RELOCATION, RELOCATION

BUILDING SERVICES JOURNAL, JUNE 2004

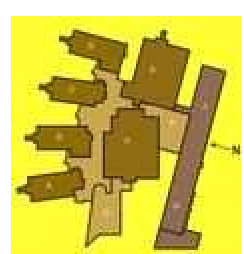
Few organisations have such conflicting needs as the Met Office: totally resilient, highly secure IT intensive facilities and green aspirations. We visit its new headquarters to find out how they combined the two.

By Stephen Kennett

With both the military and over half of the world's civilian airlines relying on its data the Meteorological Office can't afford to be out of action, ever. Yet at the end of last year it moved it's entire operation, lock, stock and barrel, over 200 miles in the largest IT facilities relocation ever seen in Europe. Two Cray supercomputers along with all the IT kit needed by a world-leading weather service provider and over 1000 staff made the journey.

The lake in the foreground is used as part of the surface water attenuation scheme and also supplies the building's grey water system.

The ‘ship's prow' gives the main entrance a distinct identity.



For the Met Office the move was inevitable. Its old Bracknell headquarters building was over 40 years old, costly to maintain and ill-equipped to house the required IT infrastructure. And so in late 2000, following a 12-month search, Exeter was announced as the preferred site for a new hq. Despite the distance from its previous home it offered clear benefits: a green field site, good transport links and was judged to have the sort of qualities that would attract and retain staff - something that was becoming increasingly difficult in the south-east.

The procurement and build programme of the new building were inexorably linked to a successful relocation. Construction was carried out under a public private partnership with several consortia bidding for the design and build of the facility plus a 15-year contract to operate it - however unlike pfi the site purchase and construction costs would be met by the client. The Stratus consortium comprising of Costain/Skanska and Group 4 Falck Global Solutions was chosen as the preffered bidder in mid 2001. By this time Zisman Bowyer and Partners (ZBP) was onboard to carry out the services design with Haden Young joining the Costain/Skanska joint venture as design and build subcontractor for the m&e. However, at the end of the preffered bidder stage the set-up changed with ZBP stepping out of the Costain/Skanska camp and effectively becoming novated to Haden Young, who had full design responsibility on the services side. Meanwhile Arups who carried out the structural design and architects Broadway Malyan remained with the joint venture. up

Site layout
A-D: General office accommodation
E & F: Computer halls/general office accommodation
G: Restaurant, sports hall and conference centre
H & J: Energy centre and plant rooms
K: Computer workshops

The central 'street' acts as the main circulation route.

Design brief

The conflicting needs of the Met Office led to a major reworking of the initial design brief. On the one hand it needed highly resilient facilities for its intensive IT operations while on the other was the desire to meet certain environmental aspirations - it is a key advisor to the government on global

The central 'street' acts as the main

warming issues.

circulation route.

The scheme that developed can be split into two distinct areas (see figure 1). To the north are the high security business critical areas, including two large computer halls housing the Cray and NEC supercomputers, the National Meteorological Centre (NMC) - another IT intensive area where the forecasts are prepared, computer workshops and the energy centre, including two separate chilled water plant rooms. To the south are four blocks of general office accommodation, a sports hall, staff restaurant and conference centre. Separating these two areas is a central 'street' that acts as a common circulation space as well as providing informal break out areas.

The 1·5 MW chp system, which supplies the absorption chiller and base electrical load. Provision has been made for a second unit at some point in the future.

The original brief from the Met Office asked for a naturally ventilated scheme, but concerns arose following the invitation to negotiate about precisely what internal environmental conditions could be achieved. "I think those discussions set them thinking a bit more about what they wanted to achieve from the building and what a natural ventilation solution might offer them," says John Stroud, associate with ZBP. "The internal gains and the internal conditions they wanted didn't really sit with a nat vent strategy."

One of the plant corridors flanking the supercomputer halls. In the background is the skid-mounted heat exchanger serving chilled water to the Cray T3Es.

