

7  
GUIDE FOR  
PRACTITIONERS

FIRE SAFETY  
MANAGEMENT  
IN TRADITIONAL  
BUILDINGS

PART 2  
TECHNICAL  
APPLICATIONS AND  
MANAGEMENT  
SOLUTIONS

TECHNICAL  
CONSERVATION  
GROUP



## **Historic Scotland Technical Advice Notes**

- 1 Preparation and Use of Lime Mortars (revised 2003)
- 2 Conservation of Plasterwork (revised 2002)
- 3 Performance Standards for Timber Sash and Case Windows (1994) (Deleted)
- 4 Thatch & Thatching Techniques (1996)
- 5 The Hebridean Blackhouse (1996)
- 6 Earth Structures and Construction in Scotland (1996)
- 7 Access to the Built Heritage (1996)
- 8 Historic Scotland Guide to International Conservation Charters (1997)
- 9 Stonecleaning of Granite Buildings (1997)
- 10 Biological Growths on Sandstone Buildings (1997)
- 11 Fire Protection Measures in Scottish Historic Buildings (1997)
- 12 Quarries of Scotland (1997)
- 13 The Archaeology of Scottish Thatch (1998)
- 14 The Installation of Sprinkler Systems in Historic Buildings (1998)
- 15 External Lime Coatings on Traditional Buildings (2001)
- 16 Burrowing Animals and Archaeology (1999)
- 17 Bracken and Archaeology (1999)
- 18 The Treatment of Graffiti on Historic Surfaces (1999)
- 19 Scottish Aggregates for Building Conservation (1999)
- 20 Corrosion in Masonry Clad Early 20th Century Steel Framed Buildings (2000)
- 21 Scottish Slate Quarries (2000)
- 22 Fire Risk Management in Heritage Buildings (2001)
- 23 Non-Destructive Investigation of Standing Structures (2001)
- 24 The Environmental Control of Dry Rot (2002)
- 25 Maintenance and Repair of Cleaned Stone Buildings (2003)
- 26 Care and Conservation of 17th Century Plasterwork in Scotland (2004)
- 27 Development and Archaeology in Historic Towns and Cities (2004)
- 28 Fire Safety Management in Heritage Buildings (2005)
- 29 Corrugated Iron and other Ferrous Cladding (2005)
- 30 Scottish Turf Construction (2006)
- 31 Stonemasonry Materials and Skills: A Methodology for Surveys of Sandstone Building Facades (2007)

## **Guides for Practitioners**

Stonecleaning – A Guide for Practitioners (1994)

Timber Decay in Buildings – The Conservation Approach to Treatment (1999)

- 1 Rural Buildings of the Lothians: Conservation and Conversion (1999)
- 2 Conservation of Historic Graveyards (2001)
- 3 Conservation of Timber Sash and Case Windows (2002)
- 4 Measured Survey and Building Recording (2003)
- 5 Scottish Iron Structures (2006)
- 6 Conversion of Traditional Buildings: Application of the Scottish Building Standards (2007)

## **Case Study**

- 1 Conservation of Phoebe Anna Traquair Murals at Mansfield Traquair Centre Edinburgh (2007)
- 2 The Investigation, Repair and Conservation of the Doulton Fountain, Glasgow Green (2008)

Available from:

Technical Conservation Group

Historic Scotland

Longmore House

Salisbury Place

EDINBURGH

EH9 1SH

Tel 0131 668 8638

Fax 0131 668 8669

email [hs.technicalconservationgroup@scotland.gsi.gov.uk](mailto:hs.technicalconservationgroup@scotland.gsi.gov.uk)

7  
GUIDE FOR  
PRACTITIONERS

FIRE SAFETY  
MANAGEMENT  
IN TRADITIONAL  
BUILDINGS

PART 2

TECHNICAL  
APPLICATIONS AND  
MANAGEMENT  
SOLUTIONS

By Stewart Kidd

Assisted by  
Sharon Haire

Published by  
Historic Scotland  
© Crown copyright  
ISBN 978-1-84917-035-2  
Edinburgh 2010

Commissioned by

TECHNICAL  
CONSERVATION  
GROUP



## **Acknowledgements**

This publication has been developed with the support, assistance and knowledge of many individuals and groups. Input from the members of the Scottish Historic Buildings Fire Liaison Group has been invaluable and the Group has been involved with suggestions, feedback and advice throughout the development of this Guide.

