



Fires are perhaps the greatest threat which face those responsible for safeguarding heritage buildings. While other risks such as theft, flood and even insect or fungal infestation can damage heritage items, only fire can destroy it absolutely. Each year, throughout the world, there are fires in all types of historic and heritage buildings. A number of these outbreaks reach serious proportions where measurable fire loss can soar to millions of pounds. The loss of important artifacts, cultural resources and national heritage mean such fires are among the most feared.

While it is difficult to determine the exact extent of the loss both English Heritage and Historic Scotland have suggested that a building of major national importance is lost or seriously damaged by fire each week. A list of recent major UK and European heritage fires is shown on page 4.

Most heritage authorities and organisations have accepted the principle that the best way to guarantee the future of a building is to keep it in use for its original purpose. Only where this is not possible will a change of use be considered although it is clear that significant strides have been made in finding appropriate alternative uses for many historic buildings. Dwellings have been created from structures as diverse as mental hospitals and barracks, old spinning mills have provided units for small businesses and shops have been created out of flour mills and warehouses. The recent conversion of an Edinburgh orphanage into the Dean Gallery of Modern Art is an excellent example of this practice.

Following the Windsor Castle fire, the enquiry chaired by Sir Alan Bailey concluded that sprinklers could play a useful role in the protection of heritage buildings especially where it was difficult to introduce other fire protection measures such as improved compartmentation. In fact, just as in new buildings, where the introduction of sprinklers can greatly assist the architect in bringing to life exciting new concepts in building design, sprinklers can, in many cases actually make it

possible for a historic building to meet current fire safety standards.

In the UK in the past 10 years there has been a realisation by many heritage professionals that sprinkler protection provides new levels of flexibility and often the ability to meet current fire regulations without major structural alterations.

#### Case Study 1: National Library of Scotland

The George IV Bridge Building was purpose-built to house Scotland's premier library and collections and is a Category B listed building. The building has a complex layout over three floors above the level of the George IV Bridge and seven below it.



In 1988 the 'ownership' of the Library was transferred from the Crown to the Library's Board of Trustees. Until then the Property Services Agency (PSA) was responsible for all aspects of building maintenance, property management and fire safety. The Trustees appointed a Buildings Manager to carry out the work previously undertaken by the PSA and it became clear that not only did the George IV Bridge building not have a fire certificate but that all previous fire safety activity had been undertaken solely to ensure that the building complied with fire safety legislation relating to means of escape in case of fire. Following the delivery of the new Building Manager's report the the Library was faced with the realisation that:

- the physical structure and layout of the George IV Bridge building bridge structure was fundamentally unsafe and unsatisfactory for its purpose;
- these problems, combined with the fuel load which the mainly paper based collections constituted, made it inevitable that anything other than a minor fire would be utterly disastrous;
- the building design no longer matched the requirements of fire safety legislation and could not be given a Fire Certificate (without substantial modification), so that continued occupation by staff and users was highly problematic.

#### Sprinklers in Heritage Buildings:

- Can compensate for inadequate means of escape.
- Provide an alternative to compartmentation.
- Sprinkler protection can help historic buildings comply with the current building regulations.

The discussions which took place looked at two possible alternatives:

- vacate the building - that is, relocate the archive/storage functions to another site. This was unrealistic and **incompatible with the Library's mission and objectives**;
- protect the building - by installing an active fire fighting system (probably based on automatic water sprinklers) which would provide immediate response to any fire in the library and ensure that the steelwork was kept below its deformation temperature and prevent structural collapse.

(There was, of course, a third alternative - to do nothing in the hope that the building, which had avoided a serious fire for some 50 years, would continue to be lucky.)

In the event, the decision to retain the George IV Bridge building was perhaps the easiest part of the process. The site was too steeped in its history and the central city location was too firmly established for evacuation to another location to be a realistic option.

