly, CRS achieves an extremely high score for providing odour-free ventilation, but is also perceived to be stuffier than the benchmark. This is slightly surprising given the 100% fresh air ventilation which provides twice the typical good practice fresh air rate of 15 litres / s / person. Eighty percent of staff reported discomfort of some sort, slightly higher than the benchmark.

Satisfaction with the lighting is typical, with people wanting less artificial light and more daylighting. Glare from sun and sky is much lower than typical, reflecting the lower proportion of window seats, the low solar transmission, the use of solar control blinds in the window glazing and the translucent insulation in the atrium glazing. The only daylight glare was via the motorised rooflights when they were open for additional ventilation.

The perceived low level of control over all environmental parameters is not surprising for a large, fully-air conditioned building such as this (figure 3). In similar PROBE buildings, the effect has been successfully countered by higher scores for quickness of response to complaints. At CRS, the responsiveness scores are quite low, a reflection of the limited options open to the facilities staff to adjust conditions locally. Several staff comments referred to dissatisfaction with the lighting controls, and a general wish to have more local control.

The occupant survey presents reasonably good results for the building, but there should be considerable scope for improvement, particularly in terms of summertime comfort. CRS scores very highly for its design, making people very satisfied and putting the building in the top 10%. Several survey respondents gave it unsolicited praise, which is quite rare.

On the downside, summertime comfort is poor. There is also concern about draughtiness from the windows and fabric, as well as floor ventilation grilles, and there is a surprising concern about building-related health.

The very high attention to aesthetic detailing and decoration in the communal spaces appears to contribute to the occupants' enjoyment of the building, and their relatively high forgiveness of specific discomforts.

Overall building performance

The occupants like the CRS building, and feel that it meets their needs well. However, in general their satisfaction with the internal environment is only slightly above average. Nevertheless, they are forgiving of its perceived shortcomings, which include a lack of responsiveness to local demands.

Much of this is somewhat inevitable in a shared open-plan space, but this perception seems to have been increased further by the limited potential for adjustment of the self-balancing displacement ventilation system, the metal halide lamps (complete with their ex-

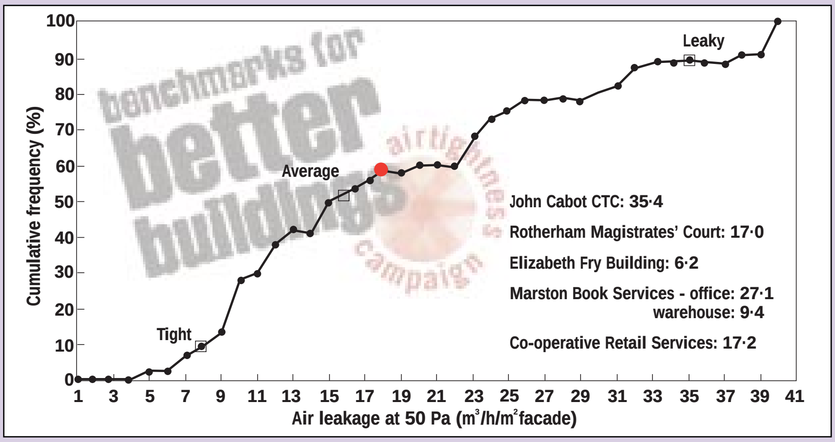


FIGURE 4: The air leakage data for the CRS headquarters building, plotted on the BRE/BSRIA database.

BRE pressure test

Brian Webb of the BRE's Building Performance Assessment Centre conducted a pressure test at the CRS headquarters building on Sunday 20 September.

The test was carried out using the large BREFAN testing rig and two medium BREFANs. The building was put under negative pressure in order to identify leakage paths in the envelope.

Several points of leakage were observed, such as the hinged doors in the main entrance, which leaked slightly along their bottom edges. Both rotating doors also leaked slightly around their frames.The brush strip was very leaky. Some leakage was also observed around the frame of the large centre window.

A side office was checked for specific sources of air leakage. A window was found to be leaky at the bottom and on the hinged side, and very leaky at the top, which suggests the window had dropped slightly. The outer frame was also leaky.

Air was observed entering the room through the suspended ceiling, and the electrical floor sockets also betrayed signs of air infiltration. On the ground floor, leakage was observed around window frames, although the windows themselves were quite good in this respect.

Air was seen to leak through the outer frame, especially along the top of the wood frame where it joins the wall. The building was found to leak badly along the bottom of some window frames in the stairwell. Air also leaked through the bottom of doors, which lacked draught-proofing. On some openable windows, mastic was found along the bottom of the openable element, but not along the other three sides.

Overall, the Q-value (Q50 / S) for the offices and main entrance was 17·2 $m^3/h/m^2$, based on an envelope area of 9046 m^2 (excluding the restaurant area which was screened off). This places the CRS hq building's infiltration rate at over three times the best practice value of 5 $m^3/h/m^2$, and close to the leaky category of 20 $m^3/h/m^2$.

The building's airtightness performance is about typical of the buildings on the BRE / BSRIA database, which itself indicates the extent of the problem of uncontrolled infiltration in recent UK buildings.

