ENTRY FORM

Refurbishment Project of the Year (value over £10 million)

The New Build Project of the Year Award is presented to the building project that most effectively demonstrates the achievement of high levels of user satisfaction and comfort and delivers outstanding measured building performance, energy efficiency and reduced carbon emissions.

Entries should be for projects completed during the period **1 April 2011 to 30 September 2012**. Entries may be submitted by any or all members (together) of the project team. This allows for a full year of data on the actual performance of the building.

Please complete the entry form below. The headings reflect the judging criteria and the judges will be looking for you to provide the relevant information under each heading.

Project Details

Project name
As you wish the project to be referred to throughout the competition.

Harrods Rooftop HVAC Infrastructure Project

Project Address

Harrods Store
87-135 Brompton Rd,
Knightsbridge,
London
SW1X 7XL

Organisations
Please provide the names of all organisations that you would like to be credited in your entry. Please ensure that the company names you list are accurate as we will be reproducing these on screen and in print. It is essential that you have the consent of all those named below to include them.

Building Services Engineer:	PSK Design Ltd
Building Owner:	Harrods Ltd
Building Occupier:	
Project Manager:	Riley Consulting Ltd
Quantity Surveyor:	Riley Consulting Ltd
Structural Engineer:	WSP Structural
Architect:	Woods Hardwick
Interior Designer:	
Mechanical / Electrical Engineer:	
Contractor:	Merit Merrell
Investment / Property Company:	
Developer:	

Entry Details

Summary
Please provide a synopsis of the project and its building performance, low carbon and energy efficiency objectives.

Harrods Ltd has over the last 10 years been focused on the enhancement of its engineering infrastructure in order to satisfy the demands of the store which continues to expand its retail square footage maintaining the existing footprint within the existing listed building.

The roof top HVAC project is a scheme which was started at a conceptual level over 10 years ago. The scheme was developed to replace the ageing infrastructures but at the same time introduce additional capacity to support the future expansion plans for the business. The ethos being to strive towards reducing energy consumption, improve comfort levels within the store, enhance the resilience of the system with the ability to respond to unplanned plant failure without impacting other systems.

During this period of refurbishment the retail offering has expanded from 925,227 sq.ft up to 1,381,691 sq.ft feet whilst the building's annual electricity consumption has decreased from 49,000MW to 41,500MW per annum during the same period. The reduction measures that have been achieved reflect the successful delivery the HVAC refurbishment project which on the backdrop of working within a Grade 2* listed building is a significant undertaking.

Considering these reductions have been achieved whilst increasing the overall footprint of the retail space (where you would normally expect to see an equivalent increase in the electrical consumption). This makes the project more meaningful and worthy of recognition.

The roof top infrastructure project has now been completed and the project team have not only delivered the brief but have exceeded the expectations set out 10 years ago.

Projected key objectives

Having committed to overhaul the HVAC infrastructure, Harrods established the key objectives to be achieved in delivering the project and what would be expected at completion when the store returns to normal service.

Future proof the system - Increase air volume to the store by 30% The existing air handling units serving the store were delivering approximately 500m^3/sec which would be required to deliver a minimum of 650m^3/sec.

Reduce shaft temperatures - When in cooling mode shaft temperatures are to be reduced from 16^{0}C to 13^{0}C to increase cooling capacity to shop floor.

Increase chiller capacity – The chiller capacity is to be increased from 10MW to 14MW to match the capacity of the new air handling plant for both increased volumes and reduce supply air temperature. The new machines should have high COP to reduce the impact on the electricity consumption.

Retain shop floor VAV concept – Due to the extensive nature of the ductwork system and the intrusive nature of changing philosophy it is imperative that the final solution adopts this system.

Reduce store hotspots – Hot spots in the store are to be eliminated.

Reduce energy consumption – As part of the infrastructure upgrade the stores' overall energy consumption should reduce to fall below the 10mw maximum demand whilst delivering the increased capacities and cooling loads.

Minimise plant footprint – With space in store being at a premium and the business continually converting back of house areas into retail, the plant solution must be delivered within the same footprint or if possible reduced.

Increase system resilience and robustness – The system would need to be configured to offer resilience across the roof infrastructures with the ability to share capacity and improve fault tolerance.

Respond to seasonal variations – The final solution should allow the system to quickly respond to seasonal variations with no delay in plant start-up or response.