It was for these reasons that the design team pushed for a mixed mode solution incorporating the Swedish hollowcore Termodeck system, and which consequently influenced the design of the building envelope. For the main blocks the precast hollowcore concrete floor planks are supported on a steel building frame, with external double-skin blockwork walls finished in white render. Compromises were made architecturally to reduce the amount of glazing, with very little use of full height windows to avoid unduly affecting the internal loads and the need for perimeter heating. Coupled sash triple glazed windows have been used in all areas bar the internal street and were specified primarily for their acoustic and thermal (providing a U-value of 1·4 W/m2K) performance. Manufactured by Scandinavian firm Modul, the windows comprise of a sealed double glazed inner sash and a single glazed outer sash that can be uncoupled. The 75 mm ventilated air gap between the two allows an integral blind system to be accommodated for solar control. A lot of attention was also paid at the design and construction stages to achieve good levels of airtightness, as this was essential to the success of the scheme. This was helped by having Termodeck onboard appointed to the main contractor. "Termodeck are very involved because they have to warrantee the solution and so are interested in the structure and the facade," explains Bryan Wyld, regional design manager with Haden Young. "It was pretty clear to the main contractor through Termodeck what had to be achieved." Pressure tests carried out by BRE on each of the blocks returned figures of between 2·5 m3/h/m2 @ 50 Pa and 4 m3/h/m2 @50 Pa, well in excess of Building Regs at the time. Similarly U-values for the envelope were above the norm, with figures of 0·18 W/m2K for the walls and 0·15 W/m2K and 0·16 W/m2K for the floors and roof respectively.

Cooling towers serving the four water-cooled chillers.

One of the central service bulkheads running through the office floor plates. The wing section partially conceals both the return and supply air ducts and the connections into the Termodeck planks.

up

Termodeck offices

Internal loads for the office areas are in the region of 47-48 W/m2, with occupant densities of between one person/6 m2 up to one person/10 m2, including a number of areas with 24/7 operation. It was felt that the design loads being considered were pushing at the limits of existing Termodeck installations and both Termodeck and the design team carried out extensive modelling. Various winter and summer conditions were considered with different internal loadings and supply air temperatures. This was based on a five-day weather pattern supplied by the Met Office, which says Stroud "vastly exceeded normal design criteria, and certainly tested the Termodeck system".

The 100% fresh air system provides air at 2·5 litres/s/m2, rising to 4 litres/s/m2 in the areas with 24 h occupation to offset the lack of a night-time purge.The initial design was to terminate the pipework coming off the site's chilled water ring main in the risers of each of the office blocks. However, partly to accommodate the Met Office's aspirations for future flexibility and also to limit the risk of not meeting the strict performance criteria it was decided to extend this to the ahus serving the offices. In reality this cooling should be off for most of the year by virtue of the dynamic control that monitors the room, return air and plank temperatures.

The system installed is geared towards individual floor control with separate heating and cooling coils in the rooftop ahus serving ground, first and second floors. This provides a degree of flexibility should there be different departments or varying hours of occupation on the individual floors.

In a typical office floor plate the central supply ductwork serves from both ends of the building primarily to keep ductwork sizes down and also to provide a degree of self-balancing. A four core pass (the fifth core is used to house the fire alarm cable) has been adopted through the 1200 mm wide, 9 m long planks with air exiting into a header duct and dropping down either side of the structural columns to supply the floor void displacement system.

In addition to the open plan spaces there are also a number of cellular offices on each of the floors. To serve these the ductwork is extended to the void (segregated by a floor barrier) beneath the office and throttled down to meet the volume requirements. In these spaces the Met Office was looking for separate control, which is achieved by the installation of switch flow dampers in the supply air ducts. A temperature sensor in the room monitors conditions and at a predetermined point the switch flow damper opens allowing the supply air to bypass the planks and come in at the ahu delivery temperature for a short burst to drop the room temperature. Unlike the rest of the offices where the concrete soffits are exposed these spaces have open grid ceilings - to maintain the radiant benefits - with return air feeding back into the general office space via cross talk attenuators.

