Engineering Practice Report

For CEng Status

25/01/2010

Engineering Practice Report

In support of my application for Chartered Engineering status, please find in my following career précis a selection of projects that meet the requirements of the UK Standards for Professional Engineering Competence.

(See list of competences within the addendum at the end of this report).

Project No.1: Brindley Place – Birmingham

My senior engineering role at Hoare Lea enabled me to take a lead role in the detailed design of a commercial development which utilised a four pipe fan coil unit approach for heating and cooling of the building. **(C3)**

Due to client requirements for maximum flexibility I designed a floor void supply air system throughout with pipe fan coils offering recirculation air only so as to provide multi-tenancy flexibility thereafter. One notable theoretical advantage of this type of system I found to have a practical disadvantage when the building was used and occupied. The floor mounted swirl diffusers offer very good flexibility in terms of being able to site the diffusers according to need but the practical application is somewhat different. When tenancy changes occurred, the demarcation of partitions to accommodate cellular offices also changed but didn't always match the position of the floor diffusers. I often found, through monitoring these changes that the new building users didn't always move the swirl diffusers and on many occasions found swirl diffusers located under partition lines, under filing cabinets that had been repositioned and some new offices had no source of supply air at all. On other occasions the swirls were located next to office workers and rather than move the diffuser, the user had just taped up part of or indeed the whole of the diffuser to divert or block air off completely. **(B3)**

When I left Hoare Lea, I was commissioned privately as an adviser to Argent for Brindley Place and was able to monitor tenancy changes and advise on such operational requirements. The lesson I learned here, is that no matter what design approach you have, maintaining that philosophy thereafter is equally important. During my time working for Argent I had on ongoing role as a mechanical auditor where I monitored the effectiveness of mechanical systems, provided trouble-shooting advice within 4No. buildings at Brindley Place carried out PPM management and acted as my client's representative when confronted by tenants, unhappy with their internal environment. **(B1, C4, D3)**

An interesting innovation on this project that I trialled, was the V.E. implementation of utilising ABS plastic pipework in lieu of mild steel for the chilled water pipework distribution system. The cost saving was considerable for the project, in terms of capital cost and installation programme, although there was an initial difficulty in obtaining a 25 year warranty (at the time) for the product from the manufacturer. One problem I found over the first year of operation was 'sagging' of the ABS pipework, even though I specified pipe supports in line with the manufacturer's recommendations. The result was that additional supports were added during the defects liability period, which then prevented the secondary problem of leakage from connections to fittings. **(A1, B2)**

The design process for this project was quite intense due to the number of interested parties, including a Dutch design architect with occasional ideas strange to a large British design team.

Each design team meeting therefore required strong discussion but fair compromise so that all elements were satisfactorily concluded to the benefit of the Client. **(D1, D2)**

During the design, I considered various manufacturers for the 4no. roof mounted chillers that I had designed into the system, 2No. serving the West and 2No. serving the east zones of the building. The client favoured McQuay, having used this company on previous projects, although due to reputation, I favoured alternative manufacturers. At the client's request, I attended two days of witness testing in Rome, Italy, and found the testing regime interesting and thorough. However, the chillers suffered from several compressor failures during their first two years of operation, with no indication of any system problems. The client eventually changed to Carrier chillers on the West zone of the building with no undue problems reported thereafter. **(B2)**

This was the first project where I used the BSRIA service for air tightness testing of the building, although for this project, I agreed with BSRIA to only test one quadrant of one floor due to programme and cost constraints. On a later project for Lloyds TSB at 125 Colmore Row in Birmingham (not mentioned in full in this report), I had the opportunity of testing a complete building with BSRIA, using their 'Fan Rover' rig. Pressurising the building to 50Pa was difficult, due to leakage, and a smoke test demonstrated the leakage patterns from the building, i.e. under floor voids, tracking up cladding between floors and dissipating at roof level with a considerable leakage from the atrium roof. **(B2)**

Project No. 2: Royal Jones and Agnus Hunt Hospital – Oswestry

As Principal Mechanical Engineer at Waterman Group, I was tasked with undertaking the design of a technically demanding project for a new research laboratory, at the RJAH.

