# Oakham Church of England Primary School

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| | |
|---|---|
| **Innovate UK project number** | 450044 |
| **Project lead and author** | White Design Associates Ltd |
| **Report date** | 2013 |
| **InnovateUK Evaluator** | Unknown (Contact www.bpe-specialists.org.uk) |

| **Building sector** | **Location** | **Form of contract** | **Opened** |
|---|---|---|---|
| Schools (primary) | Oakham | Design and build | 2011 |
| **Floor area (TFA)** | **Storeys** | **EPC / DEC** | **BREEAM rating** |
| 2639 m$^2$ | Single | B (26) / N/A | N/A |

**Purpose of evaluation**

The study - which concentrates on the review and analysis of the handover process and initial occupation of the building. The aim was to review the building and handover process, listen to those involved, and to discover whether an adequate understanding of the new school is passed on from the design and construction teams to the end users and clients and determine whether it is initially being used as designed. The study was carried out in parallel to the  BPE study of Rogiet Primary school in Monmouthshire (see separate report).

| **Design energy assessment** | **In-use energy assessment** | **Electrical sub-meter breakdown** |
|---|---|---|
| No | Yes | Partial |

The scope of the study provided an initial TM 22 analysis. However, all energy data were put into an appendix, missing from the final report. The published graphs, Figures 3a and 3b, have the wrong X axis labels and/or graph captions for the information presented (e.g. carbon (*sic*) emissions quoted in kWh/m$^2$ per annum). It is therefore no possible to quote energy consumption. During the course of the study considerable effort was put into reconciling the meter readings between the physical meters and BMS and between sub-meters and meters. The BMS was reset in April 2012 so that all BMS readings were the same as the corresponding meters.

| **Occupant survey** | **Survey sample** | **Response rate** |
|---|---|---|
| BUS, paper based. | 60 | 95% quoted |

The school scored well on all summary comfort variables. Internal temperatures are high during the summer months.  During summer conditions the school was felt to be on the stuffy side. Some of the issues identified in the survey results related to temperature and air discomfort as a result of malfunctioning automated window/rooflight systems. Noise from inside caused irritation to some building users. In the nursery and foundation stage classrooms respondents commented on the very noisy hand-dryers. Due to the toilet layout the hand-dryers were within the classrooms.

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## About this document:

This report, together with any associated files and appendices, has been submitted by the lead organisation named on the cover page under contract from the Technology Strategy Board as part of the Building Performance Evaluation (BPE) competition. Any views or opinions expressed by the organisation or any individual within this report are the views and opinions of that organisation or individual and do not necessarily reflect the views or opinions of the Technology Strategy Board.

This report template has been used by BPE teams to draw together the findings of the entire BPE process and to record findings and conclusions, as specified in the Building Performance Evaluation - Guidance for Project Execution (for domestic buildings) and the Building Performance Evaluation - Technical Guidance (for non-domestic buildings). It was designed to assist in prompting the project team to cover certain minimum specific aspects of the reporting process. Where further details were recorded in other reports it was expected these would be referred to in this document and included as appendices.

**The reader should note that to in order to avoid issues relating to privacy and commercial sensitivity, some appendix documents are excluded from this public report.**

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# Oakham C of E Primary School

## Building Performance Evaluation (BPE)

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# 1.0 Introduction and overview

This Building Performance Evaluation (BPE) project for Oakham School and the corresponding report has been carried out by White Design with Piers Sadler Consulting. It has also involved the contractor Willmott Dixon and associated company Rethinking, as well as M+E sub contractor and engineer. The process has understandably included Rutland County Council and the School Team.

## 1.1 Introduction

The purpose of the TSB funded Oakham BPE study is threefold:

- to gain a greater understanding of the importance of the handover processes in the ongoing performance of Oakham school;
- to review the original design intent in comparison with the schools own understanding of how their school is being used, could be used or should be used; and
- to embed the findings within design practice in order to develop the design of future school buildings.

The school was completed and occupied in August 2011. The collation of information and observation began in July 2011 whilst the formal study began in earnest in November 2011. White Design are both the lead authors of this study and were the lead consultants for the project. White Design and Willmott Dixon, the contractors for the build and members of the BPE team, are committed to investigating and understanding whether the design ambition of the project has been truly realised and what could be done better on future primary school designs.

This study is a termed a Phase 1 study - which concentrates on the review and analysis of the handover process and initial occupation of the building. The aim of a Phase 1 study is to review the building and handover process, listen to those involved, and to discover whether an adequate understanding of the new school is passed on from the design and construction teams to the end users and clients and determine whether it is initially being used as designed. It has been carried out in parallel to a Phase 2, two year BPE study at Rogiet Primary school in Monmouthshire. A Phase 2 study provides the opportunity to review the performance of a building over a two year process. The Rogiet study is still in progress and provides an opportunity to also test and compare some of the findings from this Phase 1 study.

## Summary of the main points in the study

On the whole, the building was very positively reviewed by staff and users and the team has been honest and interrogative in its feedback of its own performance. The BPE study has been carried out in two stages:

- Stage 1 - The information gathering, review and identification of issues
- Stage 2 - Investigate issues and identify areas for consideration, learning and dissemination with corresponding reaction plan and recommendations

There were four main areas amongst other more minor issues that were identified through the review and analysis stage and that were taken forward for more detailed investigation through the second stage of the BPE study, these were:

Lifecycle costs

Soft Landings

Winter garden

Nat vent

- The ability of the construction process to understand lifecycle cost implications and feed them into decision making. For example the heat loss and cost impact of the decision to proceed with no below pool insulation - although building regs compliant, the energy loss is 2/3 of that gained by the installation of the solar hot water system.
- Communication and ownership of the Soft Landings process and who should take overall strategic responsibility for understanding all the systems in the building through the design and handover process.
- The design intent and communication around the use of lobby/winter garden areas to access the outside from the classrooms.
- How could the process for designing and implementing a natural ventilation strategy be simplified, better communicated and reviewed throughout the design, construction and handover processes?

The above issues or areas for investigation were distilled through the Buildings Users Survey, interviews with key team members and through on site observations and walk rounds. These issues are discussed and reviewed through two specific investigative studies as well as being referred to throughout other sections of this report e.g. the Building Users survey feedback. The flag symbols above are used to indicate where these areas are covered in this report.

### Investigation 1 - Communication and handover (see section 5.2 and Appendix 19)

The first two points above were explored through this investigation and in summary this study covers:
The Building user guide; Is it a useful tool? How could it be made more useful rather than being limited to an exercise in obtaining a BREEAM credit? This study aims to link the questions to the design process and interrogates the following areas.

Soft Landings

Nat vent

Training and Operation: The study interrogates whether the five stages of the BSRIA Soft Landings process were used and whether the whole team were involved in applying the process. There was a perceived lack of training at the time of handover although ongoing support and the fault resolution process has been well received. A range of issues regarding the ventilation control strategy raised the question of who should take ownership for the strategic understanding of the whole building? The ventilation system provides a good example of a system that is influenced by the input of a number of professionals namely - Architect, M+E engineer, Contractor, window supplier, BMS supplier, window control supplier, and window actuator supplier. Furthermore it's operation and use can be subject to personal preference and will be influenced by the settings attributed to the systems by the building maintenance team. The strategic design approach and procurement of the ventilation strategy is the subject of specific investigation. (see investigation 2). This study however looks more strategically at who should take ownership for the systems as a whole.

Maintenance Costs; The early stage feedback suggested ongoing maintenance costs for the building were forecast to be in the range of £15,000 per annum, approximately three times more than the previous school building. However, the new building includes the combination of two schools and the addition of a hydrotherapy pool. The new school has also demanded the employment of an additional building maintenance employee to assist the existing building manager due to the increase in complexity of the systems installed, increased opening hours and amount of FM tasks to be carried out.

**Lifecycle costs**

How could or should the client, design, contractor and sub contractor teams provide lifecycle costing analysis to better inform long term affordable decision making? This study considers the above questions as well as providing a strategic assessment of the predicted maintenance costs and the lifecycle costs associated with major elements such as the hydrotherapy pool and solar hot water system.

Data monitoring, meter reconciliation activities have been carried out through this study by Piers Sadler as part of the BPE team working closely with the school, controls supplier and contractor. This provides relevant data not only for the purposes of this study but for the future use of the school, recording and saving ongoing energy in use data at 5min data intervals for assessment and review.

This study also considers the question who should be reviewing this data and how should they best use the information?

### Investigation 2 - Design (See section 7.1 and Appendix 18)

Natural ventilation and an improved thermal envelope are two fundamental design strategies that have been adopted by White Design for a number of years. Both these strategies have evolved and are adapted for each school to meet specific brief and budget requirements. Aspects of the performance of each of these strategies have been questioned through this study.

**Nat vent**

The windows and natural ventilation control strategy evolved through the design process at Oakham. Through the initial months of occupation there were a number of teething problems with it's operation. The BPE investigates if the system is operating as designed and whether it can be enhanced to achieve better performance with low or no cost adjustments to the system. Can enhanced use and greater understanding of the systems be translated to the users?

The output from this study provides a natural ventilation design process chart for the benefit of the school but also, and importantly, can be generically applied to all future White Design projects and those of the other team members and could indeed be used by the TSB through the dissemination of this study.

**Winter garden**

The other aspect of this investigative study interrogates the use of the winter garden / lobby areas located between each pair of classbases. The use and specification of these spaces is contrary to how winter gardens were initially conceived and designed in earlier White Design primary school projects. The study evaluates whether the current design works as originally intended, whether this current evolution of their role enhances or compromises the perceived environmental performance of these spaces? and, are there any adjustments to their use that could get better performance for the building? e.g do they need to be heated? or could a simple graphic help to promote sequential use of doors into the space to prevent excessive heat loss from classrooms to the outside?

## 1.2 Overview of the school

**Project title:** Oakham Church of England Primary School

**Employer:** Rutland County Council

**Brief:** "Our new Campus will be a learning community for children and their families. It will be a community where everyone's strengths are recognised and everyone's needs are supported. It will be a centre of excellence for services delivering specialist support to vulnerable children and families. It will be a safe place where learners can take risks in order to aim high. It will aim to send learners to further their education as knowledgeable, confident, resilient people with a sense of pride in, and respect for, their own and the global community." (Extract from Learning Vision Proposal)

**Typology:** 1.5 form entry primary school (with reception class) on existing school site
+ specialist needs school facilities
+ nursery
+ 2 halls
+ 50m2 hydrotherapy pool
+ community & family centre

**Budget:** £5.2m Total build cost - £7.6m total project cost incl. FFE, ICT, Fees

**Key dates:** Appointment of White Design Associates – September 2009
Start on site – July 2010
Completion of landscape and final handover – November 2011

**Procurement route:** Design and Build

**Design team:** Architecture and Landscape Architecture – White Design Associates
Mechanical and Electrical Engineering – Cundall
Structural Engineering – BSP Consulting
Acoustic Engineering – Mach Acoustics
Interior Designer – Cantoo

**Building contract:** Engineering and Construction Contract (NEC3)

**Contractor:** Willmott Dixon Construction

## 1.3 Project Description

Oakham CE Primary School is a 210 pupil primary school comprising 2,600m2, with additional specialist needs units, separate nursery, 2 halls, community room and hydrotherapy swimming pool. Built using pre-fabricated twin timber walls, and pre-fabricated pre-insulated roof panels insulated with recycled newspaper fibre. Delivered through a Design & Build framework.

**Nat vent**

The client and team set out to create an exemplar of sustainable design and construction. This ethos was promoted through the design process, from its orientation on site and landscaping concept to the selection of natural materials, a high thermal performance envelope design and the use of natural ventilation and daylighting techniques. A 60% carbon reduction aspiration (based on the DFE targets) driven by the client brief was a major aspect of the design.

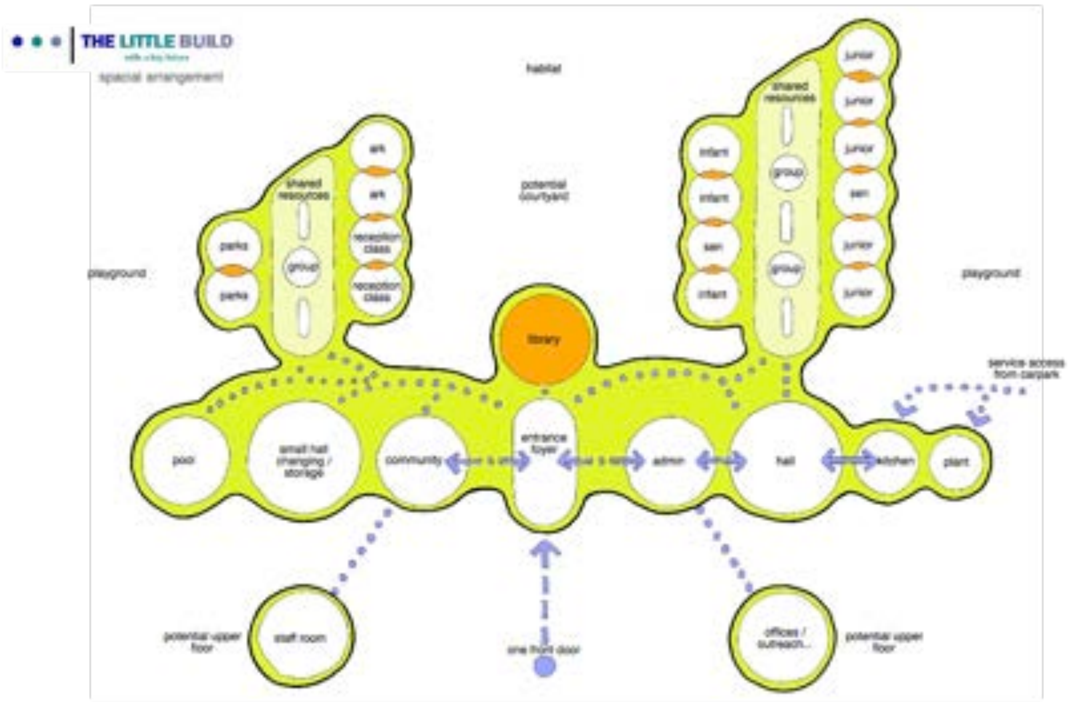
**Lifecycle costs**

The design process calculated a proposed 62% reduction achieved by focusing on the envelope in terms of thermal and airtightness properties and minimal renewables (only 0.4% of the project cost). The design proposed, minimised 'bolt on' renewables with the aim of ensuring a robust intuitive building for the end-user to help deliver the designed energy performance. This carbon reduction proposed was to be achieved within the set budget, without additional funding (e.g. from the DFE), and was proposed by close evaluation of fabric efficiency against effectiveness and capital cost of various renewables.