Individual contributions which must be gratefully acknowledged include the section on Scottish Building Standards drafted by Hugh Adie, Building Standards Division, Graham Goodall of the Scottish Fire Service Advisory Unit for proofing the fire legislation section and Mike Coull of Grampian Fire and Rescue Service/Historic Scotland for material on fire service operations. Steve Emery of English Heritage gave much in the way of constructive advice on text improvements. The National Trust for Scotland in addition to providing general feedback gave permission for photographs to be taken of some of their properties, including Newhailes House. The Case Studies were produced by Mike Coull, Bill Jackson of National Libraries of Scotland, Sharon Haire of Historic Scotland (with input from Alba Conservation Trust and Allan Cumming Associates) and the author. Nick Jordan of National Trust for England, Wales and Northern Ireland provided the Lanhydrock House Annex and also made useful suggestions.

It is also important to pay tribute to the authors and contributors of earlier TANs, 11, 14, 22 and 28, including Ingvál Maxwell (former Director of Technical Conservation, Research and Education Group, now Technical Conservation Group) from where some of the content of this Guide has been extracted.

All images are Crown copyright unless otherwise stated.

**Technical Conservation Group 2010**

# CONTENTS

Preliminaries	ii	3.2.8 Paint and other surface treatments	29
Foreword	xiii	3.3 Additional fuel loading	29
Endorsement letter from Scottish Government Minister	xv	3.4 Investigative techniques for traditional buildings	30
		3.4.1 Post-fire inspections and surveys	30
<b>PART 1: PRINCIPLES AND PRACTICE</b>	<b>1</b>	<b>4 CAUSES OF FIRES IN TRADITIONAL BUILDINGS</b>	<b>33</b>
<b>1 INTRODUCTION</b>	<b>3</b>	4.1 Causes of fire	33
1.1 Scope	5	4.2 Deliberate fires	35
1.2 Definitions	5	<b>5 LEGISLATION, GOVERNMENT POLICY AND GUIDANCE AFFECTING TRADITIONAL BUILDINGS</b>	<b>37</b>
1.2.1 Traditional and historic buildings	5	5.1 Fire safety legislation	37
1.2.2 Listed buildings	6	5.2 Building control legislation	41
1.2.3 Conservation areas	8	5.2.1 The Building (Scotland) Act 2003 and its application to traditional buildings	41
1.2.4 Scheduled Ancient Monuments	8	5.2.2 Balancing conservation with conversions, alterations and extensions	42
1.3 Broad principles affecting works to historic buildings	8	5.2.2.1 Conversions	42
<b>2 ADAPTIVE REUSE OF TRADITIONAL BUILDINGS</b>	<b>11</b>	5.2.2.2 Alterations	42
2.1 Successful adaptive reuse projects	12	5.2.2.3 Extensions	42
2.2 Adaptive reuse and sustainability	14	5.2.2.4 Ruined buildings	43
<b>3 VULNERABILITY OF TRADITIONAL BUILDINGS TO FIRE</b>	<b>17</b>	5.2.3 Roles, duties and responsibilities	43
3.1 Structural vulnerability of critical construction elements in fire	18	5.3 Summary of Scottish Building Standards – Section 2 of the Technical Handbook – Fire	43
3.1.1 Walls	18	5.3.1 Compartmentation (2.1)	44
3.1.2 Vaults	19	5.3.2 Separation (2.2)	44
3.1.3 Floors	19	5.3.3 Structural protection (2.3)	46
3.1.4 Doors	20	5.3.4 Cavities (2.4)	46
3.1.5 Roofs and roof voids	21	5.3.5 Internal linings (2.5)	47
3.1.6 Service routes, ducts and shafts	23	5.3.6 Minimising fire spread (2.6)	47
3.1.7 Aged construction	23	5.3.7 Spread on external walls (2.7)	48
3.2 Fire performance of traditional materials	23	5.3.8 Spread from neighbouring buildings (2.8)	48
3.2.1 Testing	24	5.3.9 Provision of means of escape and related facilities (2.9, 2.10)	48
3.2.2 Masonry	24	5.3.10 Facilities for fire and rescue service (2.12, 2.13, 2.14)	49
3.2.3 Timber	25	5.3.11 Other facilities	50
3.2.4 Plaster	26	5.3.12 Water supplies for firefighting	50
3.2.5 Glass	27	5.3.13 Automatic life safety suppression systems (2.15)	50
3.2.6 Steel, wrought and cast iron	27		
3.2.7 Thatch	28		