Meetings for this project were always personally chaired by the Director of Estates, due to the importance of the project, and there was considerable pressure for my design team to ensure that attention to detail was foremost in our mind, and that programme design targets were always met. This was due to the added significance of the facility being opened by HM the Queen, at a designated and immovable date. I therefore planned the design carefully with respect to the construction programme, ensuring that target dates for services design along with client approvals was aligned with the resource available. **(C1, C2, C3, D1, D2)**

Due to the variety of services, general and specialist ventilation systems, CAT 5 domestic water services, heating and fume extract systems, I had to research several technical documents from HTM's, British Standards, CIBSE and BSRIA guidelines and ACOP's to ensure that what I proposed, was accurate and current. **(B2, E1, E4)**

One of the most difficult aspects I found with this design was the coordination of services. The building was only two storeys high with ceiling voids but no floor voids. Due to the building being a research facility, every room was loaded with equipment and so there was little scope for locating HVAC equipment anywhere. I planned the design carefully, and discussed issues with users and the professional team at every opportunity, to ensure that the specialist areas were served according to usage and not just what was shown on a room data sheet. I attempted to limit any crossovers between services, especially at the pinch points and the exits from risers, and decided at an early stage that all pipework services would run in the ceiling void at Level 1, so that all isolating valves and regulating valves were within one void for access. All pipework services would either rise to above through the floor slab for points of connection or drop to all points of use below to lessen the effect of services distribution. **(A2, D1, D2, D3)**

I had to allow for the provision of domestic services to eyewash stations, drench showers and standard outlet points, ventilation throughout and fume extract from fume cupboards, which used (at the time) the standard approach for face and bypass extract to maintain a constant extract volume and efflux velocity whilst maintaining a constant face velocity over a variable sash height, to ensure containment of fumes within the fume cupboard.

I designed the services carefully so that a coordinated, maintainable, commissionable and accessible installation was achieved. **(E2)**

I took my wife and children three years later to see the project but alas, they were not as excited as I was to see the building again.

Project No. 3: Freelance Consultancy

I have undertaken several freelance projects as a Consultant Engineer, where I have sourced the design project through industry contacts, prepared fee proposals for the design, developed Client briefs through to final design. I have carried my own PI insurance for these projects. **(B1, C1, C2, D1)**

Examples are as follows:

Wickes Stores

I have carried out the full design of mechanical services for several stores, including HVAC, DWS, above ground drainage, including Fluid Cat 4 supplies to external wash down areas. This also required the preparation of coordinated services drawings and basic calculations packages, all to the absolute minimum requirements for Building Regulations approval. This was a feature of these projects, i.e. to design to a minimum standard for a services contractor, so that the contractor would be competitive in their tender bid and make profit from the tightest of financial margins.

Centrepoint – Mauritius

Due to successfully carrying out earlier design work with an international engineering consultancy, I was appointed to carry out the mechanical services design for a prestige mixed use development in Mauritius.

My electrical engineering colleague and I were brought in late to the project, and so much of the superstructure was already structurally and architecturally designed, without input from M&E engineers, and so the project had very few bespoke services risers to use. We quickly advised the Architect, that there was insufficient riser space and we identified that the only realistic alternative, would be to use back-of-house areas to create vertical service riser areas for the routing of ventilation supply air and other services. However, I identified that there would still be insufficient space for extract ductwork, so I proposed the use of the atrium for stack effect ventilation, fan assisted at roof level.

Interestingly, this project was the first and only project that I have designed, where communication has been mostly by email. There were essentially no design team meetings as the Architect was based in Jakarta, with only the occasional trip to London branch of the firm. The client and the main contractor were both in Mauritius.

Therefore, all proposals were designed around base drawings submitted by email by the Architect, and with a review of the Structural Engineer's drawings, again received by email. All queries and RFI's were made by email, and I employed a local CAD technician to CAD all my mechanical services drawings, which I then submitted by email, 'For Comment', 'For Approval' and 'For Construction', accordingly. All interim comments were received by email, which I then incorporated within the design.

Although the process was slower than a traditional design process, it all worked very well as we stayed true to the process throughout. Although it was no substitute for face to face consultation, it proved to be a workable solution.