The extract air ducts run adjacent to the central supply ducts. "The other product of this central duct distribution system was that we agreed with the Met Office that it would put all other heat producing equipment, printers, photocopiers etc, under this bulkhead with extract directly above so any heat produced won't be seen by the planks directly," says Stroud.

When it came to the installation the intention was to fit volume control dampers on each of the connections to the planks for commissioning. However, Haden Young was able to demonstrate with the first installation that the configuration was effectively self balancing, and with Termodeck's approval omitted the dampers on the rest of the floors. "Once one floor was done it was a relatively simple process of repeating it," says Wyld. "We prefabbed the ductwork, electrical containment and bracketing and worked out a sequence of how we could get it installed quickly. The only second fix was coming along and putting the lighting and fire alarms in, so it was an easy building solution."

A standard lighting scheme is adopted throughout the general office areas which uses a suspended Philips direct/indirect linear fluorescent fitting. These run out at right angles to the central bulkhead, providing 300 lux of background lighting which is supplemented by task lighting at the desks. The fully dimmable T5 high frequency units are linked to a Philips ECS lighting control system with daylight sensors and pir detectors built into the aluminium extrusion. Emergency lighting is provided by self contained battery conversion units which are automatically tested by the ECS. up

Business critical areas

Resilience was the crucial driver governing the design of the services supplying the business critical and high security areas. The IT halls, which house the Cray and NEC supercomputers, are the nerve centre of the entire Met Office, feeding data to the National Meteorological Centre (NMC) which sits on the first floor above computer hall F.

The design process was slightly hampered as the manufacturer of the new supercomputer wasn't known at the early design stages, leading to a generic solution being developed that was capable of meeting a range of manufacturers' criteria and future needs - a decision was finally made in March 2002. For Haden Young getting the design and fit out of these areas underway was a pressing matter. A series of milestones had been set at the beginning of the project, one of which was to allow the Met Office access to hall E in December 2002 when the rest of the site was still 12 months off completion. This was to facilitate fitting out of the space in order to receive one of the two Cray T3Es prior to the main move - a particularly vulnerable time for Bracknell who would be relying on only one machine to run its services. The knock-on effect of this was early commissioning of the water cooling plant with resilient comfort cooling and power needed in time for the transfer. Once installed the machine was connected via a hyper link back to Bracknell.

The statistics behind the two halls give some idea of the scale of the challenge for the design team. Each hall has a peak cooling load of 1·75 MW, equating to around 1·8 kW/m2. This is met by a total of 40 floor standing room air conditioning units located in plant corridors flanking each hall along their north and south edges. The halls are sunk below the level of the 'street' allowing room for the 1200 mm floor void needed to get the volume of air (more than 6 m3/s for each unit) into the space along with the mass of power and communication cables. From the floor void air enters the space via swirl diffusers with extract through a high level opening adjacent to the corridors.

While the NEC supercomputer relies on an all air cooling load the existing Cray T3Es in hall F use a water cooled set-up - around 300 kW for each. These are served by two skid mounted plate heat exchangers, connected to the same pipework serving the room units.

The rate of temperature rise is the crucial factor governing conditions within the halls. Initially the Met Office required a tight band of control for the spaces, however the design team managed to get this switched to tight control of the supply air temperature - a constant 21°C. In addition to the room air conditioners a pair of fresh air units are used to pressurise the halls, providing in the region of 1-2 ac/h, and helping negate any infiltration or vapour gains through the fabric. Humidity control is primarily on this fresh air system, with humidity sensors fitted in the floor voids to adjust the moisture content of the supply air as required, although in practice these levels should be relatively constant. up

Cooling loads need to be maintained even in the event of a catastrophic failure including complete hydraulic loss or a break in power. For cooling this is neatly achieved by installing split coils in each of the room air conditioning units, served from independent chilled water circuits. These follow diverse routes from separate chilled water plant rooms. During normal operation the twin circuits operate at 50% load and in the event of a problem either circuit will automatically ramp up to take on the full duty.

