REPORTS:
2015 Annual Autumn and General Meeting
Fire Conference at Hampton Court Palace
QI Training Day in West Yorkshire
Spire Repairs at St Mary's, Clapham

FEATURES:
St Peter's, Pirton, Worcestershire
St Nicholas', Radford Semele, Warwickshire

TECHNICAL:
Fire Engineering in Heritage Buildings
Introduction
A material change to any building (including change of use) will require compliance with the Building Regulations or the Regulatory Reform (Fire Safety) Order. Existing structures will have to demonstrate suitable periods of fire resistance for the load-bearing elements (including doorways through them, some of which may be heritage protected). Consideration has to be given to fire safety, the building fabric and the contents.

Consultation with insurers will be necessary. A fire strategy will have to be developed to balance active and passive measures. Operational management has to be based on fire risk. Fire engineering is a useful discipline that can maximise a project’s potential without compromising safety, showing compliance with legislation throughout the process.

Fire Engineering Strategy
A fire strategy must be developed in consultation with the design team. It has to be a balance between:
- the risk profile of the building (the potential for a fire and its occupancy characteristics);
- the sensitivity of the building (its listed status);
- the active and passive fire systems which can be adequately incorporated; and
- the level of operational fire safety management.

Reliance is placed on a package of measures which demonstrate an acceptable solution under Building Regulations. The process of developing a fire strategy will generally be as follows:
- Determine project objectives;
- Identify key stakeholders;
- Understand project limitations;
- Undertake fire risk assessment;
- Understand the operational fire safety management resources;
- Apply necessary active and passive systems.

The process may start by assessing the current Fire Safety Management, which is done by researching:
- questions about day to day responsibilities;
- existing documentation;
- the relationship with the Fire Service; and
- the history of fires.

Fire safety in buildings has to be a balance between technical systems within the building and management. A higher level of management will be required for heritage buildings. Fire safety management is essential from initial design through the entire life of the use of the building. It must minimise the incidence of fire and, if a fire does occur, ensure that appropriate fire safety systems are in place and fully functional.

Effective management can contribute by:
- working to prevent fires occurring in the first place;
- monitoring the fire risk on an on-going basis and taking appropriate action to eliminate or reduce risk;
- knowing the people in the building and any special needs (disabled and/or elderly people, children, pregnant women, etc.);
- ensuring that fire safety measures are in working order; in particular the availability of a means of escape, training staff and organizing the evacuation plan, taking command in the event of fire until the fire and rescue services arrive, updating the Fire Strategy when changes occur (the introduction of split tenancies).

Designing a Building can be Managed
Fire safety engineers will relinquish most of their responsibilities when any work is complete and the building is occupied or in use. They will provide facilities and equipment to assist fire safety managers in preventing fires. Evacuation procedures and associated training should be as simple as possible, reducing the need for staff to have to make dynamic decisions. Consideration must be given to the number of staff and their capabilities.

Fire safety design must be in line with the normal use of the building. Providing simple information to visitors should ensure smooth escape. Understanding the level of fire safety management is therefore useful to the design. This can be deduced from an integrated view of the following:
- Reaction to day to day responsibility questions;
- Review of existing documentation;
- Relationship with the Fire Service; and
- History of fires.

CASE STUDY: CROOME COURT
Croome Court is a mid 18th Neo-Palladian mansion surrounded by an extensive landscaped parkland near Pershore in Worcestershire. The mansion and park were designed by LANCAOT Capability Brown with some of the internal rooms designed by Architect Robert Adam. It was built between 1751 and 1752 and is considered to be one of the finest examples of its type.

In November 2007, Croome Court was purchased by The Croome Heritage Trust, which leased it to the National Trust to manage while funds are raised for its restoration. The Manor opened to the public on 26 September 2009.

Approvals Process
Discussions with South Worcestershire Building Control and Hereford and Worcester Fire and Rescue Service raised a number of fire issues, including:
- Operating procedures to meet varied building uses;
- The main stairs not discharging directly outside;
- The narrow exit door from the basement (door width of 725 mm would normally limit capacity to 60 people);
- Open fires in entrance hall;
- Listed doors on escape routes.

Risk Assessment
The risk assessment for Croome Court could be described as:
- "The likelihood of an accidental fire in the building from a chimney or cooking appliance igniting a secondary combustible material and causing a significant fire that compromises the escape of occupants and staff and also fire spread throughout the building."