Introduce Energy efficient lighting - Lighting loads to be reduced from 5.8MW down to 4.0Mw.

Please outline how your entry meets each of the entry criteria – judges will be looking for information in each of the sections when assessing the entries:

Any documents, charts or photos can be referenced and included in your supporting documents.

One year's evidence of measured building performance and energy use data, ideally including a DEC and an entry on the Carbon Buzz site.

The technical solution for increasing cooling, improving resilience and redundancy and as well as delivering a low energy solution has been achieved over a number of years through the delivery of the project. The tabulated data below (Graph in the supporting documentation) shows the reduction year on year of the electrical consumption. The cumulative effect of carbon reduction identifies that over 4000 tonnes of C02 is being saved each year.

The refurbishment programme has been extensive and there has been improvements across all aspects of the power and HVAC systems which has provided an overall reduction in electrical consumption of 18% whilst the retail footprint of the building increased by 5% yielding a gross electrical reduction of 25% when benchmarked against the floor area. (w\m^2 reduced from 111.1w\m^2 to 88.9w\m^2)

Year	Annum Consumption kwHr	Retail (Sq.ft)	CO2 Reduction (Tonnes)
2006	48,972,462	1,310,000	0
2007	47,085,315	1,344,134	990
2008	46,530,026	1,367,567	1281
2009	45,979,332	1,367,567	1570
2010	43,074,836	1,367,567	3093
2011	43,689,085	1,381,691	2771
2012	42,849,510	1,381,691	312
2013	41,342,804	1,381,691	4002

This information has been gathered from the building management system during the period of refurbishment

The Harrods management team review the energy consumption figures monthly and is a key aspect to how the projects gather support and internal funding.

Special challenges, objectives or constraints and the design solutions adopted.

The difficulties of working within a Grade 2* listed building which is also an icon for London and the tourist community was not used at any time as an excuse to avoid striving for the best technical solutions and taking on the big ideas. Whilst this created the hardest challenges the teams determination to work with the existing building has paid big dividends in the overall success of the project which can be measured in real terms with reduced energy consumption and improved internal environment.

The Harrods store is designed to operate using a full fresh air ducted system. The fresh air is delivered to the shop floors via large builders work shafts which traverse through the store from the roof top down through to the basement levels.

The existing rooftop equipment consisted of multiple air handling units set up in clusters located around the roof top. The units were served by air cooled chillers which were position within the zone serving the cluster of units with heating provided from a steam coils fed from the basement boiler room. The air handling units fan speed was varied to maintain the shaft pressures for the VAV system feeding the various dampers.

The air handling units operate on the basis of deliver tempered outside air into the shafts which are then controlled at each floor level using variable volume dampers. The VAV system acts directly on room temperature sensors by modulating the supply air volume to control the space condition.

The fresh air concept from the store is key to its operation as it provides the means to both heat and cool the store but to also maintain the fresh air quality demanded by the levels of occupancy and catering facilities within the store. The ductwork system is extensive and distributes throughout the store which has become part of the fabric of the building.

Whilst this is an effective means to condition the store, the continual expansion has challenged the system to the point where numerous operational problems were being experienced.

- Adjoining plant regularly failing, out of service and difficult to repair due to equipment no longer being supported by the original manufacturers.
- ·Existing air handling units were designed to deliver a short temperature of 16^{o}C which limited the opportunity for treating higher density cooling loads.
- Increasing number of hot spots in store due to central plant capacity unable to satisfy in store conditions due to supply air temperatures. Systems regularly struggle to meet the demands of the store retailers who continually seek higher lighting levels and more extensive display lighting schemes.
- When central air handling or chilled water plant fail, there was no ability to back up from other areas or share chilled water from adjacent zones as original plant concept was configured in clusters with limited flexibility.
- Existing plant struggled to respond to seasonal variations in external temperatures. Typically Spring and Autumn days that start cool and warm quickly during the day challenged the stores plant and internal conditions.
- The stores electrical intake is rated at 11Mw. This was regularly being exceeded and putting a strain on the electrical infrastructure. The demands of the retailers for more lighting, power and more cooling were limited by the maximum intake capacity

Infrastructure was a clear limiting factor for the stores expansion and with the increasing number of complaints from the retailers the infrastructure required urgent attention. Due to the scale of store and the extent of the problems experienced, the solution could not simply be solved with localised short term fixes, which would normally be applied in the retail sector.