**Winter garden**

Access to outdoor spaces from classrooms is through heated buffer spaces, the design intent was for these spaces to act as a draught lobby reducing ventilation heat losses during egress and ingress of classrooms, the BPE study will investigate to confirm if this intent is achieved in practice. The project includes a hydrotherapy swimming pool designed with solar thermal panels to help heat the pool water and general hot water. The success of this design will be investigated as part of the BPE study.

The project was procured and is being delivered through a Design and Build Framework with Willmott Dixon. The completion and handover was undertaken using Willmott Dixon's Capital works Customer Service Process, an adaptation of the Soft Landings framework.



# 2.0 Details of the building, its design, and its delivery

## 2.1 Building design – summary and findings

The building process has been evaluated through this study under the headings of Visioning, Value Engineering, and Building Design (including sub sections - Layout, Sustainability Strategy and Access). The full section can be found in Appendix 11.

The summary and findings from this section highlighted the following:

**Soft Landings**

- The design and visioning process involved timely input from stakeholders and was perceived by all parties interviewed that it had been a major success of the project;
- The value engineering process had helped produce a building within budget and on time using a project "Wish List Matrix";
- Three areas were however, identified through the review of the value engineering process that will have an effect on the ongoing performance of the building and should be acknowledged for future projects. These were:
  a) the change of the window specification and automated natural ventilation system and it's relationship to the BMS (this is explored further in Design Investigation 1)
  b). The change of daylight sensor control to lighting within classrooms
  c). The desire to target Part L pre 2010 to avoid the requirement to install swimming pool insulation

**Nat vent**

**Lifecycle costs**

The table below charts these changes and makes recommendations for future projects.

| Prior to VE | VE Decision | Effect of the decision | Response and reaction |
|---|---|---|---|
| The automatic window control natural ventilation system was originally designed as a Window master system with Window Master hardware, software and communications. The Window Master controls use algorithms based on CFD modelling of wind and rain on the external building facades. These algorithms control which windows (and louvres) open and how far. | The Value Engineering decision was to link the Window master hardware to the Trend BMS. The Trend system opens and closes the windows based on internal temperature and restricts opening if it is raining or too windy. It is also linked to the heating controls. | This potentially less sophisticated system can cause problems if it is warm or stuffy inside when it is raining. | See design investigation later in this report |
| The T5 lights in the centre of the rooms dim according to the natural daylight entering the room. Initially the peripheral lights were designed to operate with the T5s, | This required some complicated controls and was left out to save money. | The effect of this can be seen with some classrooms having the peripheral lights on despite bright conditions | Industry to provide better lifecycle information concerning impact of change. |
| Early decision was made to target early submission of Building control application to avoid new 2010 part L requirement to install swimming pool basin insulation | Decision was maintained through design process | Heat loss as a result of decision will reduce positive impact of having solar hot water | Industry needs to improve it's lifecycle cost analysis and assessment of energy return on energy invested (EROEI) |

**Nat vent**

**Lifecycle costs**

**Winter garden**

The building design layout was reviewed and a question was raised by the design team concerning the success of the winter garden/lobby spaces that are incorporated adjacent to grouped teaching spaces. This arrangement is reviewed as part of Design Investigation 1 (Section 7.2 of this document). The conceptual layout diagram for the building is shown below. There is a question over whether the design team advocated the design and use of the winter garden lobby space sufficiently to the client during the design process to get best performance out of this space.

## 2.2 Building design - process as a whole and lifecycle analysis

**Lifecycle costs**

During the structured review presentation of the outputs generated through the analysis of this BPE study a concern was raised by the client that limited information was provided by the design and construct teams on the lifecycle impact of design decision and system choices. This concern was raised in relation to the significant predicted increase in maintenance budgets over the original school.

There are some obvious reasons why the ongoing maintenance costs are higher given the school now incorporates the Parks Special school and associated hydrotherapy pool. It does however raise the question of how design and construction teams can improve communication around ongoing lifecycle cost impacts alongside the more prevalent capital costs comparisons. It also raises the question of how clients can help to promote design decisions based on lifecycle cost analysis rather than solely capital comparison.

This is the subject of the Design Investigation Maintenance and Lifecycle costs. (See section 5.2)

# 3.0 Review of building services and energy systems

## 3.1 Description of energy systems and control strategy

This description of the energy systems and control strategies is based on review of the O&M manuals, visual inspection at the school and detailed discussions with the M&E designers and sub-contractors and the controls company. In producing the description this study identified that the available documentation did not provide all the information required and that the delivery team often had difficulty providing answers to relatively simple questions, especially around the controls.

The impression given by the controls company was that they knew how to install what was required of them, but they did not make any decisions about what they installed or how this might affect the energy performance of the building.

**Soft Landings**

The impression given by the mechanical engineers was that all things related to controls were the responsibility and knowledge of the controls company. There did not appear to be a strategic overview of the mechanical system controls. This might have been the mechanical consultant's role, but they were involved in the project at arms length.

## 3.2 Brief description of systems

A technical assessment of energy systems by the BPE team is set out in section 6 of this report. The following is a brief description of the systems installed.

***Controls***
Heating and hot water systems, air handling units, ventilation and windows are controlled by a Building Management System (BMS). The BMS is controlled via supervisor software installed on a dedicated PC operated by the facilities manager. Sub-metering is also linked into the BMS

***Space heating***
The space heating is provided by two 120kW condensing gas boilers with under floor heating (UFH) on the ground floor and a radiator circuit on the first floor. Two air handling units (AHUs) extract air from and supply conditioned air to the kitchen and swimming pool changing rooms. The heating system also provides heat to the swimming pool via a heat exchanger in the pool plant room.The heating circuits are controlled by means of room thermostats which are set within the BMS. The BMS also controls the operational hours of the heating system. The night set back temperature is 10°C which means the heating will come on in a particular area if that area falls below 10°C until the temperature rises 2°C above the set temperature.

The UFH system is installed in a concrete floor slab which heats up slowly when the system is enabled and cools gradually releasing its heat after the call for heat has ceased. The UFH is on a weather compensated, variable temperature system, which varies the circulation temperature of the UFH according to the external temperature to reduce the potential for over-heating the floor slab and consequently over-heating spaces. The AHUs operate based on the occupancy schedule in the BMS. The kitchen AHU, located in the plant room and on the kitchen roof, also has local over-ride. The primary heat source of the kitchen AHU is reclaimed heat from the toilet extracts. If this is insufficient then the constant temperature pumps provide heat from the boiler circuit. The air supply set-point is 21°C. The pool changing room AHU is located on the pool changing room roof (pool plant area). The supply air temperature is varied depending on the room set-point and room temperature. There is a 6.8kW air curtain on the main doors of the building, run from the main hot water systems.

### *Hot water*

Hot water is provided by two indirect gas fired calorifiers coupled with solar thermal pre-heat. Two 50kW high efficiency condensing gas water heaters are integrated within these units. The solar thermal system comprises 2 arrays of 21m$^2$ roof mounted flat plate collectors. Each array is coupled with a 368 L solar pre-heat vessel.

Surplus heat from the solar pre-heat vessels can be dumped to the low loss header of the heating circuit via heat exchangers on top of these vessels, should solar hot water generation exceed hot water demand. The rationale is that during hot sunny weather, if there is excess hot solar hot water production, generated heat can be used to heat the swimming pool.

### *Ventilation*

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The building is ventilated by natural ventilation using high and low level windows in classrooms and roof lights in corridors, halls and other rooms. In some areas e.g. the hall, louvers provide the low level element of the system. The natural ventilation operates automatically using a Window Master system controlled by the BMS with manual over-ride. Smaller rooms are ventilated through manual window operation. The windows open when the internal temperature or $CO_2$ concentrations in rooms exceeds the set point and close when the set point is met. The set point is variable, but typically 23$^o$C so that windows open at 23$^o$C and then open further or close using a feedback loop. The windows operate on the same set points and monitoring points (room thermostat) as the heating system so that they can't work against each other. When the window setting is manually over-ridden the windows will adjust to the manually set position for 1 hour and then return to automatic. When the wind is above a set point wind speed the windows and sky lights will not open. Similarly the sky-lights will not open when it is raining, although the window control strategy has been reset so that windows can open during rain since they are top hung. This before being resolved, was one of the main complaints registered in the BUS (see section 4)

### *Air conditioning*

There is a 3.5kW Mitsubishi split system air conditioning unit in the IT server room. This operates on a local thermostat set at 20$^o$C. The time schedule is set within the BMS.

### *Sanitary installation*

Low flow taps (<6l/min) with PIR sensors are installed throughout the building. Toilets are dual flush 6 and 3 l manually operated. Showers are <8 l/min. The showers are used regularly by swimming pool users.

### *Lighting*

The building is lit by low energy fluorescent lamps. In the classrooms a combination of 35W T5 luminaries in the central area and 17W circular down lights around the periphery. Corridors are generally lit by 17W circular downlights; the halls use 54W T5s; the library area has pendant lamps with direct and indirect lighting provided by 2 x 26W (direct) and 1 x 57W (indirect) TC-TEL fluorescent bulbs. Most other areas use T5s (larger spaces) and circular down lights (cupboards, smaller spaces) of varying wattage depending on requirements. The lighting controls are as shown in the following table. Emergency lighting is provided by a mixture of separate emergency lighting and converted general lighting luminaires.

| **Location** | **On/off control** | **Dimming** |
|---|---|---|
| **Classrooms/reception area office** | Manually switched on, automatically switched off, motion sensors set at 20 minutes | Daylight sensors and automatic dimming for main T5 lighting. Also manual dimming.* |
| **Head's office, first floor** | Manual switching and motion sensors | Manual dimming on some circuits. |
| **Halls/pool/kitchen/plant room** | Manual switching only | |
| **Building manager's office/ corridors/library/toilets** | Motion sensors only, set at 15 minutes | |

| | | |
|---|---|---|
| **Cupboards** | Motion sensors only, set at 2 minutes | |

* of all the teachers asked in the BUS, only 1 was aware of the lighting control operation.

### *External lighting*
The roads and car parks are lit by column mounted sodium road lanterns, with bollard mounted fluorescent lighting around the main entrance. The external lighting is controlled by photocell and timer.

### *Communications and IT*
Four IT servers, network switches and the telephone exchange are housed in the server room. The UPS for this system is rated at 2.7kW, but the average load is 1.13kW.

### *Mechanical control panels*
There are three mechanical control panels (MCPs): MCP1 in the main plant room which controls the electrical elements of the main mechanical plant in the plant room and for the toilet extracts and AHU on the roof of the kitchen; MCP2 controls the electrical elements of the swimming pool changing room AHU, toilet AHU and server room air conditioning on the pool changing room roof; MCP3 controls the electrical supply to the pool plant.

### *Swimming pool*
The swimming pool is heated via a plate heat exchanger in the pool plant room. This is drawn off the low loss header on a constant temperature circuit. The pool water temperature set point is 33°C.

The pool hall is conditioned by an AHU which provides the space heating and humidity control. The system incorporates an air source heat pump with integral condenser which also reclaims heat from the water vapour in the exhaust air. The pool has a cover system which is linked to the environmental control of the pool hall. When the cover is off the pool hall set point is 29°C and when the cover is on the set point is 21°C. The humidity set point is 60%. The total power rating of this unit is 11.7kW. The swimming pool is circulated by two constant speed pumps (4.9kW duty and stand by with the duty pump alternating weekly), which passes the water through a series of sand filters. There are also a number of chemical mixing and dosing vessels and pumps.

### *Power and equipment*
A separate equipment inventory included in Appendix 16 has details of all the equipment in the school. There is also an equipment list in Section 5 of the Mechanical Volume of the O&M Manual.

### *Other Electrical*
The following additional electrical systems are in place:

- fire alarm
- lightning protection security and door entry
- induction loop
- disabled WC alarms
- lift

None of these is expected to have a high electrical demand.

