CASE STUDY: DARWIN CENTRE

NATURAL SELECTION

THE NEW £78 MILLION DARWIN CENTRE is a scientific research and collections facility that is used by over 200 scientists at a time. It is an awe-inspiring public space, inviting you to explore the natural world in an exciting and innovative way. The architectural highlight is a 65m long, eight-storey high Cocoon – the largest sprayed concrete, curved structure in Europe.

The second phase of the Darwin Centre, designed by C F Møller Architects, completes the western site of the museum, uniting Alfred Waterhouse’s terracotta construction of 1881 with the first phase of the Darwin Centre, which opened in 2002. Like the rest of the museum, central to the design of both phases of the centre are three important roles: safeguarding the 17 million insect and three million plant specimens held in the building; providing research facilities for its scientists; and creating inspirational public spaces for visitors.

Interwoven throughout the Cocoon is the access offered to the public. Starting on the 7th floor, visitors follow a prescribed route, stopping at interactive components allowing them to ask questions of the scientists as they work. The centre also houses the Attenborough Studio, which is a state-of-the-art communication centre. Innovative technology, specimens, live animals, spectacular natural history film footage and museum scientists come together to create an inspiring programme of free daily films and live events.

The museum’s collections are unique and irreplaceable, and they help us understand more about the natural world. Because of this, and for many other reasons, the fire strategy needed to consider far more than the minimum requirement for life safety. Property protection and business continuity are equally important, and increasingly, security and environmental impact is climbing the agenda.

Codes and standards
Codes and standards provide a means to check compliance with the building regulations. However, the requirements for fire safety codes are often developed in isolation and focus on objectives for life safety or building protection only. In addition, such codes are generic and are therefore unable to consider the unique nature of large and complex buildings, such as the Darwin Centre.

British Standard 5494 is widely used in museum design for fire safety, as it lays down recommendations for the storage and exhibition of archival documents. In fact, compliance with its
main recommendations is a pre-requisite for certain buildings appointed by the Lord Chancellor for the deposit of public records, or for approval by the National Archives. This document, however, does not correlate to the unique collection of insects and plants at the Darwin Centre, nor does it consider the operational requirements of the scientist.

There is, however, a proposed European standard in consideration – BS PD 0024 (guidance to BS 5454) – to cover changes in technology. It is likely that any new BS EN will be much bigger in scope than BS 5454 because it will include all art and museum collections as well as documents, and it will also try to cover climate and seismic conditions.

Furthermore, the Darwin Centre is subject to Section 20 of the London Building Act 1939. This requires additional fire protection measures to be incorporated into the building design, usually the provision of automatic sprinklers to safeguard principally firefighters.

In order to achieve the aspirations of the architect and to ensure that the life safety and asset protection objectives are considered, it is often necessary to deviate from the codes and standards. A performance based approach will include all relevant design inputs, and will assess the fire safety design of the building based on its unique characteristics. For The Darwin Centre, performance based solutions were utilised to satisfy, amalgamate and rationalise the requirements of Section 20, the Building Regulations, BS 5454, and the client’s aspirations.

Fire strategy
The key to fire strategies for large projects of this nature is to develop sound fire engineering objectives that can be agreed with the many stakeholders. The key elements for the Darwin Centre were to:

- Develop a fire strategy that meets the legislative requirements for life safety primarily the Building Regulations and Section 20 but in addition the protection of the collection
- Consider the principles of BS 5454 but also the functional requirements of the museum, complementing the architect’s intentions whilst maintaining a fundamental level of safety
- Develop a strategy in close consultation with all relevant stakeholders, inclusive of the approvers, and especially the scientists (the end users). This is to confirm ‘buy-in’ to the fire safety principles at an early stage and ensure a smooth approvals process through design and construction
- Provide fire safety solutions that are applicable to the nature and use of the museum with consideration to capital and life cycle costs
- Develop a strategy that has optimum fire safety management provisions so that the building’s fire strategy is upheld through the life of the building

For this project there were many interested parties who were regularly consulted and brought together, when necessary, to address fundamentals issues in the design:

- The scientists from the departments of entomology and botany
- The museum’s health and safety manager and fire safety manager
- The museum’s engineering department
- The museum’s external fire consultant
- London Fire and Emergency Planning Authority
- The museum’s curators and fit out consultants
- The building services and security consultants
- Royal Borough of Kensington and Chelsea building control
- The independent approved inspector

Of those many stakeholders on the project, key members for fire safety are the museum’s team including the fire safety manager and scientists, as they have a fundamental understanding of the estate, the operations and the collection. Involving these parties in early design decisions prevented difficult issues later being passed onto the end users, leading to onerous operational responsibilities and inflexibility.

Risk assessment
A risk assessment is a key part of the recommendations of BS 5454; the process examines the likelihood of a fire in the collection and its consequences. This results in recommendations for passive and active fire systems or positive staff actions to reduce the risk to as low a reasonably possible. In order to carry out a probabilistic risk assessment, it would be necessary to obtain specific data on the number of fires in the various buildings that make up the museum’s estate over a period of time. Over the past 12 years there were only three fires on record. These were fires deliberately started in remote places within the museum (remote due to the high levels of security) and were contained at an early stage with limited damage.