Harrods recognised that a more holistic approach need to be adopted in order to address the problems being experience and secure the long term operation of the store. A complete overhaul of the HVAC system was required to address the internal conditions, reduce the stores energy consumption but increase the system's cooling capacity.

It was also imperative to introduce resilience to mitigate down time for plant maintenance or failure.
The solution was developed to deliver a completely new infrastructure which embodied the principles stabled by the stakeholder with the prerequisite that the project would be executed with no down time to the business or disruption to the stores operation.

The Strategy

With the objectives identified Harrods established a professional team with the necessary skill sets that could design and deliver the scheme. Due to the magnitude of the undertaking and the budgets involved, it would be necessary to deliver the new infrastructure in phases and the design would therefore need to reflect this without compromising the final solution.

Following a comprehensive evaluation of different strategies that could be adopted the final solutions encompassed techniques that were not normally used in HVAC solutions but when applied to the Harrod's principles, proved very effective.

Increasing AHU plant capacity by 30% - Working closely with the air handling unit manufacture we were able to establish a compact air handling unit which allowed the unit to sit within the same footprint as the existing units, with reduced length and larger cross section. The units' volumes were increased, however, simple units were configured to only incorporate one heating coil, one cooling coil and filler bank which reduced the overall energy consumption of the air handling unit. All the motors were selected to operate with variable speed drives to align with the pressure control regime whilst reducing power consumption. The specific fan power for each system was reduced providing increased air volumes for less W/(l/s). **Reduced from 3.0W/(l\s) to 1.6W(l/s).**
Air volumes have increased from 500m^3/sec to 670m^3/sec.

Reduce shaft temperatures for cooling - When in cooling mode shaft temperatures are to be reduced from **16^{0}C to 13^{0}C** o increase cooling capacity to shop floor. Considering the increase in volume and the decrease in temperature the stores **sensible cooling** capacity has increased from 4,500kW to 7,900kw which is a **75% increase** compared with the existing installation.

Energy efficient Lighting - A comprehensive programme of introducing energy efficient lighting has been undertaken throughout the store as a planned replacement with stringent specifications for new retail shop fit outs which is part of the regular turnover within the store. This policy is continually policed and has reduced the lighting loads from **5.8MW down to 3.1MW**

Ring main introduced at roof level – In order to improve the system resilience and link the many roof zones together a 300mm diameter ring main was installed where all the chillers and AHU's would link together on a primary header and operated as a variable volume system with 2-port control. The 2-port variable volume system was required to achieve the energy targets as the number of degree days where the building is operating at its balance point dictated that the plant would be operating at part loads and therefore lower pumps speeds.

This in its own right presented a difficult engineering challenge as the philosophy of operating a ring main requires a central plant solution with a primary and secondary pumping solution. Traditionally the chillers would be configured with constant volume circulating pumps on a primary circuit to maintain constant flow through the chillers with variable speed secondary pumps serving the ring main.
The problem with the traditional solution is that it requires all the plant to be located together to coordinate primary and secondary sides which was not possible due to the congestion at roof level.
The use of a primary pumping variable volume (PPVV) system was selected as the design uses fewer pumps and less piping connections when compared with traditional primary–secondary systems and there is a reduction in the ancillary items such as electrical supplies, controls, valves etc. However, the main benefit is a reduction in the power consumption and a much reduced plant footprint. These factors help reduce the initial cost of the chilled water system and the small footprint lends itself to sites that have constrained footprints such as refurbishments.

A PPVV design displaces the small, inefficient, low-head primary pumps used in primary–secondary systems. The pressure drops around the central plant previously satisfied by the primary pumps are instead satisfied by the main distribution pumps allowing for the selection of larger, more efficient pumps (with efficiencies similar to those of the secondary pumps in a primary–secondary system).

There are challenges in achieving this solution as varying the water-flow rate through the chiller evaporator poses a number of challenges.

- Maintain the chiller flow rate between the minimum and maximum limits of the evaporator to avoid chiller lock out.
- Managing transient flows without compromising stable operation in multi chiller plants and avoid evaporator freezing.

By working closely with the design team, chiller manufacture, control valve manufacture and BMS controls installer we were able to design out the these areas and deliver a simple, robust and energy efficient solution all within a compact footprint.