The cooling sources can also be mixed and matched to overcome potential problems. The lead chiller on circuit A is a 1200 kW absorption unit running off the gas chp installation - installed primarily for energy saving reasons rather than resilience. Also serving this circuit are two 1200 kW water cooled units and an 1100 kW air-cooled chiller, which provides resilience should the cooling towers be lost as well as giving advantages at low load operation. Circuit B follows a similar set up with the exception of not having the absorption chiller. Establishing what the base load would be made sizing the chp and absorption chiller difficult. "We had to compromise by installing one 1·5 MW chp and absorption chiller and space for another when the load increases. The base load theoretically should be 3·6 MW cooling and 3·2 MVA electrical but that's with the resilience level one areas being fully loaded. We'll wait and see what develops," says Stroud.

In terms of the electrical distribution a split main hv board takes the single incoming supply which feeds a closed ring main. Separate substations serve the computer hall blocks as well as the energy centre and chilled water plant rooms with the offices served in pairs. Duplicate transformers are installed at each substation, with a two panel switchboard linked together to enable recovery from one transformer. A centralised generation system provides 8 MVA of back-up to the ring main via two generators. The rate of rise within the halls cannot exceed 1°C/s and this means the full cooling load must be provided even between an electrical failure and the time it takes the generators to kick in. A total of 24 ups modules ranging between 40 kVA and 400 kVA support the supercomputers and associated room air conditioning units, hub rooms, NMC and a proportion of underfloor power. As well as this they also supply the critical distribution circuits, allowing chilled water from the buffer vessels to continue being pumped around the circuit.

Balancing needs

Neither the Met Office nor the design team defined any specific energy targets for the building. This is primarily put down to the fact that they needed to balance energy efficiency with fitness for purpose.

Working towards a prescribed target was always going to be difficult, particularly as the massive overcapacity would potentially make low load operation inefficient and the contractual obligations would have meant some pretty tough talking at the design stage. "There was a balance between their operational requirements, the external conditions that they wished us to design to, which were in excess of normal recognised levels, and energy efficiency," explains Wyld. "So their aspirations in terms of energy efficiency were met but not in a defined prescriptive way." What the client and design team did aim for and achieve was an Excellent BREEAM rating based on the 2001 criteria, this was despite having the chp installation that ultimately docked it some points.

There is no denying that for the m&e services, the programme was tough. During that preferred bidder period the design and inparticular the m&e services were gone through with a fine tooth comb by the client's advisors at a series of sanction review meetings. "It was then that the reality of some of the resilience issues came to light," adds Wyld. "Up until then a lot of the debate had just been about the environmental issues."

With the Termodeck solution firmly established at the project's financial close - which slipped to late November - the focus shifted to the detail design, which had to be completed by March 02 in order to start procuring plant. Crucial to achieving this, and the series of milestones, was the partnering set-up says Wyld. "It would have been very difficult for the joint venture to get the commercial certainty it needed if we had been an installer only sub contractor and ZBP had just produced the design". This full integration of the design, construction and services teams ensured that the Met Office master move plan was successfully delivered. All without a second of downtime to its service.

MET OFFICE HEADQUARTERS AND OPERATIONS CENTRE, FITZROY ROAD, EXETER

ENGINEERING DATA

Gross floor area (gfa): 33 521 m2
Net usable area: 24 000 m2
Plant rooms: 4135 m2
Offices: 12 657 m2
Computer halls 1736 m2
Parking provisions cars 780; motorcycles 52; bicycles: 156
BREEAM: Yes, Excellent
Fabric leakage 3-5 m3/h/m2 of envelope @ 50 pa

EXTERNAL DESIGN CONDITIONS

Winter -3°C/-3°C general; -6°/-6° supercomputer halls and for ahu sizing/selection
-11°C winter one in 15 years condition; -13°C one in 50 years condition
Summer (a/c): 27°/19° general; 30°C/22°C super computer areas; 31·8°Cdb/23·6°Cwb summer one in 15 years condition; 34·2°Cdb/24·8°Cwb summer one in 50 years condition