## 3.3 Metering Review

This section reviews the metering in the school and compares it to the Guidelines in CIBSE TM 39. (It also identifies which meters are included within the BMS) . The narrative of metering handover issues, meter reconciliation and data recording is presented in Appendix 14 O&M Review in the section entitled ‘BMS and Monitoring’. No TM 39 type analysis of the energy or water usage of the building was undertaken other than calculations for specific plant items and the SBEM model undertaken to produce the BRUKL and EPC. A review of the 90% rule and its definition as used for the purposes of this study are provided in Appendix 15. The following table identifies the meters installed at the school.

| Gas | Electricity | Heat | Water |
|---|---|---|---|
| Main supply | Main supply | Pool heat | Main incoming water |
| Boilers | DBA | Solar heat 1 | School water |
| DHWS | DBB | Solar heat 2 | Kitchen WC supply (non-softened) |
| | DBC | Heat dump (solar to low loss header) | Kitchen softened supply |
| | DBE | | Softened supply to DHWS |
| | DBF | | Pool water |
| | DBG | | |
| | DBH | | |
| | DBI | | |
| | Main mechanical plant panel (MCP1) | | |
| | Main pool plant panel (MCP3) | | |

## Review of TM 39 Compliance

Working through the TM 39 spreadsheets is outside the scope of this review, which focuses on assessing in broad terms whether the TM 39 requirements have been met. A review of TM 39 compliance has been undertaken for gas/heat, electricity and water and is summarised in the following table with discussion/justification in the following text.

| | TM 39 requirement | Gas/heat | Electricity | Water |
|---|---|---|---|---|
| 1. | Meters directly measure incoming supplies | ✓ | ✓ | ✓ |
| 2. | Separately tenanted areas >500m² separately metered | No separately tenanted areas of this size | | |
| 3. | 90% rule met | ✓ | ✗ | ? |
| 4. | Sub-metering allows performance of low and zero carbon technologies to be monitored | ✓ | - | - |
| 5. | For buildings of over 1000m² total useful floor area, automatic meter reading and data collection facilities should be provided | ✓ | ✓ | ✓ |
| 6. | Specified uses with power ratings above indicated threshold should be separately metered | ✓ | ✓ | - |
| 7. | Any process load that is discounted from the buildings energy consumption for benchmarking purposes should be separately metered. | ✓ | ✓ | ✓ |

Notes relevant to table above:

1. There is a main meter for each of the main supplies of gas, electricity and water.
2. Not applicable in this building under the present arrangements.
3. Based on the interpretation of the 90% rule at the beginning of this section, it is met for gas, it is probably met for water and it is not met for electricity.
   The uncertainty around water is dependent on whether the losses from the heating circuits amount to 10% of the total supply. It is unlikely that this is the case.
   In the case of electricity, whilst almost 100% of the incoming supply is fed through various sub-meters, the level of sub-division into separate end-uses is, in some cases, insufficient as follows:
   - electrical energy usage of the MCP outside the meeting room which provides the power to the toilet extract fans and changing room AHU, cannot be distinguished from the small power on the first floor and server room cooling;
   - electrical energy usage of the servers cannot be distinguished from Zone C small power.

   Depending on the interpretation of end use, separation of the heat supply to each of the air handling units could also constitute non-compliance.
4. The solar heat metering and heat dump heat metering enable this requirement to be achieved.
5. The BMS provides the facility for data collection and recording, although it was not set up to achieve this under the specification. This project has set the BMS up to record the data.
6. This refers to Table 3 in CIBSE TM 39. The two categories relevant to this building are motor control centres >10kW and final electrical distribution boards greater than 50kW. The size of the corridor MCP is not known (MCP2), but since it powers the toilet AHU and changing room AHU (see Table 4) with a total kW rating of approximately 2.7kW, it is unlikely that separate metering would be required. The other MCPs are separately sub-metered. Since all the distribution boards are sub-metered, the requirement is met in this respect.
7. The swimming pool has been discounted from the EPC as a process load. Swimming pool energy usage is metered through the pool water heat meter and the pool plant panel (which covers the swimming pool pumps as well as the air handling unit). Strictly speaking, all the swimming pool energy usage is not separately metered because the pool area lighting is included within DBF, but this is anticipated to be such a small proportion of the total that it can be over-looked.

**Summary findings**

- the building has a fairly comprehensive metering strategy;
- documentation in the O&M manual has some omissions/errors such that it is not clear where some electrical items are sub-metered and the water metering in the Mechanical Schematic is incorrect;
- separate heat metering of the kitchen and pool changing AHUs would be advantageous and strictly may be a requirement under TM 39;
- separation of the sub-metering of small power from the ICT servers, air conditioning and MCP2 would be required for the electrical sub-metering to be fully TM 39 compliant;
- there was no systematic evaluation of the metering strategy according to the TM 39 methodology - the sub-metering strategy was driven more by the need to gain BREEAM points.

The review of the systems and metering strategy raises the issue of who takes overall responsibility of the coordination of all the systems in the building. Some are quite complex and require a detailed understanding. The design and build process often detaches the design engineers from the delivery design and installation process. This is discussed in more detail through sections 5, 6 and 7 of this report.

# 4.0 Building User Survey

## 4.1 Process

As part of the BPE study White Design carried out a Building User Survey at Oakham C of E Primary School. The aim of the survey was to gather the views and comments of as many building users as possible, in order to inform the subsequent stages of the study. Alongside informal interviews with key members of the design team, data from spot checks on temperature, light and CO2 levels, the information gathered from building users would enable White Design to analyse the success of the building:

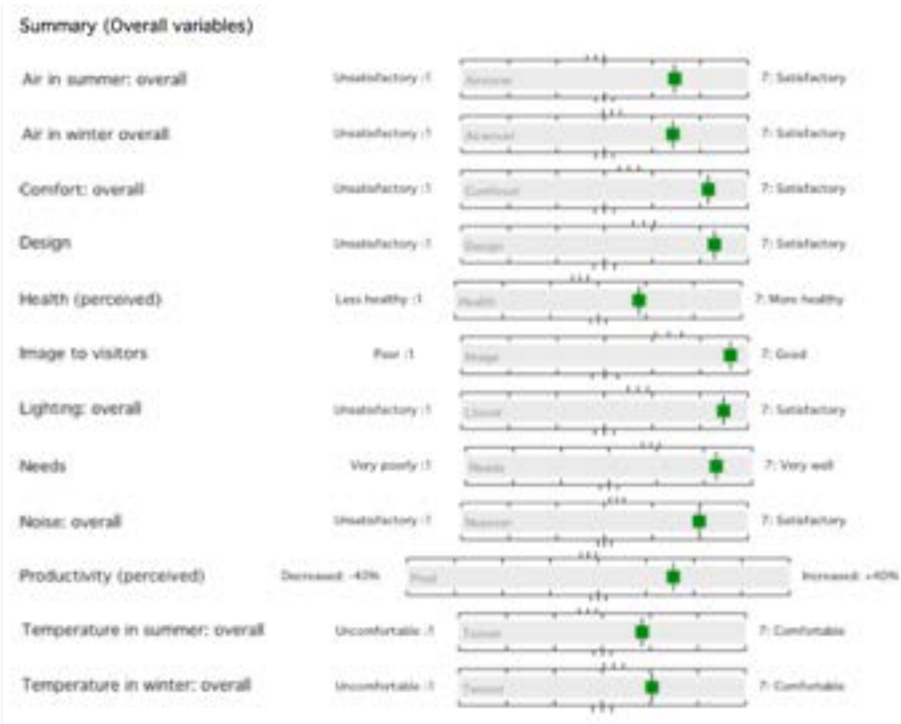
- Had the design intent been achieved?
- Did the building work when taking into account specific occupier behaviour?
- Were building users happy with the building they work in and, if not, what steps need to be taken to resolve this?

This section of the report presents the key findings from the survey. A more in-depth analysis and the full set of data tables are appended to this report (Appendix 2).

- 60 members of staff filled in the survey, meaning that White Design reached 95% of the staff at Oakham C of E Primary School
- The Building User Survey was carried out on the 24th January 2012, when the school had been operational for about 6 months

**Survey results - overall variables**

As can be clearly seen from the diagram below, the school scored well on all overall variables.

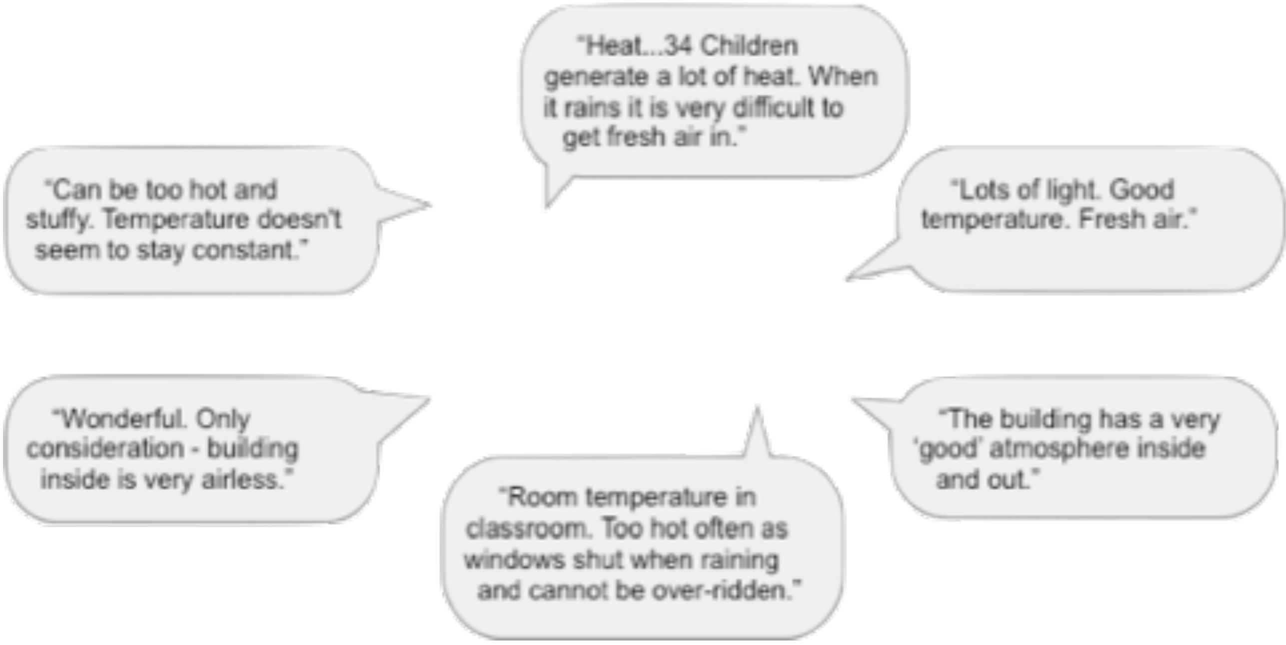



The comment from Arup stated that: “The building scores very well overall. The detailed temperature and air questions should be examined as they show some more average to below benchmark responses.”
As a result of these responses, further investigation was undertaken into those areas that scored below

average in the detailed analysis.

In addition to the formal BUS analysis, White Design also carried out informal interviews with key staff and members of the design team. Full transcripts can be found in Appendix 5. White Design also spoke to members of Mercury Class, who wrote "letters to the Architects" highlighting their opinions regarding the school building. these can be found in Appendix 7.

**Nat vent**





The BUS surveys were coded according to the room number - making it possible for White Design to link comments to specific rooms, whilst maintaining confidentiality.

## 4.2 Building User Survey - Summary of initial findings

- Internal temperatures are high during the summer months. The data collected during Spot Check Monitoring in July 2012 showed that the temperature in summer is indeed higher than the desired optimum temperature - an average of 25.3°C. Temperature in summer was also felt to be too variable.
- Temperature in winter scored as comfortable on the overall variable, but on the more detailed analysis scored low and results showed it to be too hot.

**Nat vent**

- During summer conditions the school is felt to be on the stuffy side. Some of the issues identified in the BUS related to temperature and air discomfort as a result of malfunctioning automated window/ rooflight system. Initially the windows were forced closed during rain, so classrooms were often hot and stuffy during rain and teachers could not manually override this. This has been resolved by decoupling the windows from the rooflights and allowing the windows to be manually opened when it rains.

**Soft Landings**

- Similarly temperature and its control were affected by the commissioning of the underfloor heating. In several cases the incorrect manifold was connected to a room thermostat resulting in some areas being too hot and some too cold with apparently no ability to control this - this issue has now been resolved
- Noise from inside caused irritation to some building users and two main areas of concern were raised in the comments. In the nursery and foundation stage classrooms 6 respondents commented on the very noisy hand-dryers, which due to the toilet layout were within the classroom space, and caused constant interruptions to lessons and quiet time. Elsewhere comments were made about noise from the windows on opening and shutting.

**Nat vent**

- Results indicated too much natural light. This was not supported with further comments. Indeed all related comments in the BUS seem to indicate that natural light is a positive benefit of the school design.
- The scores for control over cooling, heating and noise were above the benchmark mean, but below or at the scale midpoint. However, only 1/5th of building users felt this to be important.

## 4.3 Summary recommendations

**Soft Landings**

- Change hand dryers in the Nursery and Foundation stage classrooms. This was noted at the TSB Feedback meeting to headteacher who said this change would be a priority.
- Ensure design team aware of effect of noisy hand-dryers for future design.
- Provide clearer training to staff on use of lighting controls.
- Provide clearer training to staff on reason for windows opening ($CO_2$).

The following recommendations relate to H&S and should be brought to the attention of the school, contractor and design team. These comments are extracts from the BUS:

- "Clear window not suitable for pool with regards H&S."
- "Would prefer a working kitchen away from D&T for hygiene purposes."
- "Office fire door needs push bar or something similar."
- "Button at main entrance of building too low, children can reach the button themselves."