Considering, therefore, the small number of statistical data for the museum as a whole, a comprehensive qualitative risk assessment was undertaken for the Darwin Centre. In each case, the risk assessment used a qualitative scale to represent the perceived risk, and the outcome determines whether additional mitigating measures are necessary.

It is important that the risk assessment separates the collection from the remainder of the building so that the genuine risk from fire to the collection can be evaluated. In addition to the assessment for the cocoons, a fault tree risk analysis (a more systematic and quantitative form of analysis) was undertaken with specific reference to the storage of ethanol for the adjacent Darwin Centre Phase 1 (zoology), which uses this hydrocarbon for specimen storage.

It was important to follow a logical process for considering the threat of fire to the collection. Our experience from the fire safety design of the Grand Egyptian Museum in Cairo, the British Museum Great Court project and the Scottish National Portrait Gallery, has helped develop the following methodology:

Prevention This will be influenced by the management of the building and is a proactive approach to the fire protection of the collection. The prevention strategy of ensuring that a fire does not occur by controlling ignition sources and materials/fuel sources in the space was worked closely with the security consultants and response team. And if a fire does break

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Suppression systems
When considering contents protection in buildings, the most common approach is to install an automatic sprinkler system, and this is recommended by BS 5454 and section 20. High pressure water mist and inert gas suppression systems are alternative approaches widely used in museum spaces. The former has no current UK approval which can make procurement protracted, although they are accredited throughout Europe and North America. Suppression was not part of the initial brief – the estate is not generally protected by suppression and there were no additional requirements by insurers. Some stakeholders were conscious that a suppression system would be a reactive approach to a fire, meaning that some of the collection would already have been lost, while others were aware of the overall benefits of sprinklers protecting the wider collection should a fire occur.

Therefore, as part of the trial designs under the performance based approach, we investigated and outlined the advantages and disadvantages of suppression so as to enable the design team, but more importantly the museum, to establish the optimum package of fire safety systems and procedures for the collection areas. The risk assessment process was used to inform the matrix.

When considering the effectiveness of each of the suppression systems in a matrix, the important aspect is the nature of storage of the collection. A relatively small number of sample specimens – usually trays of insects and plants – would be out of the main store and in the hands of scientists either being studied in the labs, or out of the Cocoon in the public exploration tour. The majority of the collection, however, is stored within cabinets in the two-hour fire resisting compartments of the Cocoon. So in terms of overall risk, an assessment of the inside of the Cocoon and the cabinets would inform how a fire may develop and whether any suppression system would be effective.

Historically, the collections were stored in wooden trays placed neatly in solid timber cabinets. But the trays were made of thinner wood than the cabinets, and that would mean ignition would be easier. Furthermore, the trays were stacked in a vertical orientation with the front open, allowing the gaps between the trays to supply oxygen to a fire.

In addition, the hydrocarbon Naphthalene (C8H8) used as a deterrent to pests had soaked into the timber over a number of years, which would contribute to the development of a potential fire. Clearly, the timber cabinets presented a significant combustible load in addition to the collection itself.

The assessment for the Cocoon also addressed the architectural finishes and furniture. No other furniture was placed in the space and the finishes were class 0 non-combustible, in accordance with BS 476 Part 6 and 7. Any accidental ignition is likely to come from faulty equipment of mechanical and electrical services, so the building services strategy, including equipment and facilities, was limited to:

- Lighting power supplies (fluorescent
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Fuel load, the storage of the collection in Naphthalene soaked timber cabinets was unacceptable. Normally a suppression system would be needed to control the potential fire development if a breach of security or an unlikely accidental ignition occurred.

Running concurrently to the fire risk assessment was the integrated Pest Management (IPM) strategy developed by the building services and environmental engineers. Pests are perceived to be the single largest risk to the collection, and unsuitable environments damage documents more extensively than any other single factor, according to BS 5454.

The storage cabinets were of great importance to a successful IPM strategy and were therefore given a Pest resistant rating of 1, requiring a permanent barrier. The choice of new cabinets were metal encased storage compactors mounted on metal bases, which run on steel rails set flush into the screwed of the floor. These are airtight storage systems that protect the collection from atmospheric conditions including light, temperature, humidity, pest and fire.

With the new steel cabinets, the likelihood of a fire involving the storage of samples has been greatly reduced. The stakeholders therefore agreed that the effectiveness of a suppression system would be limited in this situation, considering the full package of fire safety measures provided.

Summary
Developing fire strategies for museum buildings presents some interesting challenges for the fire engineer. Artifacts and collections can be locked away in fire resisting archives as a simple approach to fire safety. But protecting our national or international heritage from the effects of fire while complementing the architect's intentions and allowing the building to be used by staff or the wider public is the challenge.

Using a performance based approach based on a detailed risk assessment, and involving the key stakeholders for the project at the earliest stage, is key to a successful fire strategy. If the end users are consulted throughout it means that the building or the collection can be used in a day to day operation while maintaining a fundamental level of safety, so that our heritage can be enjoyed for many years to come.

Reducing the risk of fire included substituting the old Naphthalene-soaked timber storage (top) with metal encased and airtight storage compactors (above).

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References:
1. BS5454:2000 Recommendations for the Storage and Exhibition of Archival Documents