This risk was not considered to be high. The consequences of a fire should still be minimised. The greatest identified risk would be the refurbishment process and specific procedures were undertaken during the construction process.

The National Trust’s Fire Incident Reports (2011-13)
An evaluation of these fire incident reports revealed that:
- No incidents recorded for Croome Court during the sample period;
- Unwanted alarms, although high, are not excessively so. The greatest risk of unwanted alarms was complacency;
- The most useful information from the fire incident reports across the National Trust building stock was the cause of the fire (vegetation fires were excluded);
- The highest instance of fire was from a cooking source (44 incidents), followed by electrical (28).
Final Exit

Final exit should be to ground level and out to fresh air (BS 9999). The stairs either discharge into the Great Hall. Because this did not comply, a fire engineering solution was developed. This prompted a change in the evacuation process, using the (existing) narrow final exit door (725 mm).

Evacuation Modelling

Computational evacuation modelling was undertaken to consider the likely evacuation times from each floor based on the busiest event. It also looked at final exit time from the basement level. The intention was to show that, regardless of the small final exit door, there was sufficient holding capacity in the protected route for the numbers of people expected.

Six different scenarios were assessed and the results are tabulated below:

<table>
<thead>
<tr>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entry (Workplace)</td>
<td>Further Use of Basements</td>
<td>Further Use of Basements (Including Red Zones)</td>
<td>Further Use of Basements (Excluding Red Zones)</td>
</tr>
<tr>
<td>Time (minutes)</td>
<td>Time (minutes)</td>
<td>Time (minutes)</td>
<td>Time (minutes)</td>
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</tbody>
</table>

Modern Fire Engineering Approaches

The increase in knowledge of fire dynamics now available allows consideration of the potential fire in a room or building and the impact this may have on both the means of escape and any active and passive fire protection. BS 9999, for example, accepts that increased cooling of a space reduces the risk to occupants escaping as the products of combustion are above head height for longer periods. This can lengthen travel distances and reduce restrictions in widths of escape doors. Similarly, if the ventilation rate to the fire is of a higher percentage, there is likely to be less heat exposure to the structural elements. It is possible to determine the impact of a fire in different rooms on the passive fire resistance of the doors. It is also commonly recognised that fire spread beyond the room of fire origin is likely to occur at flashover conditions, not out of fire growth.

Using fire dynamics, it is possible to predict the heat release rate (HRR) for flashover in compartments. This can be related to a time or a fuel load density. If the time is significant or the fuel load is high, flashover is unlikely to occur during the escape period and will therefore have reduced impact on the doors in that room.

Fire Doors

Existing staircases are now protected enclosures. These, enlarged to include some corridors, have to be protected with new certified FD 300 fire doors (30 minute fire resistance with restricted smoke leakage). The following diagrams show the protected enclosures with red lines, indicating which doors needed to be upgraded.

The Fire Loading Matrix

English Heritage has worked closely with the Building Research Establishment (BRE) and Leeds University, to correlate the performance requirement of a fire door in rooms of different geometries with differing fire load potential. Through a series of crib fire tests, the BRE studied the temperature distribution in the room, mainly at door positions. The result is a matrix which prescribes the possible door upgrade requirements, if any, based on an assessment of room volume, fire loading, surface spread of flame requirements and fire load spacing.

The diagram above shows the assessment for one room at Croome Court.

Using the room volume, the time to flashover has been calculated in each room and is given below:

![Fire Loading Matrix](image)

Fire Alarm

The building will be fitted throughout with a new automatic fire alarm and detection system in accordance with L1/P1 to BS 5839 part 1. Standard sounders are provided in the Building. A voice alarm system with a prescribed message is used in the basement to facilitate escape in this unfamiliar area, as agreed with Building Control and the Fire Service.

The Croome Court Fire Strategy summarised

- The Client has understood the management implications of the principals in the Fire Strategy.
- The Fire Strategy has identified objectives (the safety of the occupants and protection of the building and its contents).
- The use of open fires has to be managed.
- Adequate means of escape have been provided.
- Computational evacuation modelling was carried out to demonstrate low escape times.
- Emergency lighting will be provided to support escape throughout the building.
- Escape signage will not be provided but will be considered for special events.
- A new L1/P1 fire alarm and detection system is included.
- The periods of fire resistance for the load bearing structural elements are acceptable, with upgrades to the lintel and plaster in specific areas.
- Adequate facilities for the Fire Service have been provided.
- Information on understanding the management requirements are highlighted in the Fire Strategy Report.