Project No. 4: Mander Centre – Wolverhampton

A challenging retail refurbishment project, at the Mander Centre, required specialist fire engineering together with Mall ventilation, as the two main focus elements of this design.

The overwhelming issues with this project, were the integration of the smoke and general ventilation services within the existing structure, as well as the fire engineering of the Centre in relation to the Architect's new ceiling design. A particular problem was maintaining the minimum smoke layer of 2.5m, due to height restrictions within the Centre.

I had several meetings with the Fire Officer on this issue, and had to compromise, by installing drop down fire screens in front of several larger shop units, so as to comply with the requirements of BRE 168 and 386. **(D2, D3, E1)**

Additionally, the only safe exit for smoke exhaust was via the roof, but as this was the shopping centre car park, I had to extend 4No. structurally supported vertical exhaust stacks, each architecturally clad to offer aesthetic treatment. **(A2, E2)**

I designed the system so that the fans were installed within these vertical stacks, were inverter driven to accommodate the smoke extract rates, (calculated by the Fire Engineering specialist), as well as a background ventilation rate, based on occupancy levels. I did consider naturally ventilating the Centre but the existing layout was not conducive to this approach. **(A1, A2, E3)**

The structural and spatial limitations for the Centre did not allow the installation of supply and extract air to the space, and so I only had sufficient space for the abovementioned combined smoke and general extract ventilation. I decided on mechanical extract with natural inlet ventilation, but at the time did not have the comfort of thermally modelling this, that is so prevalent today. I was concerned that, due to all the fresh air make up to the Centre being via the several entrance doors, the ventilation losses during the winter months may have been too cold for the Centre to retain a feel of comfort, and so not be a welcoming place for people to come and shop. **(E3)**

I did not want make-up rates to the Centre, to be catered for by open doors, as during times of no traffic the doors should remain closed, to retain heat as much as possible. I therefore designed into each of the glazed entrance facades, permanent louvres so that these alone would accommodate the minimum fresh air requirements. I also found, by speaking to end users, that most people would come into the Centre and not generally remove their coats / jackets during the winter months, unless they were to use a retail unit for a length of time, each of which had their own form of heating. I also calculated that due to many retail units having a largely open door policy, that there would be a heat contribution from the warmer retail units to the cooler Mall areas. Coupled with occupancy loads, lighting and small power loads, overdoor heaters at entrance foyers and the important fact that each Mall had low ceiling heights, I calculated that the ventilation loss would be largely offset by these heat load contributions, and even at an ambient design condition of -4°C, the Centre would be maintained at a comfortable 18°C during winter months. **(A2, B2, B3, C3, D2)**

From further discussions with the Centre staff, there were no real concerns about overheating during summer months, as there were no external walls or glazing communication directly with the Mall, except for the atrium roof but here, all solar gains would largely be confined at high level.

The structural problems mentioned earlier, resulted in my design of the smoke / general extract ductwork being installed central to the Malls, and at the deepest point in relation to the architect's profiled ceiling. Due to this, I sized the ductwork at its maximum 4:1 aspect ratio, and on the horizontal runs, had a continuous open side slot along its entirety, to accommodate the extract air volumes during a fire condition. I had protracted discussion with the architect to arrive at this solution, that matched the functional service requirements, the architect's aesthetic needs, and the structural implications of the existing building. **(D2, E2)**

Another specific problem within the Centre, was condensation formation on the underside of the glazing, which was single glazed and which was not being replaced. This was apparently a real nuisance, as announcements over the tannoy, during several site visits demonstrated, i.e. that the public take care, whilst walking through the atrium area of the Centre, due to the floor being wet.

I considered whether the smoke / general extract system that I had designed, would be sufficient to prevent this condensation from happening, but as the extract points for this system were below the level of the pitched roof glazing in question, there was the possibility that this would not be effective.

