Fire Suppression in Historic Buildings

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For many years fire suppression systems have been distrusted. There is an assumed connection or association between sprinklers, the principal form of fire suppression used today, and fire alarms. People perhaps presume that if one sprinkler in a building goes off, they all go off. But in reality sprinklers and alarms perform quite different roles. Sprinklers are purely mechanical devices that deliver water to the point where it is needed most, not electronic devices like smoke and fire detectors. They are a simple and robust form of technology that has been in use for more than 100 years. In recent years much work has also gone into reducing the size and number of sprinkler heads needed to control a fire.

The objective of a fire suppression system is to 'knock down' and 'hold down' a fire so that it can be finally put out and prevented from re-kindling. The final extinguishment and 'break up' of a fire is usually the task of the fire service.

Where a fire cannot be 'seen' or reached because, for instance, the fire is seated within a bookcase or in a void, a properly designed sprinkler system will, nevertheless, control the fire by its wetting action, preventing it from growing outwards and upwards. Such a controlled fire will burn out, usually in 20 minutes, or be extinguished by steam. In contrast to a suppression (sprinkler) system, a fire extinguishing system such as a gas or mist system, has a far more difficult task, particularly where it depends on a single release of gas or mist. If the fire is not fully extinguished, it can easily re-kindle, so such systems must be designed to carefully match results on test fires in test rooms identical to the actual rooms in the building. Furthermore, they may not work if, for instance, a door or a window is left open.

One side-wall sprinkler located above the capital provides protection for this room and its contents. The house remained in continuous use throughout the installation, and by using special dust-extraction drills, this table was laid just one hour after installation.

The dome of the US Library of Congress – spot the sprinkler!

CONSIDERATIONS FOR INSTALLATION

A sprinkler system consists of three components: a water supply, distribution pipework and sprinkler heads. There are no detectors other than the sprinkler heads themselves and

there is no necessity for electrical linkages except to provide automatic notification – for example to the fire brigade and building managers.

WATER SUPPLY

The mains water supply may be sufficient in itself but if not, it will be necessary to install a storage tank and, if an adequate head of water is not available, a pump. For many historic buildings, the tank size required by the Loss Prevention Council (LPC) Code may, in practice, be unnecessarily large. This is one of the areas where expert engineering design may be called for to find a non-standard design solution.

Typically a fire in a residential building will be controlled by a few sprinkler heads requiring only a small supply of water to which the fire brigade can, if necessary, connect up when they arrive on the scene. In some cases a lake or a pond may be conveniently situated to provide an assured supply. Pumps can be powered by a diesel engine as a precaution against failure of the electricity supply, perhaps due to the fire. However, diesel engines require a fair amount of maintenance. In a recent project on a historic building and its particularly valuable contents, the insurers have agreed to accept a sprinkler supply which relies on mains water backed up by a small electric pump and tank alone.

PIPEWORK

In the past, distribution pipework was laid using steel pipes, but now copper, stainless steel and, most recently, plastic pipes suitable for potable water are also used. The pipe jointing system is a critical issue. In the case of plastic pipes, solvent welded joints eliminate all hotwork and avoid the problems of using large tools in confined spaces. Plastic pipes can also be cut to size on site and fitted into awkward spaces, so avoiding the need for costly prefabrication.

It is essential to design plastic pipework to maintain water flow in a fire; usually this means that each sprinkler head must be fed from two directions. The pipework is isolated from the supply by robust main valves and provision is made to drain down the system and to simulate the discharge of a sprinkler head for test purposes.

SPRINKLER HEADS

Sprinkler heads come in various designs. Modern miniature sprinkler heads respond rapidly when exposed to heat from a fire. The linkage in them is commonly a glass bulb containing alcohol that causes the bulb to shatter at a precise temperature. There are two main types: one sprays water equally in all directions and is usually set in a ceiling; the other is a sidewall sprinkler which has a deflector fitted to it which enables it to throw the water from the wall. It is the latter type of sprinkler that has a particular application in historic buildings. Both types have considerably enhanced coverage by comparison with their predecessors. So-called ‘concealed’ sprinkler heads are also available which are hidden behind a flat plate that drops off in a fire. Unfortunately the plate has to stand slightly proud of the adjoining surface making it visible and the performance of a ‘concealed’ head in a fire is slower so the whole system must be correspondingly beefed up. These considerations usually negate any benefit in historic buildings.