# 5.0 Details of aftercare, operation, maintenance & management

## 5.1 Soft Landings

**Soft Landings**

A Willmott Dixon version of the Soft Landings process was introduced at the outset of the project, though it is interesting to note that, despite being heavily involved in the Health Check meetings and handover of the building, the Facilities Manager did not hear the term Soft Landings until some six months after practical completion. The Willmott Dixon version of the process differed from the formal BSRIA process - see below diagram for comparison (activities highlighted in red were not completed, orange were intended as Soft Landings, but were not seen through or completed in full, and green were completed). Regarding Stage L2, there was not on-site support, but regular meetings were held as set out on the following page.

| RIBA Plan of Work 2008 | | | | Soft Landings | | OGC Gateways (at end of stage) and milestones in the RIBA *Plan of Work* |
|---|---|---|---|---|---|---|
| *Stage letter and name* | | | *Main activities* | *Principal additions* | *Supporting activities* | |
| Preparation | A | Appraisal | Identify client needs. Do feasibility studies | | Define roles and responsibilities | 1. Business justification |
| | B | Design brief | Develop an initial statement of requirements and procurement methods | **Stage 1. Briefing:** Identify all actions needed to support the procurement | Explain Soft Landings to all participants. Identify processes and sign-off gateways | 2. Procurement strategy |
| Design | C | Concept | Implement and expand the brief. Prepare the concept design. Review the procurement route | **Stage 2. Design development:** to support the design as it evolves | Review past experience. Agree performance metrics. Agree design targets | 3A. Design brief and concept approval |
| | D | Design development | Develop concept design. Update outline specification and costs. Complete project brief | | Review design targets. Review usability and manageability | Apply for detailed planning permission |
| | E | Technical design | Prepare technical design and specification sufficient for coordination and information for statutory standards | | Review against design targets. Involve the future building managers | 3B. Detailed design approval |
| Pre-construction | F | Production information | Prepare detailed information for construction. Review information provided by specialists | | Review against design targets. Involve the future building managers | Apply for statutory approvals |
| | G | Tender documentation | Prepare or collate tender information | | Include additional requirements related to Soft Landings procedures | |
| | H | Tender action | Identify and evaluate potential contractors and/or specialists. Submit recommendations to client | | Include evaluation of tender responses to Soft Landings requirements | 3C. Investment decision |
| Construction | J | Mobilisation | Let the contract. Issue information to the contractor. Arrange site handover to the contractor | | Confirm roles and responsibilities of all parties in relation to Soft Landings requirements | |
| | K | Construction to practical completion | Administer the contract. Provide further information as required. Review information provided | **Stage 3. Pre-handover:** Prepare for building readiness. Provide technical guidance | Include FM staff and/or contractors in reviews. Demonstrate control interfaces. Liaise with move-in plans | 4. Readiness for service<br>Practical completion |
| Use | L | Post-practical completion | **L1** Administer the contract after practical completion and make final inspections | | Incorporate and Soft Landings requirements | Final account |
| | | | **L2** Assist building users during the initial occupation period | **Stage 4. Aftercare in the initial period:** Support in the first few weeks of occupation | Set up home for resident on site attendance | |
| | | | **L3** Review of building performance in use | **Stage 5. Years 1 to 3 Aftercare:** Monitoring, review, fine-tuning and feedback | Operate review processes. Organise independent post-occupancy evaluations | 5. Benefits evaluation |

The building was procured under the Design & Build route. Full details of Willmott Dixon's standard aftercare process can be found in Appendix 4 - in the section entitled "Introduction of Customer Care Team and Post Contract Aftercare". This makes reference to the key aftercare documentation and manuals, and states that Practical Completion of the main building has been set as Friday 22nd July. It also highlights the frequency of aftercare meetings: General frequency will be: 6/8 weeks after Practical Completion, then 4mths, 7mths and 11mths. Full Maintenance during the twelve months defects period is provided by Willmott Dixon.

The Handover date was brought forward so that the school could move in to the building over the summer holidays, allowing time to get used to the building prior to children arriving for the start of the academic year in September.

### Training and handover date

**Soft Landings**

One area where it was felt improvements could be made was training. The project manager felt the BMS training session to be insufficient and too early. The Contractor team felt that expectations need to be managed where training on systems is concerned. "With BMS and other systems you want users to have little involvement but key individuals to understand, monitor and control the systems. There are defined optimum levels e.g. $CO_2$ levels, temperature etc, which system is set at. The school shouldn't need to input into that."

One of the potential reasons for the concerns surrounding a perceived lack of training could have been the handover date being brought forward. This was to allow more time for teachers to move in before children returned but led to some systems still to be commissioned and therefore preventing timely training.

In addition to training, the Willmott Dixon Soft Landings process provides the building users with manuals. The Facilities Manager felt that there was "Lots of technical data about specific bits of kit, but not much overall guidance e.g. where the bit of kit is in the building" This is information that is perhaps better suited to a Building User Guide than O&M Manual.

As part of the BPE process a full review of both the O&M Manual and Building User Guide was undertaken (see section 5.3 and Appendix 14).

The communication around handover is explored in the next section under a specific design investigation.

## 5.2 Design Investigation - Communication and handover - maintenance and lifecycle costs

Lifecycle costs

This investigation started as an attempt to uncover more information about maintenance costs, but, through the study, has adapted to cover wider issues surrounding communication and handover. The following summarises the main points (please see Appendix 19).

Early stage feedback from informal interviews suggested that the ongoing maintenance costs for the building were forecast to be some three times higher than the previous school building.

Soft Landings

This increased cost came as a shock to key members of the school and client group. This, coupled with some teething problems with the use of the building systems and its controls, led the investigation team to question whether there were fundamental communication and handover issues at the beginning of the design process that lead to difficulties and failed expectations later on. This concern was raised by Rutland County Council in the structured review meeting as part of the BPE dissemination process to the team held in May 2012

The questions below were distilled through the Buildings User Survey, interviews with key team members and through on site observations and walk rounds.

### Maintenance costs - initial questions covered

- What is the current cost of maintenance, and how does this compare to the previous school?
- How should or could contractors, sub contractors and designers better identify and communicate the maintenance and ongoing lifecycle costs for a new buildings.

### Maintenance - the costs

The early stage predictions prepared by the School and Rutland County Council suggested that ongoing maintenance costs for the building would be in the range of £15,000 per annum. This is approximately three times more than the previous school building. In fact, updated budget information from the school's Office Manager states that the Maintenance budget for 2012 to 2013 is £32,642, when including repairs & spares for those contracts (which are always extra). In addition the school can expect an overspend of some £5,000:

"We are likely to go over this by at least 5k. This is the first full year that we have had so it was a 'shot in the dark' when we predicted last April for budget purposes. So, R&M more likely to come in at nearer 40k for 12/13" Extract from email from Office Manager. Repairs and Maintenance for the previous school in 2009-2010 was forecast at £15,073, which included repairs and spares also, but actually came in nearer to £9,000.

| Supplies and Services | 2009-2010 | 2012-2013 |
|---|---|---|
| **Building Maintenance (budgeted)** | £15,073 | £32,642 |
| **Building Maintenance (actual and predicted)** | £9,000 | £40,000 |

Therefore, this equates to an increase of £31k (344%) per year for Repairs and Maintenance in the new building vs the old building.

Possible causes for this increase include:

- The combination of two schools
- The addition of a hydrotherapy pool
- Increased opening hours due to increased use of community spaces

However, at least some of this extra maintenance costs is down to the higher complexity of the systems and equipment in operation at the new building.

The new school has also demanded the employment of an additional building maintenance employee to assist the existing building manager due to the increase in complexity of the systems installed, increased opening hours and amount of FM tasks to be carried out. However, this cost is not included within the budget as detailed above, as the new member of staff, used for lettings, is covered by lettings income.

See table below showing calendar of maintenance activity.

| Area | Company | Jan | Feb | Mar | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | |
| **BMS** | bg Controls | | X | | | | | | X | | | | |
| **M & E** | T. Clarkes | | | X | | | | | | X | | | |
| **Swimming Pool** | Hallams | | | | X | | | | | | X | | |
| **Hoists/Beds** | Multicare | | | | X | | | | | | X | | |
| **Hall Floors** | Capital Floors | | | | | X | | | | | | | |
| **Kitchen Equip** | CPS | | | | X | | | | | | X | | |
| **PAT Testing** | K. Taylor | | | | X | | | | | | | | |
| **Lift** | Thyssenkrupp | | | | X | | | | | | X | | |
| **PE H&S Check** | G.M. Services | | | X | | | | | | | | | |
| **Window Actuators** | Window Master | | | | | | | | X | | | | |
| **Fire Extinguishers** | Initial Facilities | | X | | | | | | | | | | |
| **Lightning Protection** | Cardinal Specialist Services | | | | X | | | | | | | | |
| **Grounds** | Horizon | X | X | X | X | X | X | X | X | X | X | X | X |
| **Fire Alarm** | Global | | | | X | | | | | | X | | |
| **Intruder alarm**<br>**Door Access**<br>**Hearing Loop**<br>**Cords dis. toilets** | Swift security<br>Swift security<br>Swift security<br>Swift security | | | | | X<br>X<br>X<br>X | | | | | | X<br>X<br>X<br>X | |
| **Mini Bus**<br>**Tail Lift**<br>**Tax**<br>**Insurance**<br>**Service**<br>**MOT**<br>**Breakdown** | J. Coates<br>Post Office<br>RCC<br>Tim Norton<br>W.H. Higgins<br>RAC | | X | X<br>X<br>X<br>X | | | | | | X<br>X | | | |

We can see from the tables above that the costs for maintenance, spares and repairs for 2012-2013 are significantly higher than costs at the old school building. Members of the client team have clearly been shocked by this increase, which brings us to the next question:

- How should or could contractors, sub contractors and designers better identify and communicate the maintenance and ongoing lifecycle costs for a new building?

### *Lifecycle Costing*

Lifecycle costs

Concern and some disappointment was shown by Rutland County Council client carried out during the structured review as part of this study, in the lack of information made available by the design and construction teams during the design process with regards to maintenance costs and processes. Unfortunately this is a scenario common to most Design and Build projects, modern buildings addressing BREEAM requirements and local authority capital funding processes. We can explore each of this areas in more detail;

### *Design and Build projects*

These require the Contractor and Design Team to procure a building where capital cost and time constraints dominate. Concern over risk to programme prevents appropriate up-front thinking to ensure best lifecycle value can be achieved. Current D+B contractual arrangements are limited in their use of any "carrot or stick" opportunities to ensure contractors and design teams stay engaged after the end of the 12 months defects period to help realise the design benchmarks of the building. Design and Build, by it's very definition, limits the opportunity for design and construction to be an integrated process.

### *BREEAM*

BREEAM accreditation has been shown to demonstrate increase in ongoing running costs when buildings achieve BREEAM Very good or Excellent.
Research by Halcrow (Sustainable Offices, SWERDA, 2010) on four buildings they completed to BREEAM Excellent standard demonstrate an 10 - 20% uplift in ongoing maintenance costs as a result of the systems installed to support the achievement of BREEAM. This is in comparison to what the ongoing running costs would have been if the building had been designed to be solely building regs compliant. This observation is not intended as a criticism of BREEAM, more that clients and design teams need to better understand what is involved with achieving a BREEAM target. The assumption is usually that BREEAM equates to a low energy building and therefore a low cost to run and maintain building. The energy aspect is understandably a part of BREEAM but does not tell the whole story and the construction industry needs to understand and better advocate how to use the additional specification benefits of BREEAM to ensure clients feel they are getting best value and not a just a more complex and more expensive to maintain building. There is a move nationally with public sector procurement to focus on EPC and DEC performance over BREEAM accreditation. Whilst in today's economic climate this is a simpler and more specific target, the construction industry could better understand what it is selling when designing BREEAM buildings and clients and building owners and users could better understand what they are buying.

### *Local Authority funding processes*

The design process in PFI contracts, and the now redundant BSF programme, is dominated by Facilities Management teams who assess and analyse not only the ongoing maintenance costs but the replacement cost and lifecycle performance of equipment and systems specified in the design. These funding processes have the opportunity to be highly involved with long-term effects of decisions that are made early on. By contrast, funding processes used by Local Authorities are often unable to link Capital and Maintenance budgets, therefore preventing the opportunity to invest more in better equipment up-front to reduce long-term maintenance costs.

Design processes that follow the traditional Local Authority route are subject to much less scrutiny,because the people who take responsibility for long-term lifecycle costs are not enabled in the decision making early on. This means that the involvement of maintenance teams in the design process is not often meaningful and only occurs at the point of pre-handover.

One particular aspect of the design that could have had a significant impact on ongoing heat energy consumption would have been the installation of insulation below the pool. During the design stage it was decided not to insulate the pool basin to save costs (see section 2.1 and Appendix 11), but to include solar thermal arrays to reduce heating energy requirements. Some consideration was given to the relative merits of pool insulation versus solar thermal, but this is not documented. This evaluation considers the energy implications of the decision. The table below shows a steady state approximation of the heat losses through the swimming pool basin with and without insulation.

| Component | U value (W/m2K) | int temp (oC) | ext temp (oC) | area (m2) | Q (W) | heat loss (kWh/yr) |
|---|---|---|---|---|---|---|
| **Wall uninsulated** | 1.57 | 33 | 10 | 30 | 1083.3 | 9490 |
| **Floor uninsulated** | 0.74 | 33 | 10 | 50 | 851 | 7455 |
| **Wall insulated** | 0.25 | 33 | 10 | 30 | 172.5 | 1511 |
| **Floor insulated** | 0.25 | 33 | 10 | 50 | 287.5 | 2519 |
| **Total uninsulated** | | | | | | **16944** |
| **Total insulated** | | | | | | **4030** |

The calculation suggests that the insulation may have resulted in about 13,000kWh/yr energy savings. This is equal to approximately 2/3 the energy produced by the solar thermal system (around 20,600kWh/yr). In order to evaluate the decision not to insulate, information on capital cost of the insulation and solar thermal systems would be required as well as a prediction of the amount of heat dumped from the solar system to the swimming pool. This information is not available at present.