5.3.14 Maintenance and liaison	50	<b>PART 2: TECHNICAL APPLICATIONS AND MANAGEMENT SOLUTIONS</b>	
5.4 Traditional buildings and statutory protection	51		
5.4.1 Listed buildings and conservation areas	51	Preliminaries	ii
5.4.2 The Ancient Monuments and Archaeological Areas Act 1979	51	Foreword	xiii
5.4.3 Government policy and guidance: Scottish Planning Policy 23: Planning and the Historic Environment 2008 (SPP 23)	51	Endorsement letter from Scottish Government Minister	xv
5.4.4 Scottish Historic Environment Policy (SHEP)	52	<b>1 INTRODUCTION AND SCOPE</b>	<b>3</b>
5.4.5 The Construction (Design and Management) Regulations 2007 (CDM Regulations)	52	<b>2 PRINCIPLES OF FIRE SAFETY MANAGEMENT</b>	<b>5</b>
5.4.6 Other relevant legislation	53	2.1 Legal compliance	5
<b>6 USING BRITISH STANDARDS GUIDANCE FOR FIRE SAFETY AND FIRE ENGINEERING TO PROVIDE ALTERNATIVE COMPLIANCE WITH BUILDING STANDARDS AND FIRE SAFETY LEGISLATION</b>	<b>55</b>	2.2 Fire safety policy	6
6.1 Approaches to fire safety provision	55	2.3 Fire safety accountability	6
6.2 Fire safety measures	55	2.4 Fire safety manuals and record keeping	6
<b>7 INTRODUCTION OF FIRE PROTECTION MEASURES INTO TRADITIONAL BUILDINGS</b>	<b>57</b>	2.5 Physical fire safety improvements	6
7.1 The conservation principles	57	2.6 Fire detection and alarm systems	6
7.2 The rules	57	2.7 Manual firefighting equipment	7
7.2.1 Essential	57	2.8 Automatic fire suppression systems	7
7.2.2 Appropriate to risk	57	2.9 Firefighting access and water supply provision	7
7.2.3 Compliant with legislation	57	2.10 Staff training	7
7.2.4 Minimally invasive	58	2.11 Residential accommodation and staff welfare facilities	7
7.2.5 Sensitively integrated	58	2.12 Control of contractors and maintenance activity	7
7.2.6 Reversible	59	2.12.1 Introduction	7
7.3 Other requirements for retrofitting fire protection measures	59	2.12.2 The joint code	8
<b>8 RISK MANAGEMENT AND FIRE RISK ASSESSMENT</b>	<b>61</b>	2.12.3 Crown premises	9
8.1 Introduction to fire risk assessment	61	2.12.4 Typical fire hazards to be considered during construction works	9
8.1.1 Objectives of a fire risk assessment	61	2.12.5 Control of hot work, permits and procedures and presumptions against hot work	10
8.1.2 Application of risk assessment techniques	62	2.12.6 Method statements	10
8.1.3 Reviewing and recording of risk assessments	63	2.12.7 Site briefing and induction of contractor personnel	11
8.2 Risk management	63	2.13 Liaison with the fire and rescue services	11
8.2.1 Applying risk assessment data to inform the management of a traditional building	65	2.14 Business and property records	11
		2.15 Coordination with insurers	11
		<b>3 FIRE PROTECTION OF BUILDINGS</b>	<b>13</b>
		3.1 Fire protection measures	13
		3.2 Installing fire protection equipment in traditional buildings	14
		3.2.1 Tailoring a fire protection project to the building	14
		3.3 Structural fire safety (passive measures)	14
		3.3.1 Means of escape	14