INTERNAL DESIGN CONDITIONS

Winter: 21 °C min +/-2 °C min; 50% rh +/- 10%

computer halls
Summer (non a/c): 27 °C drt
Summer (a/c): 27°C drt; <70% TermoDeck office areas; 21 °C +/-2 °C; 50% rh +/- 10% computer halls
Circulation & toilets 16-26°C street; 19°C min toilets up

U-VALUES

Walls 0·18 W/m2K; floor 0·15 W/m2K; roof 0·16 W/m2K; glazing 1·4 W/m2K triple glazed/internal blinds/vent external void; 1·4 W/m2K double glazed east/west street entrances

STRUCTURAL DETAILS

Slab thickness 260 mm
Clear floor void 380 mm generally
Floor to ceiling 3300 mm generally
Live load 4·0 kN/m2 offices; 7·5 kN/m2 roof plant rooms
Dead load 2·5-3·0 kN/m2 main roofs; 5·25 kN/m2 core; 1·0

OCCUPANCY

Offices 8-10 person/m2; meeting rooms 2-5 person/m2

Noise levels

Offices NR38; meeting rooms NR35; toilet & circulation NR40; external breakout limits NR56 day, NR38 night

OCCUPANCY

0700-1900 with 100% during 1000-1800 Loads
Calculated cooling load 4·6 MW

(IT/resilience 1 loads: 3·6 MW) Installed cooling load
4 x 1·2 MW water cooled, 2 x 1·2 MW air cooled, 1x 1·1 MW absorption
Fan power 1 W/l/s
Equipment 25 W/m2 general open plan
Lighting 11 W/m2 generally
Occupancy 10 W/m2 general open plan

VENTILATION

Scheduled supply air temp 21°C to Termodeck planks generally, 15°C to first floor Termodeck planks to allow higher load density if required
Room temp 27°C max, 19°C min (summer & winter)
Fresh air 8 litres/s/per person
Filtration EU category Supply, bag EU6; panel EU4. Extract, panel EU4

PRIMARY AIR VOLUMES

AHUS at 1·7 m3/s, 2·5 m3/s, 3·0 m3/s, 5·4 m3/s (total: 12·6 m3/s) for meeting/conference rooms
AHUS at 1·0 m3/s, 1·0 m3/s, 1·0 m3/s, 0·41 m3/s, 0·63 m3/s (total: 4·1 m3/s) for toilets Offices (Termodeck areas) 6·6 m3/s , 7·1 m3/s , 6·9 m3/s , 7·6 m3/s , 6·6 m3/s , 2·7 m3/s, 6·3 m3/s (Total: 43·8 m3/s)

Catering 3·1 m3/s Dining room 5·3 m3/s
Supercomputer halls 2m3/s fresh air, no extract

DISTRIBUTION CIRCUITS

HTHW 90°C; MPHW 70°C; LTHW 80°C flow/60°C return
DHWS 60° storage; Chilled water 8°C flow/14°C return

REFRIGERANT

Chillers R134A plus lithium bromide; NER/UPS rooms R134A

ELECTRICAL SUPPLY

Transformers 4 x 2 x 2 MVA

UPS system 1 x 0·4 MVA; 2x 0·12 MVA(n+1); 2 x 6x 0·4 MVA(n+1)

LIGHTING

Types indirect/direct T5 high frequency

Lux levels Office 300 plus task lighting; conference 300; kitchen 300/500; computer 500; toilets 150; stairs 100; circulation areas 200 (street) plus localised lighting

Glare index 19

Lifts 6 x 10 person; 2 x 17 person; 1 x 13 person all at 1 m/s

COSTS

Total cost approximately £80 million

Building services total approximately £30 million

CREDITS

Client

The Met Office

Construction Manager

Costain/Skanska JV

Architect

Broadway Malyan

M&E design, construction and commissioning

Haden Young

Environmental engineer

ZBP

Mechanical engineer

ZBP

Electrical Engineer

ZBP

Structural Engineer

Arup

DO YOU NEED MORE INFORMATION ABOUT THE TERMODECK® SYSTEM?

CONTACT US