I therefore designed in, a secondary local bespoke ventilation system, running along the perimeter of each side of the atrium, with directional drum louvres angled to blow air across the pitch with extract via the general system. The ductwork was mounted within a recess, so could not be seen from below, and the idea worked very well and the announcements ceased. **(A2, C4, E2)**

Project No.5: St. Pancras International Railway Station - London

In the June of 2007, I was teased away from a secure permanent position as Principal Engineer at Waterman Group, for a risky move and somewhat out of my comfort zone, to lead a team of 12No. mechanical engineers for fit out works at St. Pancras in London. I had not worked within the rail sector before, and took the opportunity, as the project was the second biggest project after the Olympics at the time. **(B1, C2, C3)**

Working amongst professionals of many nationalities, and many different agendas, the information receipt from all parties was constantly changing, and so the design was constantly fluid.

Routing of services required continuous site visits, to verify whether proposed routes on paper were achievable in practice, due to the age of the building, accessibility issues or whether English Heritage would even allow the route. The main contractor demanded detailed information constantly, and I had to attend daily meetings to discuss immediate and impending issues. **(B3, D1, D2, D3, E2)**

Due to foul drainage levels, it was not possible to use a standard gravity drainage system. A vacuum drainage system was therefore employed during the shell and core works, which we added to and modified, to suit the fit out. This had several failures during its early operation, which were mainly due to foreign objects being thrown into toilets, and then either blocking or causing leakage from the system. As the vacuum drainage system operates, slugs of foul water can travel up to 20 m/s and on one occasion, it was discovered, that a coin that had been dropped into a toilet, had most likely travelled at this velocity and taken an elbow fitting straight off. **(A2, B2, C1)**

To understand the operation of this rarely used system, I organised a site seminar, from a specialist who had an interesting proposal that he was to present to Building Control. This was that when a vacuum toilet or series of W.C.'s operate, then enough air is drawn into the system from the surroundings, to sufficiently ventilate that space, with make-up air being then naturally drawn from adjacent areas, so much so that standard mechanical extract ventilation is therefore not required. This was an interesting idea, at least. **(E4)**

Due to the nature of the building, fire engineering was integral to the design. Although the calculations for this were carried out by Arup Fire, the onus was on our design team to translate these calculations into a practical design solution, where mechanical smoke ventilation was required. This often proved difficult, due to the abovementioned dynamic changes to the architectural design and room changes. One sector of the building in the undercroft retail area, required a high rate of smoke extract from three separate zones, and the ductwork route was limited, due to feature raft ceilings over which, I could not run ductwork due to its size. The area also changed several times in terms of room and area modifications. This was particularly problematical, resulting in me revising one drawing eight times, before a buildable design, that met all the requirements of Arup Fire, were met. **(A2, B2, C1, D2, E1, E2)**

A major issue that arose during the fit out process, was that the 4MW of chilled water provision designed into the building at the shell and core stage, proved to be insufficient to cater for the building loads, that had moved considerably since the early stages. The updated calculations that I carried out, demonstrated that an additional 1MW of chiller load was required, to ensure sufficient cooling capacity was in place.

The pipework infrastructure however, was in place for just 4MW of cooling capacity, so I had to carry out a full analysis of the projected new loads, to ascertain exactly where the pipework was undersized. I found many areas of the system, where the flowrate increase was just too great for the pipe size installed, but equally, there were many areas where I could not practically change the pipework for a larger size.

I also considered reducing the chilled water loads to retail units, to reduce the overall flowrate requirement, but this was ultimately not an option, due to the contractual obligations under the tenancy agreements, that were already in place.

My options seemed limited, as I knew that the chilled water flowrate had to increase from circa 170 kg/s at 4MW to circa 210 kg/s at 5MW, but I was restricted in how I could do this. I had nowhere to go.