### Summary

**Lifecycle costs**

**Soft Landings**

- Time is required through the design processes to interrogate specification and design decision to achieve overall best project value. High value decisions are made at the outset of a project.
- Design teams and client teams need to identify through the soft landings process the continual interrogation and identification of the impact of design decision on ongoing lifecycle costs. This could be a regular agenda item in design team meetings.
- Client procurement processes should consider contractual arrangements where post completion activities are required of the design and construction teams to work in collaboration with client teams to ensure best ongoing performance.
- For Oakham specifically it could have been possible to reduce overall heating energy consumption for the pool had below pool insulation been installed.

## 5.3 Review of O&M Manual and Building User Guide

This review has focussed on the mechanical, electrical and controls documentation within the O&M manuals with particular reference to those parts of the documents which refer to energy.

The review describes the information in the manuals and provides a brief critique on the quality of the information, including specific points which relate to the main energy systems (heating, hot water, ventilation, lighting and small power). It is not intended to describe the systems present or how they work (these are covered in section 3.2 and Appendix 12).

### Reactions / recommendations

Following review of the O&M manuals and the building users guide as shown in detail through the Design and Construction audit the following reaction and recommendations can be made (see Appendix 14 for further details):

***O&M***

- The basis of the metering strategy could usefully be incorporated within each of the mechanical and electrical sections of the O&M
- O&M provision of detail regarding actual installed plant rather than general manufacturers literature.
- Inclusion of pool plant within the O&M manual
- Water heaters and boilers - In each case it would be useful to have some basic information upfront so that identifying the correct item within the manufacturers literature was possible.
- Include reference to commissioning in this section or detail where the commissioning information can be found.
- Include details of the lighting strategy and how it varies in different rooms and areas
- include a description of the Trend 963 Supervisor software and which elements are scheduled within the software.

***Building User Guide(BUG)***

**Soft Landings**

- Develop Building User Guide with building users to determine what information would be useful and how it should be presented. Develop document throughout the design process rather than an attempt to "catch all" at handover.

## 5.4 BMS review and monitoring

This part of the BPE project ran in parallel with the handover of the building. During the project many discrepancies were identified between the BMS and meter readings as well as problems with the meters themselves.

The extent to which these discrepancies would have been identified had the BPE project not been running is not clear, but it is suspected that much of the metering may have been of limited use at the end of the defects period without this project.

Some key issues identified are:

- two electricity meters not working and one absent;
- main panel electricity usage about 10% less than suppliers' meter;
- main gas meter not on BMS;
- gas usage by sub-meters 10% less than total;
- solar thermal heat meters incorrectly installed;

- large discrepancies between all heat meters and the equivalent BMS readings;
- water supply to domestic hot water system initially not on BMS;
- initially good agreement between meters and BMS equivalents, but this got worse after changes to BMS in February/March 2012;
- water sub-meters usage about 15% more than main incoming water meter.

At the end of the project the above issues have now been resolved except:

- The discrepancies between main and sub-meter usage still present for gas;
- The correlation between the solar heat dump meter and the solar thermal meters needs more data before it can be checked.

Working out whether meters are working correctly and reconciling the data has been a very involved process. The controls sub-contractors are not necessarily aware of what the data they are recording means and therefore whether it is correct. Mechanical and electrical sub-contractors, main contractors and clients are all pleased to hear that the meters have been installed correctly, but don't necessarily check. Since no one is using the collected data, building handover can take place without rigorous reconciliation of the meters.

**Recommendations**

The BMS has been set up without data recording/collection. BREEAM, Building Regulations and TM39 require metering to be set up with the capability to monitor but without monitoring actually in place.
Perhaps if monitoring was required the metering would be more likely to be installed correctly in the first place.

## 5.5 Conclusion from aftercare, operation, maintenance and management

**Soft Landings**

***Soft Landings***
Whilst the reference to Soft Landings gathers momentum through the handover process it has been clear through the review of the overall process that it was not embedded or reinforced from the outset of the project as a holistic process. The emphasis on who owns the Soft Landings process needed more clarity. Currently design team members, client team and users see it as the responsibility for the contractor to manage at handover. The BSRIA Soft Landings guidance refers to the formation of the Soft Landing team at the inception and briefing stage.  This was not clearly established. However this is not isolated to the Oakham project and is common place across the industry where procurement processes and consequentially design processes predominantly focus on the end of the project at handover, and build in limited ownership of the project post handover for construction and design teams. Equally the soft landings process is relatively new and needs clients, design  teams and contractors to embrace it's use and take ownership of the process.

***The Building User Guide***
This document currently has limited acknowledgment other than to achieve the relative BREEAM credits. Given it's title, White Design will champion it's use in future and would recommend through this review that it should:

- be developed with the end user; i.e what questions do they have and what do they need to know.
- be updated at the end of the first year's occupancy of the building
- be initiated much earlier in the design process.

***Who uses the metering data?***

The extent of metering provided to meet BREEAM, TM39 and building regulations raises the question who uses and how are we using the data that these meters give us? School facilities manager's and care takers have not historically needed to be skilled in interpreting data across a range of new metering systems. The Oakham project does raise the need for more emphasis on training provided by the construction team and sub contractors to the end users on specific systems. It also raise the need for training generally outside of the project to facilities managers as a whole around what should they be looking for from the information provided through more complex systems and metering data and what should they do in response.

# 6.0 Energy use by source

## 6.1 TM22 Energy Analysis

### Data compilation

During the course of the study considerable effort was put into reconciling the meter readings between the physical meters and BMS and between sub-meters and meters. The BMS was reset on 16 April 2012 so that all BMS readings were the same as the corresponding meters.

The scope of this study is to provide an initial TM 22 analysis. This has been done based on manually collected data. The manual readings have been obtained from the meters and from the BMS. The cut-off date for data for use in this assessment was 21 June 2012, exactly 11 months after the handover of the building. The composite data set for gas and heat can be found in Appendix 15.

### TM 22 Analysis

The full report into TM22 Analysis and Energy demand and breakdown can be found in Appendix 15.

A ‘simple assessment’ has been undertaken using TM 22. This involves inputting the gas and electricity energy usage for the 149 day period from 24 January 2012 to 21 June 2012 and breaking the energy usage down into renewables (solar thermal) and ‘separables’ (swimming pool).

The results of the TM 22 simple assessment are summarised in Figure 3a (includes separables) and 3b (building energy demand excluding separables but including renewables generation).

Some observations on the results are as follows:

- there is a very marked contrast between the very low energy usage from the EPC calculations and the much higher raw TM 46 figure (this is a published benchmark for this building type);
- the raw TM 46 energy usage is dominated by heating fuel, whilst the EPC figure is dominated by electricity (Figure 3a);
- the building’s energy usage lies between the two benchmarks with or without the swimming pool energy usage – suggesting the benchmarks are not very helpful;
- electrical and gas energy usage in the building are approximately equal;
- swimming pool gas and electricity energy usage are similar and amount to about 40% each of the total gas and electricity usage of the building (Figure 3a);
- the building’s gas energy usage is more than three times the BRUKL figure, whilst the electrical usage is about 1½ times the BRUKL figure.

**Figure 3a:TM22 Simple Assessment Results**

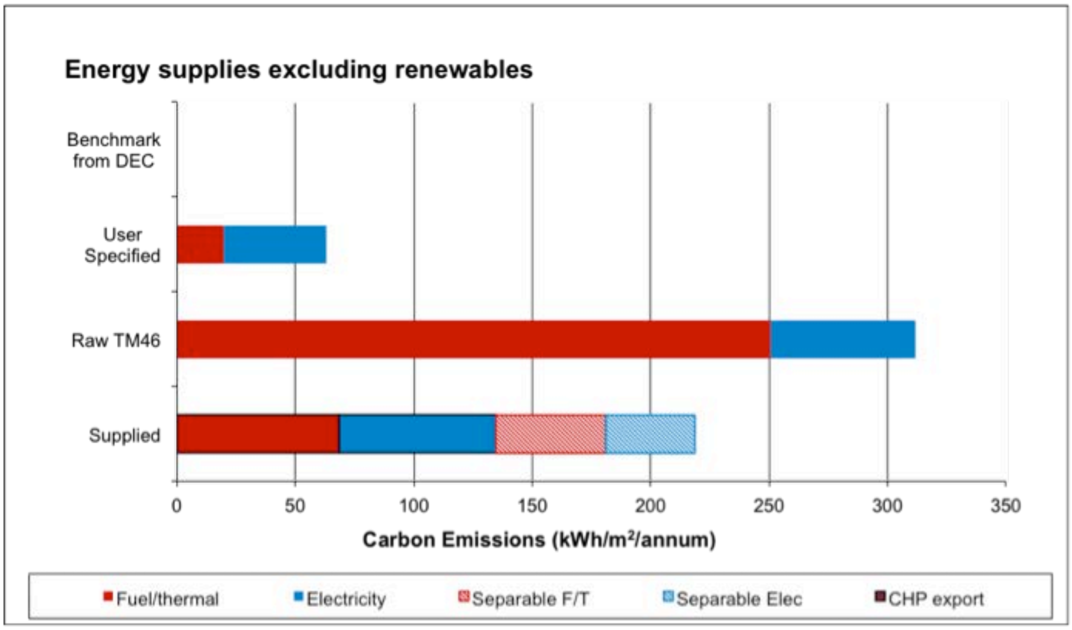
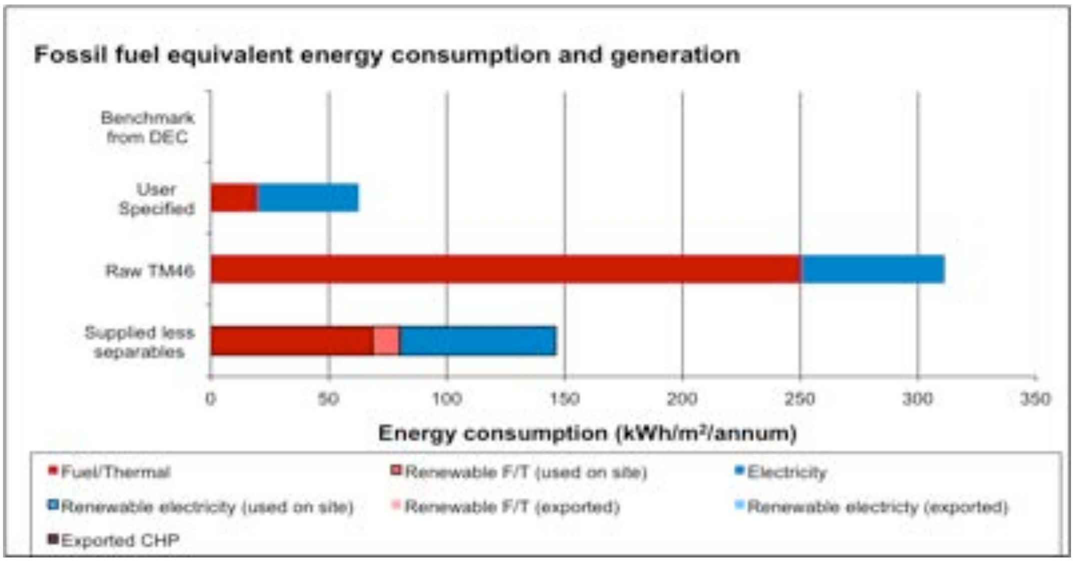



**Figure 3b: TM22 Simple Assessment Results**




## Further energy analysis

### *Overall Electrical Energy*

- Pool electrical plant dominates electrical usage at the school at 86,000 kWh/yr (the plot is truncated at 40,000kWh/yr - see Appendix 15 for further details)