The decision to undertake a major programme of fire protection improvements was taken in 1992 building on studies undertaken in 1989. The comprehensive plan was implemented in two phases over 8 years:

Contract 1 involved the construction of a new North Staircase which was driven into the building through all of its floors to provide (for the first time) a direct fire exit route from the Reading Room. Other benefits from this Contract included the creation of additional space at the same level as the Reading Room

Contract 2 involved the installation of a second external fire evacuation staircase running the full height of the building; the installation of sprinklers on all stack floors and public spaces; the renewal of electrical, heating and ventilation plant and lifts.

Additional benefits provided under Contract 2 included the creation of a new roof top space (made possible by the relocation of new ventilation plant on the roof itself) which it is anticipated will be fitted out to extend services to users in the future.

Apart from the extent of the suppression system it is noteworthy for a number of reasons:

- stainless steel pipework was used for the system. The **decision to avoid the use of 'black' steel was not taken** lightly- when consideration is given to the problems of corrosion and sludge formation in black steel, it can be seen that the benefits of stainless steel are considerable. In fact, when taking into account reduced labour costs and the cleanliness of the installation it has become increasingly clear that stainless steel is a viable alternative;
- most of the system was prefabricated off-site. This offers many advantages, not the least of which is the elimination of some potentially hazardous processes which would otherwise have to be carried out in proximity to the collections;
- the huge number of joints in the smaller pipes used neoprene seals and were crimped, rather than being formed by brazing, making this element of the work both rapid, clean and safe;



Stainless Steel pipework can be a quick & clean alternative to traditional materials

- in some locations the newest form of cpvc pipe (specially fabricated for use in sprinkler systems) was used;
- it was decided to use the sprinkler system pipework to provide background heating in the stack floors by circulating warm water through the system. This revolutionary concept was new to both the fire engineering companies and those responsible for sprinkler engineering standards. The approach enabled the library to avoid having to install a separate background heating system for the stacks and at the same time minimise the extent of the service and pipework provision in the stack floors. The fact that the sprinkler system is fully monitored means also that any leaks from the system are immediately notified to the Library security control suite.

## Case Study 2: Duff House

Duff House is a mansion constructed in the Baroque style between 1735 and 1754 by the then foremost Scottish architect William Adam. Originally commissioned by William Duff of Braco,



Lord Braco, later the First Earl of Fife. The 6th Earl (who had become a Duke on his marriage to the eldest daughter of Edward VII) donated the house and its surrounding park land to the two neighbouring Burghs of Banff and Macduff.

Between 1910 and 1946 the house was variously a hotel, a sanatorium, prisoner of war camp and a barracks. Having suffered damage by bombing as well as the ravages of military occupation Duff House was returned to joint municipal ownership in poor condition. Various options were considered (including demolition) and the condition of the property deteriorated further. In 1956 the house was taken into the care of the Secretary of State for Scotland as a Scheduled Monument and work was undertaken to render the building wind and water tight.

In 1988 it was decided that Duff House was to become a jointly administered (by the new Aberdeenshire Council, the National Galleries of Scotland and Historic Scotland) outstation of the National Galleries of Scotland and was to become the new home of more than 180 paintings from the national collections as well as a range of important furniture, carpets and other furnishings.

Not only was the refurbishment intended to bring the house back to its original condition but, perhaps for the first time in its life, the interiors of Duff House would match the richness of the exterior.

Apart from the necessary refurbishment, upgrading and redecorating necessitated by more than 50 years of disuse, the project also had to consider the need for protection of the contents against the threats implicit to any gallery or museum. This meant that consideration had to be given not only to security matters but also to the fire safety of the building and its priceless contents

Initial discussions involving the expertise of the Museums and Galleries Commission Security Advisor as well as Historic Scotland's own specialists indicated that the **legally required** levels of fire protection would not prove adequate for the new risks. Historic Scotland commissioned a fire risk assessment and when this was completed it indicated that the risk from **fire was significant and that the building's structural integrity** would provide little or no fire separation for the areas where some of the most valuable paintings and artworks were to be displayed.