It is thought that damage caused by a fire during construction – plus inadequate sealing of one section of envelope – has contributed to air leakage. Heating and draught problems have been confirmed by infrared thermography. The contractors have been called back to carry out remedial work.

Brian Webb is a senior scientist with the Building Performance Assessment Centre at the Building Research Establishment. This pressure test was funded by the DETR as part of the BRE/BSRIA/*Building Services Journal* initiative on improving building airtightness.

tended run-up and restrike times) and the somewhat capricious automatic controls.

Electrical consumption for normal office building services is very similar to the *ECON 19* typical benchmark, with high lighting and humidifier consumption offsetting relatively economical energy use elsewhere.

To obtain better internal comfort levels the cooling and fans would need to run more, but savings should be possible by paying closer attention to both humidity and lighting control. Gas consumption levels are reasonable, though a little on the high side for such a well-insulated office with relatively high internal gains. There should be some room for improvement with operational fine-tuning.

Electrical consumption for office equipment and the computer rooms is very high, appearing to contain significant avoidable waste. In particular, the facilities management staff should be able to meet their objective of significantly reducing the amount of office equipment left on overnight.

It may also be possible to improve the efficiency of the computer suite air conditioning, starting with humidity control and reviewing the need for 4 ac/h full fresh air.

Overall, the CRS hq building provides an attractive and stimulating working environment, which is liked by its occupants. However, it does suffer many of the problems experienced in similar prestige air conditioned buildings, namely:

- ☐ difficulties with controls, particularly lighting controls;
- ☐ high energy consumption, partly owing to cultures of service-before-economy and a widespread lack of time/interest in energy management;
- ☐ high installed loads for lighting, fans and humidification;
- ☐ extended hours of pumping, with heating operating in summer and particularly with relatively large chilled water systems serving relatively small 24-h cooling loads;
- ☐ problems with understanding, reliability and management of the more advanced technologies such as ice storage.

The new facilities manager is keen to improve both occupant satisfaction and energy performance, and the PROBE study suggests that fine-tuning of operations and controls could prove to be highly rewarding.

The PROBE Team for the Co-operative Retail Services hq investigation comprised Mark Standeven, Robert Cohen, Bill Bordass and Adrian Leaman. Thanks are extended to the Co-operative Retail Services facilities manager Cedric Jefferies and maintenance supervisor Phil Kelly.

References

[1]Bunn R, 'It's all at the Co-op', *Building Services Journal*, 8/96.

[2]Bordass W and Leaman A, 'PROBE 1: Tanfield House', *Building Services Journal*, 9/95.

[3]*Energy Consumption Guide 19: Energy use in offices*, DETR, 2/98.

[4]BRECSU, *BRECSU General Information Report No 15*, 3/94, p51.

Further reading

Evans B, 'Summer cooling: using thermal capacity', *Architects' Journal*, 12 August 1992, pp38-41.

Key design lessons

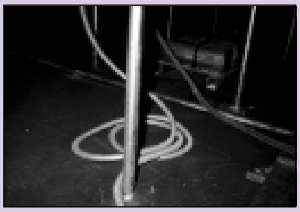
Strategic services design The performance of the displacement ventilation system has been compromised by heat gains in the floor void, gains directly from the lamp ballasts and heat gains indirectly from equipment and lighting left on overnight. It also appears that some of the cooling effect of the chilled beams at the perimeters of the atriums may be being lost into the rising plume of exhaust air.

The general office area. Some perimeter chilled beams are located in the atrium extract path.

Occupant control of local conditions is limited. However, unlike other comparable PROBE buildings (eg Tanfield House and Aldermanbury Square), the self-balancing nature of the concept means that maintenance staff are limited in their response to a complaint about conditions. They feel that they have reached an acceptable compromise, but apart from relocating a floor diffuser, there is little they can do to respond to an individual's perception of poor local conditions.

Condensors installed to serve the computer room chillers are located very close to the inlets serving the office chiller.

Ice storage has proved troublesome both technically and managerially, while opportunities for removing stored heat from the building fabric overnight by simple means have not been taken up. It is difficult to make ice storage systems pay in the UK, where we do not pay punitive electricity charges on summer days as they do in North America.



Lighting ballasts in the floor plenum are believed to be responsible for a 1°C hike in supply air temperature.

The building energy management system is liked by the facilities staff, but the use of trend logs for monitoring environmental conditions (along with utility consumption of the submeters) had not been enabled. The facilities staff first asked the suppliers to configure these for the PROBE survey. Clients, designers and bems specialists alike should not take it for granted that end-users will be completely familiar with new plant, controls and software applications – and how to get the most from them. It is essential that more time is spent both on improving usability, and on clients, consultants and specialists working together in order to achieve a good result.

One of the rogue humidifiers which often runs in summer to replenish the moisture that is removed at the cooling coil.

Glare control The translucent insulation worked really well in controlling glare in the atria, unlike many mechanical shading devices. The mid-pane blinds in the windows (tilt-adjustable only) are also good in this respect, as is the uplighting. Occupant satisfaction with lighting overall was average, with a preference for more daylight.

Evidence of the high rate (in reality up to 40 every month) at which the metal halide lamps need to be replaced. Each lamp costs £25.