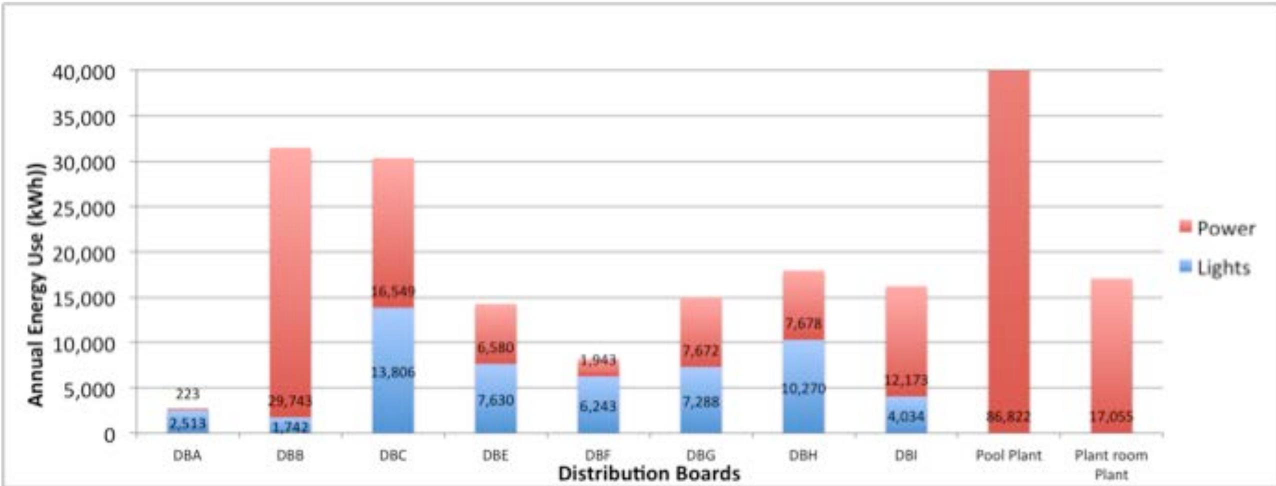
### *Lighting*

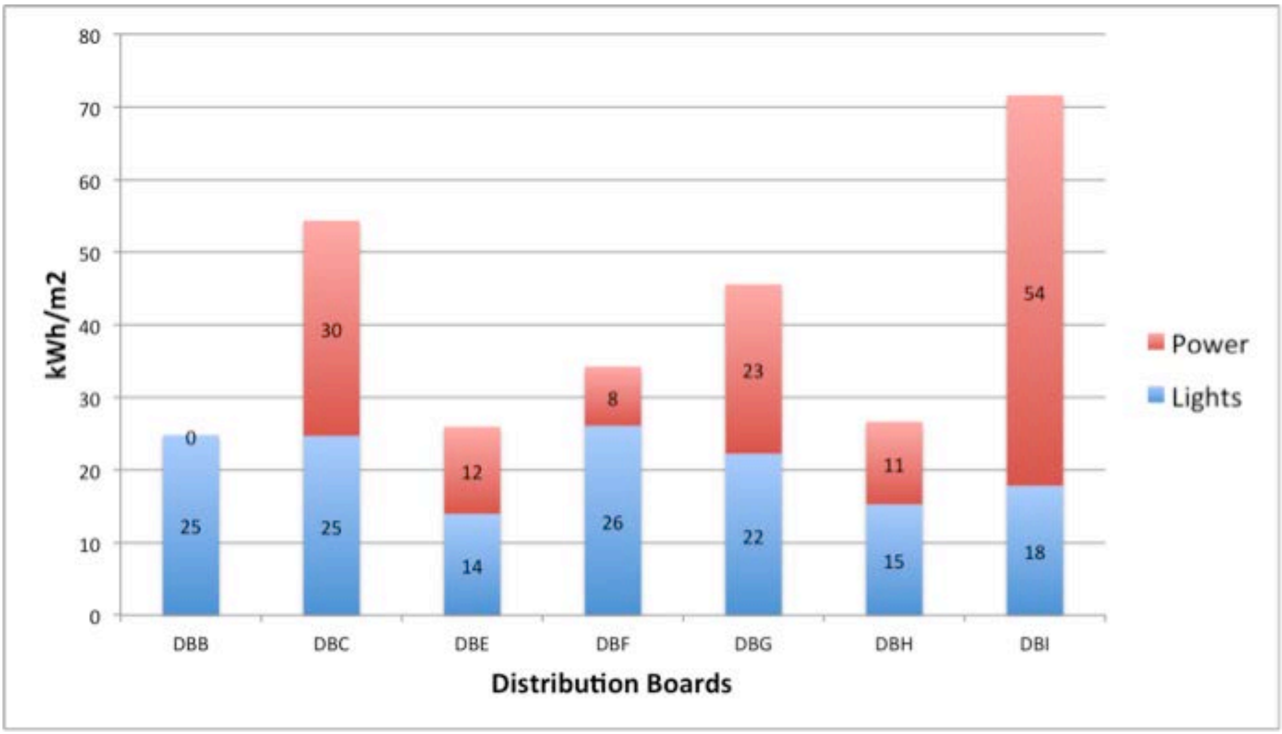
- The lighting energy use across the various building zones varies from 14-26kWh/m2/yr.
- Distribution Board F (DBF) has the highest lighting load, perhaps reflecting the longer occupational hours of the Ark nursery which has both breakfast and after school clubs. See Appendix 10 for details of Distribution Board Zone locations within the building.

- DBF also has a higher proportion of corridor than other areas, which may contribute to the higher lighting load per area.
- Generally the discrepancy between areas is still significant and further investigations of lighting usage are recommended to establish whether there are opportunities to reduce the lighting energy of all areas to around the performance of the best areas (DBE and DBH).

***Power***

- The much higher power usage of DBC and DBI than other areas is attributable to the metering of the servers, network switches and telephone exchange (DBC) and the condenser, extract fans and changing room AHU (DBI).
- Based on continuous operation (8360hrs/yr) the servers etc (1.13kW) would use 9898kWh/yr electricity. This is about 60% of the power usage of DBC and without this the power usage would be in line with other areas.
- In DBI, the toilet extract fans (2.2kW) are set to run for 72 hrs per week. This is equivalent to a further 8369kWh. The calculation illustrates that these items are capable of being responsible for the higher power usage of DBI.
- Comparing the other areas DBG uses a lot of power compared to the main teaching areas, even though several rooms in this area are not in constant use. This could at least in part be due to the Sensory Room cooling unit.
- The power usage of the LCD screens in each classroom is also considerable. The absence of a screen in DBF may be the reason for the lower power usage in this area despite the longer operational hours.






Recommendations on general electrical usage are as follows:

- A more detailed investigation of lighting usage including installed wattage and operational hours is warranted by the findings of the Zone C calculation. Investigation of the differences in behaviours in Zones E and H compared to other areas may also yield some savings. A saving of 10% of the >50,000kWh/yr lighting energy usage would save about £500/yr.
- The operational temperature of the IT server room is probably lower than it needs to be. An increase in the set point would have a big impact on the running hours of the 5kW condenser. Therefore, working with the school's IT advisers, consideration should be given to increasing the server room temperature from 19$^{o}$C to a reasonable maximum level of around 25$^{o}$C+. The savings are likely to amount to a few thousand kilowatt hours per year worth several hundred pounds. Rather than investigating the power usage of the plant, the change could be made and the benefits monitored through the BMS.
- Reducing the operational hours of the toilet extracts would also result in considerable energy savings if the hours could be reduced by a reasonable proportion. If the running hours of the fans could be reduced by 50% the savings would be around 3000kWh/yr worth about £300.
- A separate investigation of kitchen electrical energy usage would be warranted by the ~30,000kWh/yr electrical energy usage of the kitchen.

***Heating***

Nat vent

The data collected to date provides very little opportunity to break down the heating energy usage and analyse heating energy usage in different areas in more detail. Furthermore there is no detailed monitoring data available on winter temperature, UFH operation, $CO_2$ levels and window opening, so analysis of heat losses which could be controlled through improvements to operational and behaviour changes is not really possible.

However, some of the discussions from the follow up to the BUS including with the facilities manager indicated that the windows were opening in winter when it was cold outside. This occurs either because the room temperature exceeded the set point, or because the $CO_2$ concentration exceeded the set point.

The recommendation on general heating is as follows:

- It is recommended that these issues are investigated in detail by observing the temperature and $CO_2$ levels through the day on several winter days and in several rooms, together with the UFH and window behaviour. The effectiveness and set up of the optimum start and weather compensation should also be investigated. Based on the results, heat losses could be estimated. Reducing the heat loss may be a matter of programming the heating controls, but options such as opening internal doors to reduce $CO_2$ levels may also be effective. If 20% of the heating energy usage of ~200,000kWh/yr heating energy usage was attributable to this mechanism the cost would be around £1200/yr.

***Swimming pool water heating***

- The heating energy for the swimming pool water taking into account boiler heat losses is about 99,500kWh/yr.
- The set point of the swimming pool water is very high at 33°C because this is a hydrotherapy pool. This has been set based on experience of the users.
- The room set point is 29°C when the cover is off and 21°C when the cover is on. The humidity set point is 60%.

The pool AHU suppliers recommend that the air temperature set point is 1°C higher than the water set point. The actual arrangement is considerably different. It is likely that the lower room set point may make the water feel cooler due to evaporation heat loss.

Based on the above, the following recommendations are made:

- At present there are doubts about the functionality of the solar heat dump – this investigation should be complete;
- It is understood that the pool will be heated through the holidays – it is recommended that consideration is given to allowing the pool water temperature to fall during the holidays (depending on usage), perhaps by only allowing solar heating – the installers should be consulted regarding an appropriate set back temperature;
- If the room set point was raised above the water temperature as recommended by the AHU suppliers it may be possible to reduce the water temperature as evaporation heat loss would be lower. It is recommended that the pool water temperature is reduced to 31°C and the pool hall temperature increased to 32°C and that from this point further adjustments are made based on user feedback, always maintaining the room set point 1°C above the water temperature.
- If the room humidity set point was raised slightly from 60% to say, 65%, the rate of evaporation would be reduced, this would reduced heat loss from the pool water and may reduce the electrical energy requirement (see below). The AHU manufacturers have indicated that this would be acceptable. This could only be done with the approval of the swimming pool and building designers as there could be structural implications.

***Swimming pool power***

The swimming pool annual electrical power consumption is used primarily to condition the space and circulate the water through the filters. Electrical power is also used for mixing and dosing chemicals and running the pool controls.

The recommendations for saving on pool water heating will also affect the pool power demand, so for example reducing the heating hours of the pool should reduce evaporation which in turn should reduce condenser energy usage. Similarly increasing humidity should reduce condenser usage, but increasing the temperature set point will increase fan and condenser energy.

Further recommendations are:

- Investigate the potential to run the water circulation and or filtration intermittently and install a timer if feasible. An alternative might be to install a variable speed pump or duty assist pumps with lower kW ratings. A reduction in energy use by 30%, assuming that most of the saving was of day time electricity, would save about would result in a saving of about £900/yr.
- Consider introducing a holiday set back temperature for the pool hall of, say 15$^{o}$C.
- Instead of running reclaimed heat the toilet extracts to the kitchen AHU run this reclaimed heat the much shorter distance to the swimming pool heat pump. Requires engineering input and would probably not be cost effective, but would be a better solution than the kitchen reclaimed due to the much shorter distance involved and the more continuous heat demand of the swimming pool compared to the kitchen AHU.

## 6.2 Spot check monitoring

Spot check monitoring was undertaken on 5 and 6 July 2012. Monitoring for the following parameters was undertaken:

- Temperature ($^{o}$C)
- $CO_2$ (ppm)
- relative humidity (%)
- light (Lux)

The objectives of the monitoring were as follows:

- to confirm that the $CO_2$ and temperature measurement within the BMS was correct
- to evaluate the environmental conditions in key areas around the school

The weather was warm and mostly heavily overcast during the monitoring and the results are relevant in this context.

In most cases one reading was taken per room or area, but in some cases more than one reading was taken, for example Lux measurements with the lights on and off or in different parts of the room.

**Nat vent**

The roof lights in the school do not open when it is raining. However, on the two survey days some of the rain sensors were incorrectly indicating rain, causing roof lights to remain closed. This replicates the condition when it is warm, humid and raining.

### Results

The full set of results are presented in Appendix 8 of this report.

***Temperature***

- The external temperature was measured at 22.8$^{o}$C and 19.2$^{o}$C on 5 and 6 July 2012.
- Internally the temperatures were reasonably consistent typically ranging between 24 and 27$^{o}$C. Although within BB101 guidelines, members of staff felt this temperature range to be too hot.
- The pool and server room were at 28.7$^{o}$C and 19$^{o}$C, respectively, reflecting the set points of these spaces.
- The kitchen was visited just before lunch was served and it was expected that it would be very warm, but the temperature was reasonable at 25.1$^{o}$C. The cook complained that the small kitchen window does not open and the door was propped open with a mop and broom crossed over the doorway to prevent children entering.

**Nat vent**

- The natural ventilation was generally functioning correctly during the survey with coupled windows open in most spaces. However in breakout spaces the roof lights were often closed. When the sun was out during the survey the school did not suffer from excessive solar gain and the brise

soleil were generally found to be functioning well. The suggestion is, therefore that the temperatures were caused by high internal heat gains and low heat loss.
- Although there is no data to support this, the school was warm first thing in the morning during the survey, suggesting that the night did not provide sufficient opportunity for the school to cool down.

### *Relative Humidity (RH)*

- The external RH was 54.9% and 59.9% on 5 and 6 July respectively. The RH inside generally ranged from 47-58%, with corridors and breakout areas having some of the extreme conditions.
- Where circulation areas are well ventilated and not adjacent to classrooms eg stairwell and corridors at the front of the school the RH was relatively low, but the corridors and breakout spaces adjacent to classrooms had some of the highest RH levels. This is because the breakout spaces are ventilated by rooflights which were not functioning correctly on the days of the survey so they were closed in some cases.

**Nat vent**

- The RH levels were all well within the range of 30-70% indicated as acceptable in CIBSE Guide F and typically a little below the external condition suggesting that conditions internally were good and that the natural ventilation was generally working.
- RH in the pool hall was 65.7%, well above the set point, suggesting that the AHU may be struggling to maintain the set point.

### *$CO_2$*

- The external $CO_2$ concentrations were measured at 430ppm and 444ppm during the monitoring survey. Typical values in the school were around 450-700ppm, with high levels in enclosed spaces and busy classrooms above 1000ppm. The highest levels were as follows:
  - heads office, small room door closed following meeting – 1030ppm;
  - corridor breakout space, rooflight closed – 1140ppm;
  - room 41, active and full classroom, rooflight closed, blinds closed (perhaps impeding natural ventilation) – 1330ppm.
- These figures demonstrate the problem of stuffy air when spaces are not adequately ventilated. The head's office had the window slightly open, but opening the window further creates a hazard for children in the playground outside, so it cannot safely be opened further.
- It is notable that the $CO_2$ set point in the classrooms has been set at 2000ppm, above the recommended standard in Building Bulletin 101. This is to prevent excessive ventilation with cold air in winter.

There are no easily implementable recommendations to address high $CO_2$ levels as these essentially reflect the design, but some observations which have implications for future designs are:

- natural ventilation through roof lights is problematic as these need to remain closed in rain and therefore stuffy conditions may arise when it is raining;
- windows should be designed to open safely without causing an obstruction which could be a safety hazard;

**Nat vent**

- in classrooms where conditions are liable to become stuffy, natural ventilation is problematic as maintaining the air quality can result in excessive heat loss and discomfort through the influx of cold air.

### *Light*

External light levels during the survey were 5400 Lux below cloud cover and 51,000 Lux in sunlight. The survey monitored Lux levels in spaces, generally as they were found when visited. In some cases the contrast between lights on and off was monitored. Where possible the measurements were taken towards the centre of the room, away from direct sunlight, between artificial lights and at desk top level. Care was taken to stand away from the meter so as not to create shade.