Increase chiller capacity – In order to deliver the increased chilled water capacities but reduced the overall electrical consumption selection of the chillers required high COP machines. To achieve the duties and COP targets a combination of water cooled chillers and air cooled chillers were selected to achieve the targets providing a **total of 14.7MW.**

Operationally this provided performance benefits as in the early and late season there can be wide swings in temperatures which the use of dynamic air cooled machines allowed them to be started, brought on line and operational quickly. The air cooled machines were configured to provide the base load cooling during the summer months with the air-cooled machines supporting during the peaks. **COP on the AC machines are 3.7 and 6.2 for the water cooled.**

Convert the roof infrastructure from Steam to LTHW - As part of the refurbishment works the decision was made to remove the old steam system and introduce LTHW via a steam\LTHW plate heat exchanger. This eradicated issues with high losses, leaks and safety and the system now operates as a weather compensated system delivering water to the AHU's between 40^{0}C and 65^{0}C reducing standing losses.

Specific elements of excellence and innovation in terms of design, equipment or application including lighting, heating, and cooling, façade or public health services.

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Specific energy efficiency aspects of the project, such as energy metering, monitoring and targeting, use of recycled/recyclable materials and other low carbon features.

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This involved the retrofitting of general circulation space lighting as well as display lighting to LED technologies whilst maintaining the lighting levels and colour temperatures.

Increasing AHU plant capacity by 30% - Working closely with the air handling unit manufacture we were able to establish a compact air handling unit which allowed the unit to sit within the same footprint as the existing units, with reduced length and larger cross section.

Whilst the AHU volumes have increased, their replacements were simplified and were configured to only incorporate one heating coil, one cooling coil and filler bank which reduced the overall energy consumption of the air handling unit. All the motors were selected to operate with variable speed drives to align with the pressure control regime whilst reducing power consumption. The specific fan power for each system was reduced providing increased air volumes for less W/(l/s).

Fan specific power reduced from 3.0W/(l\s) to 1.6W(l/s).

Primary pumping variable volume system

Evidence of costs and expected savings associated with these measures and anticipated payback periods.

Year	Annum Consumption (kwHr)	Retail (Sq.ft)	CO2 Reduction (Tonnes)	Cost Savings (£)
2006	48,972,462	1,310,000	0	
2007	47,085,315	1,344,134	990	£169,843.23
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2009	45,979,332	1,367,567	1570	£269,381.70
2010	43,074,836	1,367,567	3093	£530,786.34
2011	43,689,085	1,381,691	2771	£475,503.93
2012	42,849,510	1,381,691	312	£551,065.68
2013	41,342,804	1,381,691	4002	£686,669.22

Description of commissioning, handover and soft landings processes, and how they contributed to achieving the designer's intended building performance.

Extensive commissioning has taken place to set up the chilled water system.

Due to the complexity of creating a ring main to link all the AHU's and Chillers which operate as a primary pumping variable volume system it was important to ensure that once the system was completed that the differential pressure control of the pumps worked closely with the chillers to ensure that the flow variation to satisfy loads did not exceed the flow tolerance of the chillers.

To achieve the perfect system balance where the flowrate to the system needed to load match with the chillers to ensure that the minimum chillers operate to satisfy the demand. This required 6 months Of commissioning which included the seasonal variations to achieve the optimum system pressure, pumping capacities and control valve hysteresis.

The commissioning was undertaken in line with the CIBSE guidance KS9 – commissioning of variable flow pipework systems.

Evidence of collaboration between members of the project team that has contributed to improved performance.

The project has demonstrated strong collaborative working between the project team in the delivery of a complex project spread over a 10 year period. The ability to establish a strong design brief early in the process, maintain the principles through design and construction phases and finally deliver the project with no dilution of the original vision is very rare.

The project has been delivered without any down time to the stores operation despite the complete replacement of all air handling plant and chillers serving the store during the some of the coldest, wettest and warmest periods experienced in recent history.

The difficulties of working within a Grade 2* listed building which is also an icon for London and the

tourist community was not used at any time as an excuse to avoid striving for the best technical solutions and taking on the big ideas. Whilst this created the hardest challenges the teams determination to work with the existing building has paid big dividends in the overall success of the project which can be measured in real terms with reduced energy consumption and improved internal environment.
Evidence of any BREEAM or LEED assessment, or other third party evaluations.
Information has been based on the metered data collected by the stores BMS and EMS system.