The only other option that I discussed with the project director, and finally implemented, was to change the chilled water flow and return temperatures and temperature difference, so that we 'massaged' the design to suit the installation. The original design flow and return temperatures where 7.5/13°C respectively, with a 5.5°C ΔT, and I changed this to a 7/13.3°C flow and return for a 6.3°C ΔT, to maintain the same flowrate for the higher chiller load. This proved to be workable, as the LMTD over the chillers, would remain much the same. This was acceptable by the client and was written into the tenancy agreement. **(A1, A2, B3, E3)**

The kitchen extract system, for the main new restaurant at St. Pancras, became one of the most intense design issues of the project, which required me to attend weekly meetings with several interested parties. The only available route to exhaust the kitchen extract, was via a riser within an adjacent new hotel build, by the Manhattan Loft Corporation. The restaurant owners were responsible for their ductwork up to a certain demarcation line, from which I was responsible for connecting to and routing the ductwork to atmosphere. **(D1, D3)**

However, the restaurant owners consultants had a different interpretation of relevant documentation, such as BS5588 Pt9, DW172 and the ASFP Bluebook to name a few, and they refused to design in fire cladding or use fire rated ductwork for their installation, which led to long protracted discussions between various parties regarding safety in design and project responsibilities. **(B2, E1)**

The owners of the duct riser, the Manhattan Loft Corporation, would not allow any access points on interim floor levels for cleaning of the ductwork, and so together with a specialist cleaning contractor, and over several meetings, I devised a system whereby a man access could be gained to this (and another kitchen extract) duct, from a bespoke exhaust chamber at roof level, via an abseiling hook up system, all whilst maintaining minimum duct velocities at 6 m/s and efflux velocities of 12 m/s, and within the guidelines of CIBSE TR19, for duct cleaning. **(C1, C4, D2, E2)**

The whole process for this one design item, took four months to conclude, painfully demonstrating how the design process can be hugely enjoyable, but terribly frustrating.

In terms of the project completion, and due to size and complexity of the project, practical completion was achieved on paper, but only with a client who ultimately took a measured view about the definition of practical completion. It could not be categorically stated, that all commissioned data was accurate and verified by the Engineer or the clients representatives, but that the systems were commissioned as much and as a accurate as they were ever going to be.

This was nevertheless a hugely rewarding project to be involved with.

Final Comment

All through my career, with the various companies I have worked for, I have attended numerous CPD seminars, have researched new subjects when required, such as earth tubes for an educational building at NG Bailey and rainwater harvesting systems for medical centres at Waterman Group. I have a personal library of over 200 documents from CIBSE, BSRIA, BRE, ACOP'S, British Standards, HTM's and Approved Documents and am committed to furthering the reputation of professional engineers. **(E4)**

End of Engineering Practice Report

January 25th 2010

Addendum of Competences:

A **Use a combination of general and specialist engineering knowledge and understanding to optimise the application of existing and emerging technology.**

- A1: Maintain and extend a sound theoretical approach in enabling the introduction and exploitation of new and advancing technology and other relevant developments.
- A2: Engage in the creative and innovative development of engineering technology and continuous improvement systems.

B **Apply appropriate theoretical and practical methods to the analysis of engineering problems.**

- B1: Identify potential projects and opportunities.
- B2: Conduct appropriate research and undertake design and development of engineering solutions.
- B3: Implement design solutions and evaluate their effectiveness.

C **Provide technical and commercial leadership.**

- C1: Plan for effective project implementation.
- C2: Plan, budget, organise, direct and control tasks, people and resources.
- C3: Lead teams, develop staff to meet changing technical and managerial needs.
- C4: Bring about continuous improvement through quality management.

D **Demonstrate effective impersonal skills.**

- D1: Communicate in English with others at all levels.
- D2: Present and discuss proposals.
- D3: Demonstrate personal and social skills.

E Demonstrate a personal commitment to professional standards, recognising obligations to society, the profession and the environment.

- E1: Comply with relevant codes of conduct.
- E2: Manage and apply safe systems of work
- E3: Undertake engineering activities in a way that contributes to sustainable development.
- E4: Carry out CPD necessary to maintain and enhance competence.

Supplementary Note to EPR – Project Dates

Project No.1 – Brindley Place, Birmingham

Traditional Design between 1997 and 1998

Project No.2 – Royal Jones and Agnus Hunt Hospital, Oswestry

Traditional Design between 2006 and 2007

Project No.3 – Freelance Consultancy

Various design and build and traditional projects over last 5 years

Project No.4 – Mander Centre, Wolverhampton

Traditional design between 2001 and 2002

Project No.5 – St.Pancras International Railway Station, London

Traditional design between 2007 and 2008