The fire consultant recommended a comprehensive programme of fire protection improvements including an automatic fire suppression system.

At this stage it became clear that there were three options for the future of Duff House:

- to do nothing and retain the house as an empty shell
- to refurbish the building as a gallery and provide only the minimum fire safety measures required by law for life safety protection
- to follow the recommendations of the consultant and upgrade the building with a fire safety system commensurate with the risks to which the gallery and its contents would face.

The principal reason for the concerns about the hazards to which the house and contents were exposed expressed by the consultant related not just to the lack of structural fire safety inherent in the building but also to the location of the house and in particular the relatively basic level of fire brigade intervention which might be anticipated if a fire should occur.

As is normal in rural areas, fire brigade cover is provided by a retained station - that is, a fire station staffed by part-time fire fighters who respond from their homes or work when a fire is reported. In the case of Duff House, it is likely that the first fire appliance to arrive would take some seven minutes after the call was received at the Grampian Fire Brigade control centre in Aberdeen. If the nearest fire appliances were busy elsewhere (as was the case at the Windsor Castle fire) then it could be 15 minutes for the first appliance to arrive and up to 20 minutes before any additional support arrived. Specialist vehicles such as aerial appliances or a salvage tender might take 45 minutes to arrive from Aberdeen.

The decision in the end was to go for the conversion to a gallery and for full fire protection. In addition to an automatic sprinkler system and the pumps and reservoirs needed to operate this, the Duff House project involved the installation of an analogue addressable fire detection system, an air sampling fire detection system, dry risers, emergency lighting and portable fire extinguishers.

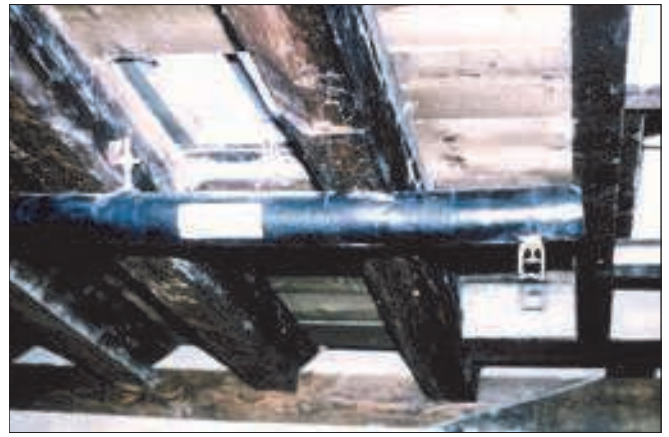
In addition to these active systems, the opportunity afforded by the total re-servicing of the building (involving the insertion of 38km of electrical rewiring) also enabled fire segregation and compartmentation to be upgraded.

In the design process care was taken to ensure that where sprinkler pipes were likely to be exposed to extremes of temperature such as in the attic spaces full insulation and trace heating were incorporated in the design.

Opportunities were taken to exploit available voids for pipe runs (even though the use of 'black' steel pipe - the only



From the illustrations it will be seen that, with care and planning, sprinkler heads can be introduced into sensitive environments here aesthetic considerations are paramount.



Pipework in unheated area must be protected from frost. This is easily achieved by using trace-heating and thermo insulation along the length of the pipe.

material then approved for use at that time - placed some constraints on pipe sizes and joint design). In order to minimise the amount of disturbance to historic fabric it was determined that sprinkler pipework would be located in the structural void between floors with access being available from the floor above. This required careful removal of floorboards throughout the house to enable the technical sprinkler design to be translated into the pragmatic reality of the actual constructional detail of the building.

The interior architecture determined the type, choice and position of each sprinkler head - for example, in rooms with plain ceilings and deep coombed cornices, sidewall sprinklers were mounted at the base of the cornice. In rooms with more elaborate ceiling decoration, care was taken to install recessed sprinklers (with coloured caps) on the centre line of the decoration.