- With the lights on the range was 180-2420 Lux, whilst with the lights off the range was 170-1880 Lux.

- The classrooms tended to be bright with lights off despite the often overcast conditions, with Lux levels typically 750-1500 Lux.
- Classroom 35 was an exception with 520 Lux. This was due to artwork on the classroom windows.

Whilst the survey is only a spot check and does not address the important issue of artificial light levels when external light sources are minimal, some conclusions can be drawn as follows:

- the building generally has good levels of natural light, particularly in teaching areas without glare being a problem;
- during the hours of the survey the brise soleil resulted in the southwest facing classrooms having less natural light than the northeast facing classrooms
- generally the lighting levels exceeded those in the specification with the exception of the stairwell.

**Recommendations resulting from spot check**

The spots check observations corroborated concerns around overheating stuffiness and therefore the natural ventilation strategy as a result this confirm our desire to focus on this area through the specific design investigation which is summarised in the next section.

**Nat vent**

- Natural ventilation design to ensure rooflights and clerestory windows operate independently to allowing adequate ventilation and $CO_2$ release even in rainy weather.
- natural ventilation through roof lights is problematic as these need to remain closed in rain and therefore stuffy conditions may arise when it is raining;
- windows should be designed to open safely without causing an obstruction which could be a safety hazard;
- in classrooms where conditions are liable to become stuffy, natural ventilation is problematic as maintaining the air quality can result in excessive heat loss and discomfort through the influx of cold air.
- Ensure artwork is kept away from glazed areas as this dramatically reduced lux levels
- It is recommended that the potential for night time ventilation is explored as a way of cooling the building in summer.

## 6.3 Benchmarking Oakham C of E School against other schools

The two tables below show EPC and DEC data for Oakham and other schools.

The benchmarking data from BSRIA, the second table, suggests that Oakham C of E Primary School performs well against a range of schools that have an EPC rating from within the last 3 years.

All EPC vs DEC data in this table show that the EPC rating is considerably better than the actual performance as evidenced in the DEC. Therefore Oakham School can expect to see an increase in energy consumption from EPC to DEC data.

Comparisons against local primary schools, the first table, are less conclusive as Oakham C of E Primary School does not yet have a DEC with which to make comparisons. None of these primary schools have an EPC as they were built / sold before this was a requirement.

However, this data will help to show the school how they compare when their DEC is published.

| Project | Postcode | Occupied | TFA m2 | Pupils | EPC/ BER | DEC 2010 | DEC 2011 | DEC 2012 | DEC 2013 |
|---|---|---|---|---|---|---|---|---|---|
| **Oakham C of E Primary School** | | 1 Sep 2011 | 2639 | 283 | B26 | N/A | N/A | N/A | N/A |
| **Malcolm Sargent Primary** | PE9 2SR | 1970 | 2096 | 630 | | 81 | | | |
| **Granby Primary School** | LE2 8LP | Victorian | 2000 | 442 | | 109 | 109 | | |
| **Sileby Redlands Community Primary** | LE12 7LZ | Victorian | 1181 | 220 | | 116 | 108 | | |
| **Glen Hills Primary School Academy** | | 2001 | 2430 | 500 | | | 74 | 71 | 48 |
| **South Wilford Endowed C of E Aided Primary School** | NG11 7AL | 2002 | 1362 | 290 | | 142 | 122 | 142 | 142 |
| **Old Fletton Primary School** | PE2 9DR | 1997 | 1714 | 320 | | | 101 | 92 | 92 |

| Project | Occupied | TFA m² | Pupils | BREEAM | EPC/BER | DEC/OR 2010 | DEC/OR 2011 |
|---|---|---|---|---|---|---|---|
| Bessemer Grange | September 2010 | 685 | | Very good | | N/A | N/A |
| Loxford School of Science and Technology | April 2010 | 14,610 | 2030 | Excellent | B (31) | N/A | E (116) |
| Brine Leas (Sixth form centre) | September 2010 | 2799 | 300 | Very good | B (36) | N/A | E (esf) |
| Stockport Academy | September 2008 | 10,490 | 900 | Very good | B (47) | E (106) | G (163) |
| Petchey Academy | September 2007 | 10,490 | 1200 | Very good | C (64)*** | G (200) | G (193) |
| Pennywell Academy 360 | June 2009 | 10,172 | 860* | Very good | B (34) | D (96) ** | F (146) |
| Cressex Community School | July 2010 | 11,624 | 500**** | Very good | B (31) | N/A | N/A |
| St Peter the Apostle High School | June 2009 | 16,185 | 1600 | Very good | B ( 25)***** | N/A | N/A |

TFA: Net floor area
EPC: Energy Performance Certificate
DEC: Display Energy Certificate
BER: Building Emission Rate in $KgCO_2/m^2$ per annum
OR: Operational Rating in $KgCO_2/m^2$ per annum
*Design figure. Current occupancy 1100+
**Error on floor area calculation
***Error on fuel source
****Currently under occupied full capacity is 1100 pupils
*****Scottish EPC which uses a different methodology

BSRIA

# 7.0 Technical Issues

## 7.1 Design Investigation - Natural Ventilation and Buffer zones

### Overview

A core part of the design strategy at Oakham was the sustainability brief. Key elements were:

- natural ventilation to teaching areas
- buffer zones to mitigate heat loss to the outside
- high-performance building fabric

This study looks in depth at the first two of these areas.

The natural ventilation strategy:

- What was the strategy?
- What elements (windows, actuators, controls) were specified and what were installed?
- Review of communication and decision making process
- How was the system installed and commissioned?
- Is it working as designed?
- Are the controls suitable?
- Review against other projects
- Conclusions - for Oakham and for future projects

The design of the buffer zones:

- How has the design of buffer spaces evolved and has this lead to improved performance?
- Has the external buffer space aided performance at Oakham?
- What design and in-use issues affect the effectiveness of buffer spaces?

These two areas of the design illustrate the importance of communicating design intent to end users and for the designer to understand the way the building will be used on a day-to-day basis (predicting and expecting behaviours). For example, investigation after occupation of the building showed that both doors to the buffer zone (inner and outer) were frequently kept open when ushering pupils in and out of the classroom. The photograph at the bottom of the page shows the inner door kept open during lessons.

Soft Landings could be better used throughout the design process to involve the end users in discussions about strategic options - particularly where these require the building to be used in a certain way to provide a suitable internal environment or to minimise heat loss.

The full findings of the investigation, including diagrammatic representation of the schools assessed can be found in Appendix 17.

The key findings and conclusions can be seen below, along with the Process Diagrams that were created as a dissemination tool as part of the Design Investigation.

### Key recommendations

Generic Design Recommendations - Ventilation:

- Design of building section should facilitate use of clerestory windows, instead of rooflights, for cross ventilation

Nat vent

**Lifecycle costs**

**Soft Landings**

- Discussions during early design stages should outline strategic options and costs
- This should be facilitated through the Soft Landings process, where applicable
- Detailed discussions between the design team and specialist sub-contractors / suppliers should cover:
    - controls / ease of operation for building users
    - level of front end control for facilities manager
    - separate controls for windows and rooflights
    - acoustic requirements of system (control of external noise and volume of noise created by system operation)
- Noise level of final system depends on control system options; it is best for automatic opening to be slower / quieter (minimising disturbance) and for manual opening to be quicker / louder (providing immediate feedback to the end user)

Generic Design Recommendations - Buffer Zones:

**Winter garden**

- Buffer zones should either be outside of the thermal envelope, or be unheated spaces
- If spaces are to be heated then users should have clear understanding of how the spaces can be used to preserve heat in the building and prevent unnecessary heat loss. This should be enforced through the Building Users Guide
- If the spaces are heated then a clear user guide or simple graphic could be used to help understand the principle behind the design
- Where easier alternative routes to the outside exist, the buffer zone will not be used and as such not reduce heat loss. Alternative doors leading directly from the classroom should not be included in the design if optimum use of the buffer space is sought
- If direct access to the outside is a desired brief requirement simpler, highly transparent and direct routes through buffer spaces should be implemented e.g Dewstow Primary School

Specific Recommendations for Oakham C of E Primary - Ventilation:

**Nat vent**

- Display clear user guide explaining ventilation strategy and window controls
- Ensure O&M manual provides sufficient information to enable Facilities Manager to make necessary adjustments to the system

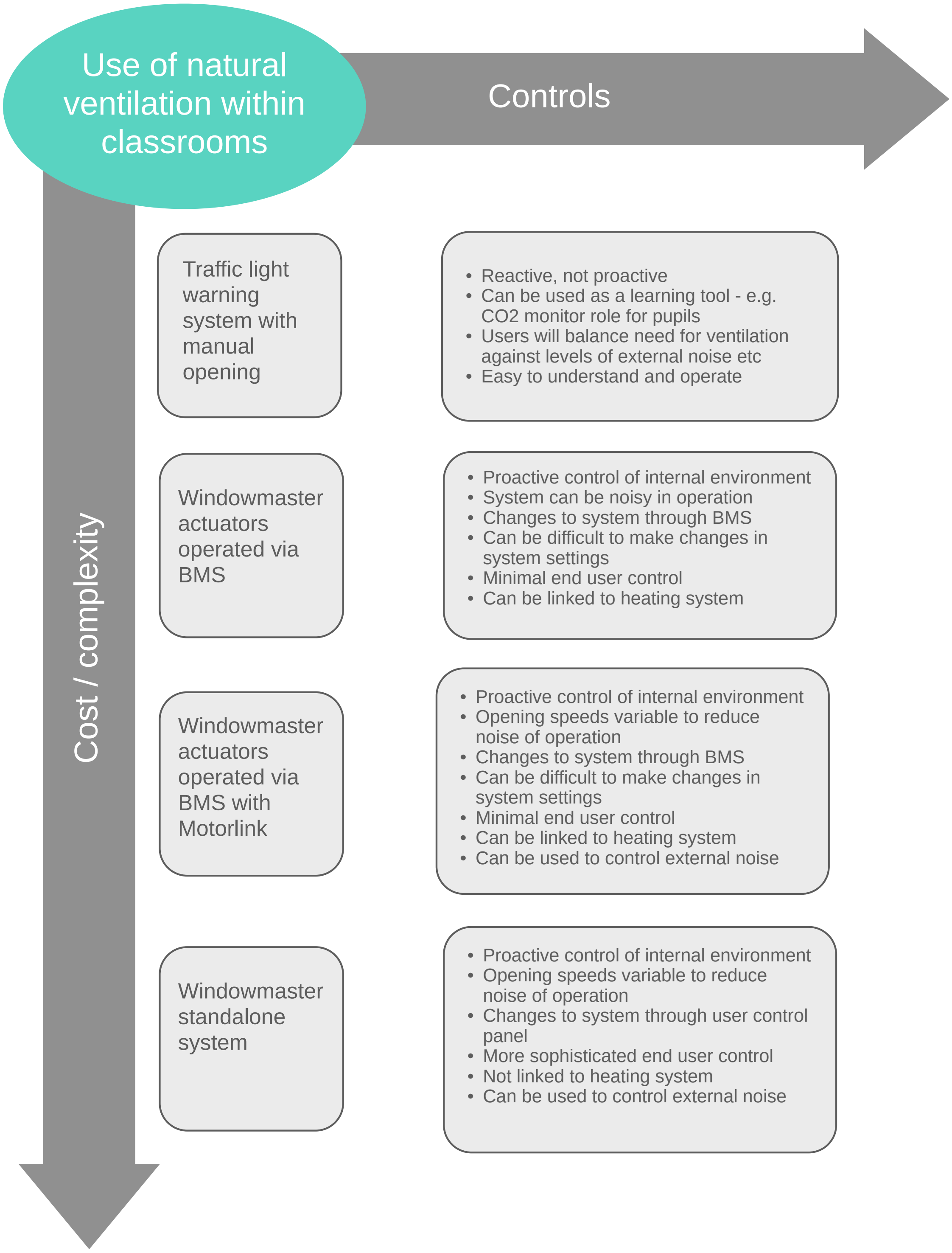
Specific Recommendations for Oakham C of E Primary - Buffer Zones:

**Winter garden**

- Continue to heat space as at present - ensure that internal cloakroom doors are shut before opening external cloakroom doors
- Stop heating this space
- Display clear user guide or simple graphic to emphasise the principle behind the design. For example, by promoting closing of external doors when internal doors are open

## Process Diagram for design of Natural Ventilation Systems

**Nat vent**



## Process Diagram for design of Buffer Zones

**Winter garden**

Use of buffer zones to reduce heat loss from classrooms

Environmental brief

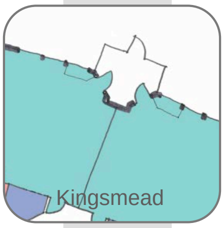
Educational brief

£700 M²

As a simple, tempered space for occasional shelter

Yes

- Space can be used as shelter, occasional use for wet play
- Untreated Space
- Use the airlock approach - keeping internal doors closed when external doors are open
- Preference for south facing glazing
- Clear entry/exit procedure
- Engage and communicate to staff and pupils

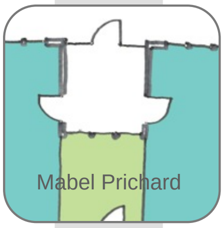



No

As external storage, a cloakroom or toilet

Yes

- Space can be used as additional storage space, cloakrooms and toilets
- Consider responsive, radiant heat source - not underfloor heating, if there are toilets in this area
- Use the airlock approach - keeping internal doors closed when external doors are open
- Preference for south facing glazing
- Clear entry/exit procedure
- Engage and communicate to staff and pupils