The mechanical works for this sprinkler system are hidden in cupboards beneath two public telephones

PROS AND CONS

Effective fire prevention measures such as staff training and smoke detection systems are often relied on as an alternative to fire suppression. Yet early warning by smoke detection is very far from being a guarantee against fire loss, and it can be completely ineffective, even with automatic dialling. Disasters such as those at Uppark and Windsor Castle happened despite the prompt attendance of the fire service.

Most fires in sprinklered buildings are controlled by the action of one or two sprinkler heads at most. Sprinkler heads are basically valves that are held shut by a temperature sensitive linkage. They are rated to respond to the sort of temperature that can only be the result of a flaming fire. By the time a sprinkler head goes off the fire that set it off has, by definition, reached the stage where only water will stop it. By acting directly onto the seat of a fire, sprinklers reduce the level of water damage compared with the only alternative, the fireman's hose or hydraulic monitor. By acting early in the development of a fire, both fire and water damage are minimised. The often repeated assertion that sprinklers are synonymous with water damage is therefore nonsense.

Properly designed, a sprinkler system provides the highest possible assurance against significant fire damage to buildings and their contents. When, a few years ago, the IRA firebombed Oxford Street, those shops that were unprotected by sprinklers were gutted. Those that had sprinklers were trading again immediately. Life safety is also enhanced in a sprinklered building. The only blemishes on the near perfect safety record of sprinklers have resulted from failures that have occurred where either the system was not correctly designed or when the main valves were closed off at the time of the fire.

THE EXPERTS' VERDICT

The benefits of sprinklers have long been recognised by the insurance industry. Discounts on premiums are given for properties protected by sprinklers. The Loss Prevention Council (LPC) in the UK sets very exacting standards for the installation of sprinklers on behalf of the industry. These are set out in the *LPC Rules for Automatic Sprinkler Installations (incorporating BS 5306: Part 2)*.

The benefits of sprinklers are less well recognised in the Building Regulations, largely because sprinklers have been thought of as providing protection to property rather than life safety. However, this situation is changing and, increasingly, regulatory authorities are prepared to take carefully designed fire engineering solutions into consideration.

Although English Heritage has given no clear lead on the value of sprinklers in historic buildings, the case for fitting them has gained authoritative support from Historic Scotland by way of Technical Advice Note 14 *Installation of Sprinkler Systems in Historic Buildings*. In America the debate is virtually over. For instance, the National Parks Authority, which is responsible for many of the USA's most precious historic buildings, makes widespread use of fire engineering techniques and has installed sprinkler systems in many of the buildings in its care. The fire codes in most of the individual states are based on the NFPA (National Fire Protection Association of America) Codes. Of particular relevance are NFPA 914 *Recommended Practice for Fire Protection of Historic Structures* and NFPA 909 1997 *Standards for the Protection of Cultural Resources Including Museums, Libraries, Places of Worship and Historic Projects*.

INSTALLATIONS IN HISTORIC BUIILDINGS

The case for installing fire suppression systems in historic buildings is a strong one. Old buildings are particularly susceptible to fire damage, a large number of listed buildings are damaged by fire every year, many of them being burnt to the ground. If a modern warehouse is destroyed by fire, the building and its contents can usually be replaced if the money is there to do so, whereas historic buildings and their contents are, by definition, irreplaceable except by replica. It is therefore important to take measures to prevent fires from getting out of control.

Those who are familiar with sprinkler installations in commercial buildings will be understandably horrified at the thought of serried ranks of sprinkler heads popping through drawing room ceilings and the nightmare of threading bulky pipes through the delicate fabric of an old building. It does not have to like this. The design of sprinkler systems for historic buildings requires a completely fresh approach. To begin with, the level of protection required can be drastically reduced by comparison with a warehouse building. The average sized bedroom in a country house can usually be protected by no more than a single sprinkler head. In a relatively elaborate interior they are easy to hide particularly by using the sidewall type of sprinkler head which gives remarkably good coverage. In plainer interiors much can be done to minimise their visual impact, bearing in mind that a modern sprinkler head is a fraction of the size of a smoke detector and can be finished to match the surrounding decorations.