### Benefits of Heritage Sprinklers

Where once the idea of installing sprinkler systems into mansions, castles, churches, museums and libraries may have seemed absurd it's now clear that a sprinkler system can save nationally and internationally important structures and their contents. One of the more recent converts to the cause of sprinkler was a senior art conservator who was heard to say 'Of course I want sprinklers - I can restore a wet painting, but can't do anything with a burnt one'.

Sprinklers have also been used as a compensating feature in developments where the Building Regulations cannot be complied with in respect of means of escape or access for the fire brigade. Some projects have even reported that providing sprinklers has resulted in a cost saving where the building authority has permitted trade-offs in respect of means of escape facilities and structural fire protection measures.

### Standards for Installation

Sprinklers can be installed using any one of a number of accepted standards. The longest established design and installation standard is BS 5306 Part 2: 1990 (Fire extinguishing installations and equipment on premises Part 2 Specification for sprinkler systems). A new European standard EN 12845 is expected to be published late in 2002 and this will replace the BS.

### Types of Systems

While there are a range of different types of sprinkler systems used in a range of premises it is considered that only wet systems should be specified in heritage buildings. These systems are the simplest, easiest to maintain and are also the most cost effective. Pipework can be in copper, steel, stainless steel or in CPVC (chlorinated polyvinyl chloride) which is approved for the purpose. If water pressure and flow are

adequate then it is possible that the sprinkler system can be connected (subject to the approval of the water authority) directly to the cold water main where it enters the dwelling. Where tanks and pumps are demanded because the flow or pressure are inadequate these can be sourced from a range of BASA member companies who manufacture approved and certificated equipment.

### System Design and Installation

While there is nothing mysterious about sprinkler systems the high reliability and effectiveness of these systems has come about over the years by strict adherence to the sprinkler rules and design standards. It would be wise to select a contractor who is not only capable and competent but who also has an established track record and who can offer proof of compliance with an established quality assurance system.

For example, all Installer members of the British Automatic Sprinkler Association can provide documentary proof of compliance with international quality assurance standards and all also hold an approval (Registration or Certification) from a third party certification service which



Fires in Historic Buildings frequently cause complete destruction!

itself is accredited by a Government-approved body, the United Kingdom Accreditation Service (UKAS).

Most BASA members have been in business for more than ten years and some for more than thirty - all can provide objective proof of their competence. BASA itself was founded in 1974.

#### Supposed cause of serious fires In heritage buildings 1995—1999

Cause	No. of fires	Estimated loss £
Deliberate ignition	33	5 847 706
Electric	7	4 360 000
Spontaneous combustion	1	250 000
Smoking materials	1	60 000
Under investigation	4	4 858 000
Unknown	4	433 460
<b>Total</b>	<b>50</b>	<b>15 809 166</b>

**Presented by:**



### A few facts about Fire Sprinklers:

1. No one in the UK has ever died as a result of a fire in a building with a working sprinkler system.
2. Only the sprinkler heads in the immediate vicinity of the fire actually operate.
3. Sprinkler heads can be completely concealed.
4. Sprinkler systems do not need pumps or tanks if mains pressure is adequate
5. Sprinklered buildings prevent fire fighter deaths.
6. Sprinklers do not 'false alarm' they will only operate if there is an actual fire.
7. For a small additional cost an alarm switch can be built-in to the system to call the fire brigade automatically should the sprinklers operate.
8. Maintenance costs for sprinklers are very low - around £500 a year
9. Sprinklers save lives - and property - and are the only devices which can detect a fire, sound the alarm, call the fire brigade and extinguish or control the fire.
10. Finally, despite preconceptions, sprinklers are not difficult, unsightly or expensive to install - the cost of sprinklering even the most complex or sensitive building is unlikely to exceed £40 per square metre - the same cost as a high quality carpet.

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