No

As occasional multi-use space - e.g. for wet playtimes

Yes

- Space can be used as additional storage space, cloakrooms and toilets
- Consider untreated “Cool Zone” space
- Use the airlock approach - keeping internal doors closed when external doors are open
- Preference for south facing glazing
- Clear entry/exit procedure
- Engage and communicate to staff and pupils


No

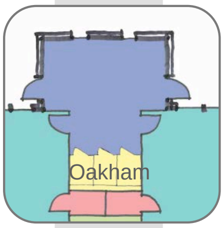
Below this line

The specification for the room is over and above that for lobby room, so falls within BB guidelines and is treated as part of overall building footprint

As daily-use additional teaching space

Yes

- Space can be used as additional teaching or break-out space
- Treated space
- Part of overall footprint of the building
- Building Regulations will apply e.g. Acoustics, Heat etc...
- Note: Oakham buffer zone is not used as “daily-use” teaching space, though specification




£2092 M²

## 7.2 Thermographic Imaging

The full Thermal Imaging report can be found in Appendix 1. The thermographic imaging study concluded that there were three anomalies noted through the investigation, these were:

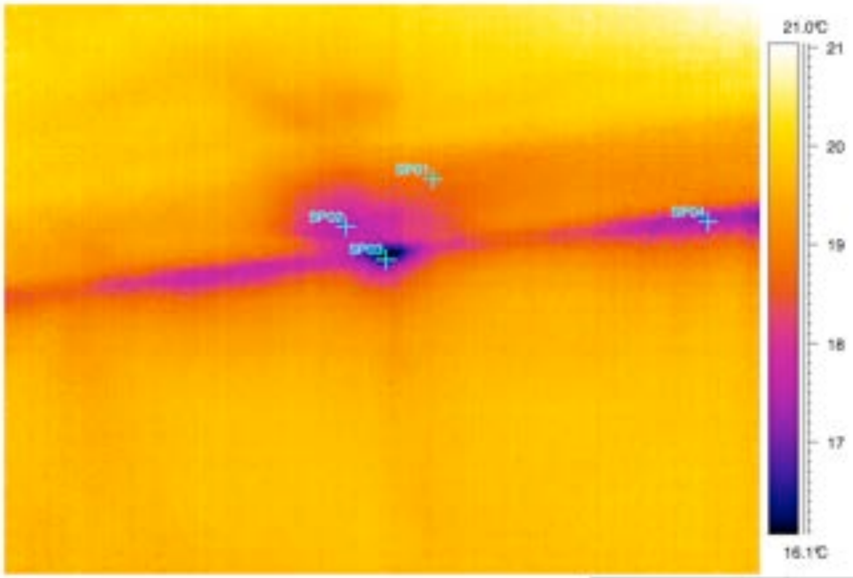
- cold spots on the walls
- some window and door frames appearing to have less than standard performance
- heat gathering at the top of wall at parapet level

The three anomalies have been investigated further to understand the reasons behind these results.

***Cold spots on the walls***

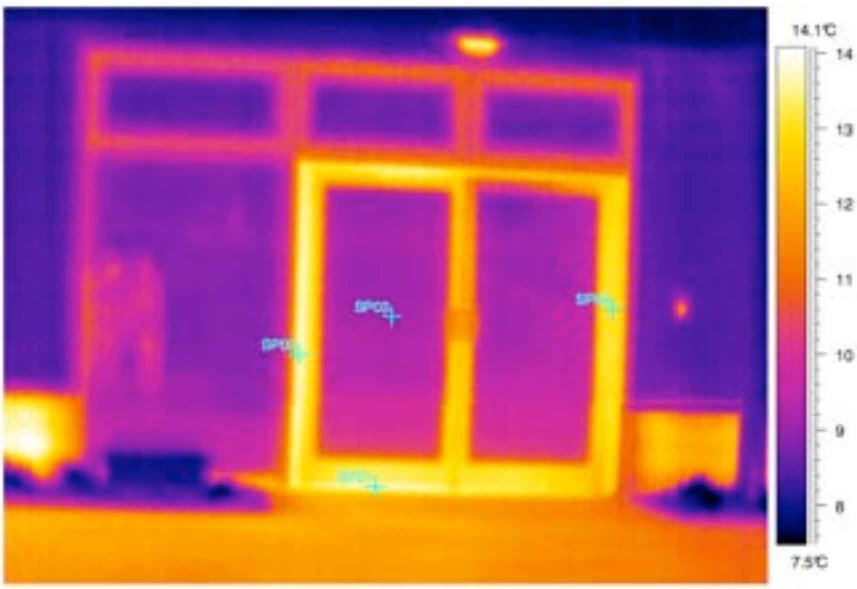
The cold spots on the wall were assumed by the report to have been caused by insulation in the wall being dislodged for example by the addition of external light fittings or similar.

There was a worry about the overall U-Value as indicated in the report. However, communication with BSRIA indicated that this was not a concern based on results of the thermographic survey:



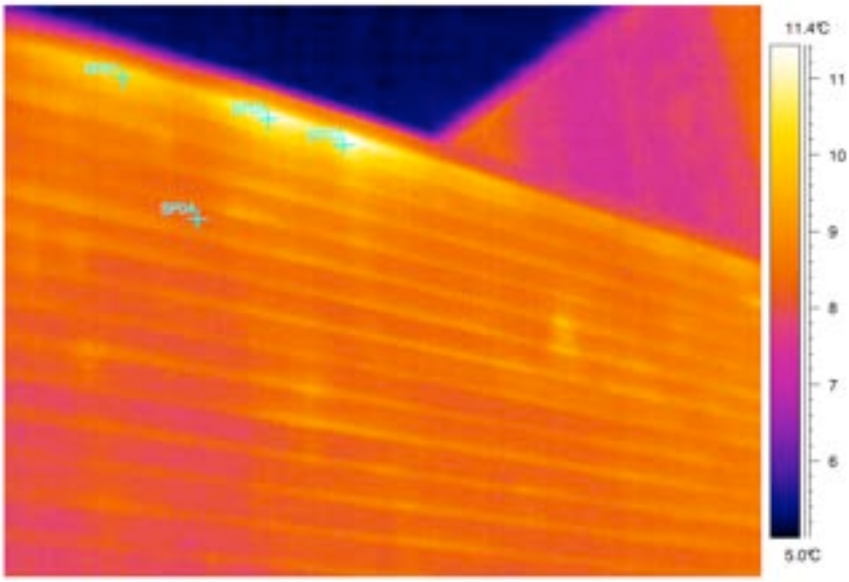

***Some window and door frames appearing to have less than standard performance***

The window and door operating systems are known to have had a problem returning to a fully closed position. This issue was present at the time of the thermographic imaging study and will be tested by a mapping the problem windows identified through the thermographic study against those that were known to have an issue closing. This may prove the correlation between these window and door anomalies.



***Heat gathering at the top of wall at parapet level***

The heat gathering at parapet level is expected to be caused by heat loss through the walls rising in the cavity behind the cladding and gathering at high level under the aluminium cladding.



# 8.0 Key messages for clients, owner, occupier and wider lessons

## 8.1 Summary of findings

The following table pulls together the key messages, conclusions and recommendations from the TSB BPE study at Oakham. It groups them under broad themes of Design, Systems, Information and Process.

The items identified in blue are those that are specifically relevant to Oakham school whilst the other items represent learning for us (the design team) and the wider construction industry to be taken into future projects.

| Broad themes | Item | Specifics |
|---|---|---|
| **Design** | **Design specification** | Change hand dryers in the Nursery and Foundation stage classrooms. This was noted at TSB Feedback meeting to headteacher who said this change would be a priority. |
| | **Design specification** | Ensure design team aware of effect of noisy hand-dryers for future design |
| | **Design specification** | Clear window not suitable for pool with regards H&S. |
| | **Design** | Would prefer a working kitchen away from D&T for hygiene purposes. |
| | **Design specification** | Office fire door needs push bar or something similar. |
| | **Design specification** | Button at main entrance of building too low, children can reach the button themselves.” |
| | **Design and Lifecycle cost** | For Oakham specifically it would have been possible to reduce overall heating energy consumption for the pool had below pool insulation been installed. |
| | **Design Ventilation Strategy** | Natural ventilation design to ensure roof-lights and clerestory windows operate independently to allowing adequate ventilation and $CO_2$ release even in rainy weather. |
| | **Design Ventilation Strategy** | Natural ventilation through roof lights can lead to stuffy internal conditions if these need to remain closed in rain. |
| | **Design Ventilation Strategy** | In classrooms where conditions are liable to become stuffy, natural ventilation can be problematic where maintaining the air quality can result in excessive heat loss and discomfort through the influx of cold air. |
| | **Design Ventilation Strategy** | It is recommended that the strategy for secure night time ventilation is further developed as a way of cooling the building in summer. |

**Lifecycle costs**

**Nat vent**

| Broad themes | Item | Specifics |
|---|---|---|
| **Systems** | **Electrical** | A more detailed investigation of lighting usage including installed wattage and operational hours is warranted by the findings of the Zone C calculation. Investigation of the differences in behaviours in Zones E and H compared to other areas may also yield some savings. A saving of 10% of the >50,000kWh/yr lighting energy usage would save about £500/yr. |
| | **Electrical** | The operational temperature of the IT server room is probably lower than it needs to be. An increase in the set point would have a big impact on the running hours of the 5kW condenser. |
| | **Electrical** | Reducing the operational hours of the toilet extracts would result in considerable energy savings if the hours could be reduced by a reasonable proportion. If the running hours of the fans could be reduced by 50% the savings would be around 3000kWh/yr worth about £300. |
| | **Electrical** | A separate investigation of kitchen electrical energy usage would be warranted by the ~30,000kWh/yr electrical energy usage of the kitchen. |
| Nat vent | **Heating and Ventilation** | It is recommended that detailed observation of the temperature and CO2 levels throughout the day on several winter days and in several rooms is measured, together with the under floor heating and window behaviour. If 20% improvement of the heating energy usage of ~200,000kWh/yr was achieved this could save around £1200/yr. |
| | **Swimming Pool** | it is recommended that consideration is given to allowing the pool water temperature to fall during the holidays |
| | **Swimming Pool** | It is recommended that the pool water temperature is reduced to 31oC and the pool hall temperature increased to 32oC and that from this point further adjustments are made based on user feedback, always maintaining the room set point 1oC above the water temperature. |
| | **Swimming Pool** | If the room humidity set point was raised slightly from 60% to say, 65%, the rate of evaporation would be reduced, this would reduced heat loss from the pool water and may reduce the electrical energy requirement |
| | **Swimming Pool** | Investigate the potential to run the water circulation and or filtration intermittently and install a timer if feasible. |
| Soft Landings **Information** | **Training (BUG)** | Provide clearer training to staff on use of lighting controls |
| | **Training (BUG)** | Provide clearer training to staff on reason for windows opening (CO2) |
| | **Training** | Better training given by suppliers on the use of metering and BMS data. |
| | **Training** | More generalised training given to building/facilities managers on the how to interpret energy/metering data. |
| | **O&M** | The basis of the metering strategy could usefully be incorporated within each of the mechanical and electrical sections of the O&M |

| Broad themes | Item | Specifics |
|---|---|---|
| | **O&M** | O&M provision of detail regarding actual installed plant rather than general manufacturers literature. |
| | **O&M** | Inclusion of pool plant within the O&M manual |
| | **O&M** | Water heaters and boilers, some basic information upfront required so that identifying the correct item within the manufacturers literature could be possible. |
| | **O&M** | Include details of the lighting strategy and how it varies in different rooms and areas |
| | **O&M** | include a description of the Trend 963 Supervisor software and which elements are scheduled within the 963. |
| | **O&M** | Include details of the lighting strategy and how it varies in different rooms and areas |
|  **Soft Landings** | **Building User's Guide (BUG)** | Use building users guide as an interactive tool to be used and added to through the design and construction process. |
| | **Building User's Guide (BUG)** | Should be developed with the end user; i.e what questions do they have and what do they need to know. |
| | **Building User's Guide (BUG)** | Could be updated at the end of the first year's occupancy of the building |
|  **Lifecycle costs** **Process** | **Lifecycle costs** | Time is required through the design processes to interrogate specification and design decision to achieve overall best project value. High value decisions are made at the outset of a project. |
| | **LIfecycle costs** | Design teams and client teams need to use the soft landings process for the continual interrogation and identification of the impact of design decision on ongoing lifecycle costs. This could be a regular agenda item in design team meetings distinct from cost reporting. |
| | **Soft Landings** | Soft landings process needs to be championed by all team members not just the contractor |
| | **Soft Landings** | Soft Landings team should be identified at the inception and briefing stage. |
| | **Soft Landings** | Client procurement processes should consider contractual arrangements where post completion activities are required of the design and construction teams, to work in collaboration with the end user to ensure best ongoing performance. |

## 8.2 Dissemination of the findings

We have carried out and plan the following dissemination activities in the bullets listed below:

- We have presented the outputs to our office on two occasions and embedded the reinforcement of the natural ventilation and buffer zone design brief information with design QA audits for future school designs. As a direct impact of this research the design process at St. Gregory's Sixth form college incorporated high level natural ventilation through top hung clerestorey windows. This allows roof level ventilation to be functional year round even when it is raining. This approach was used in earlier White Design buildings but has since been more difficult to implement due to the increase in cost to the roof design, which have more often favoured lower cost roof-light installations.
- We will upload the Design investigations and we have presented them as independent and downloadable pdf's for our website.
- We have planned a dissemination event with Rutland County Council.
- We are planning to present a second dissemination with either Bristol City Council or East Sussex County Council with whom we are currently delivering primary school projects.