The use of sprinklers may enable existing doors to be retained without alteration, as a carefully positioned sprinkler head may enable even a modestly constructed door to withstand the effects of fire, not for half an hour or an hour but,

in effect, indefinitely. In the same way glazing can be similarly ‘upgraded’ and local authority building control officers acknowledge these ‘trade-offs’.

A plastic sprinkler pipe with solvent-welded joints being installed in a convenient ceiling void below the floor joists

One of the first sprinkler systems installed in a historic building in the UK was at Duff House, a William Adam masterpiece in the north of Scotland. This project, which was managed by Historic Scotland in the early 1990s, was designed to provide comprehensive protection for the building. The system was remarkably successful in discreetly placing the sprinkler heads so that they go virtually unnoticed. In the mid 1990s a grand Georgian country house in Northern Ireland was the next major project of its kind. Here the sprinkler system was run in LPC-approved plastic pipework, which enabled it to be installed with virtually no damage to the fabric of the building, while the building remained in use. Not only is the installation almost invisible, but much of the clutter of earlier fire safety installations was removed at the same time. Significant projects followed at the ancient Parliament House and at the National Library of Scotland.

One of the most interesting of the more recent sprinkler systems is at Newhailes on the outskirts of Edinburgh. This delightful house of the Scottish Enlightenment by James Smith, 1686, was refitted and extended by William Adam from about 1720. Here the National Trust for Scotland has embarked on a fascinating conservation project. The philosophy of this project, ‘to conserve as found’, is at variance with the requirements for visitor access. The fire officer’s requirements started out being, frankly, horrendous but they virtually melted away when the intention of providing a sprinkler system was introduced. The challenge at Newhailes is to minimise visual or physical intervention. Newhailes is an extraordinary survival with a very simple yet fragile interior. All involved in the project are agreed on one thing: if it can be done here, it can be done anywhere.

Achieving such objectives often means that tortuous pipe routes have to be found through the fabric. In some cases pipe sizes far below those normally associated with commercial installations may be the only answer. The starting point must be the availability of accessible voids. The system must be designed to fit the building. To guarantee the effectiveness of such a bespoke system, the hydraulic design of every part of the system needs to be carefully worked out. This dictates a very different approach to the normal industry standard for sprinkler installations. By contrast, in a warehouse or a large modern retail unit the obvious arrangement for sprinkler pipework is in a grid. Such sprinkler systems are invariably designed and installed by specialist contractors in accordance with a system of rules. This approach is not suited to historic buildings where a more fundamental level of engineering design is required and, inevitably, the detail is not known in advance of the work.

Other issues that have been addressed in recent projects include the use of pipework materials that ensure that the sprinkler water comes out clean, the elimination of ‘hot work’ and, in one case, the use of sprinkler pipes to actually heat the building, so greatly reducing the total quantity of services installed.

Alternative forms of fire suppression which offer the prospect of even less water damage are being developed. These work on the principle that the hot smoke rising could draw in a mist of fine water droplets, smothering the fire. There are, however, a number of drawbacks. As with gas extinguishing systems, the enclosure must be near perfect. The technology and its underlying engineering principles are nothing like as tried and tested, and the systems are not simply mechanical like sprinklers so there is a risk of accidental discharge. As yet the reliability of such systems is not proven, so the extent to which regulatory authorities will accept their use to trade off more basic life-safety measures will be, at best, limited.

If there is a weakness in the case for installing sprinklers in historic buildings it is a lack of experience and expertise among building conservationists, consulting engineers and contractors. Nevertheless, the fundamental case for the application of fire engineering principles to the protection of historic buildings, as opposed to ‘cook book’ and regulations-based approaches, is overwhelming. Already, those in the field of building conservation who have grasped this particular nettle, look at projects like the restoration of Windsor Castle (where no fire suppression was installed) with some amazement, knowing that a single sprinkler head would have prevented the original tragedy.

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