3.3.2	Rationalising passive fire protection to structural elements	15	4.3.2.2	Use of sprinkler systems in heritage protection	41
3.3.3	Compartmentation	16	4.3.2.3	Installation standards	41
3.3.4	Survey and assessment	18	4.3.2.4	Hazard classifications	42
3.4	Smoke control	18	4.3.2.5	Components of a sprinkler system	42
3.4.1	Smoke control methods	20	4.3.2.6	Water supplies for sprinkler systems	42
3.4.2	Release ventilation measures	20	4.3.2.7	Pumps	44
3.4.3	Introduction of smoke control systems in traditional buildings	22	4.3.2.8	Valve sets	45
3.5	Doors and door fittings	22	4.3.2.9	Pipework	45
3.5.1	Fire rating and upgrading doors	23	4.3.2.10	Sprinkler heads	46
3.5.2	Sealing gaps in doors	25	4.3.2.11	Sprinkler head temperature rating	46
3.5.3	Latches	25	4.3.2.12	Response time	48
3.5.4	Door closers	25	4.3.2.13	Sprinkler orientation	48
3.5.5	Door holders	26	4.3.2.14	Sprinkler types	48
3.6	Enhancing the fire resistance of floors	26	4.3.3	Water mist systems	50
<b>4</b>	<b>ACTIVE FIRE PROTECTION SYSTEMS</b>	<b>29</b>	4.4	Foam systems	52
4.1	Fire detection and alarm systems	29	4.5	Gas systems	52
4.1.1	Classification and application of fire alarm and detection systems	29	4.5.1	Inert gases	53
4.1.2	Sounders and warning devices	30	4.5.2	Chemical gases	53
4.1.3	Voice alarm systems	30	4.6	Oxygen reduction and air inerting systems	53
4.1.4	Remote connections and alarm receiving centres	30	4.7	Lighting and signs	54
4.1.5	Fire detection and alarm system components	31	4.7.1	Fire signs – general	54
4.1.6	Manual call points	32	4.7.2	Exit signs	54
4.1.7	Fire control panels	33	4.7.3	Emergency escape lighting in traditional buildings	56
4.1.8	Managing unwanted alarms	34	4.7.4	Types of emergency lighting	56
4.1.9	How to eliminate unwanted alarms	34	4.8	Equipment, installers and standards: third party certification	57
4.2	Manual firefighting equipment	35	<b>5</b>	<b>FIRE AND RESCUE SERVICE MATTERS</b>	<b>59</b>
4.2.1	Fire classification	35	5.1	Statutory framework – fire and rescue services operations in traditional buildings	59
4.2.2	Portable fire extinguishers	35	5.2	Liaison with the fire and rescue services	59
4.2.3	Hose reels	36	5.3	Scottish historic buildings fire database	60
4.2.4	Siting of extinguishers and hose reels	37	5.4	Firefighting in traditional buildings	61
4.2.5	Fire blankets	38	5.4.1	The building itself	62
4.2.6	Wet and dry rising mains	38	5.4.2	Contents of the building	62
4.2.7	Drencher systems/sparge pipes/water curtains	39	5.4.3	Control of volunteers and staff	62
4.3	Automatic fire suppression and firefighting systems	39	5.5	Fire and rescue service operational considerations	62
4.3.1	Water-based systems	40	5.5.1	On arrival	63
4.3.2	Sprinkler systems	40	5.5.2	Initial operations	63
4.3.2.1	Alternative compliances with SBS requirements and fire safety regulations – automatic fire suppression systems (AFSS)	40	5.5.3	Developing situation	64
			5.6	Water supplies for firefighting	64
			5.6.1	Public water supplies	64
			5.6.2	Private water supplies	65

5.6.3	Supplementary water supplies	65	<b>PART 3: CASE STUDIES</b>	<b>91</b>
5.7	Access and signage for fire and rescue services	66	1. Duff House, Banff	92
5.7.1	Access signage	66	2. National Library of Scotland: George IV Bridge Building	94
5.7.2	Access for fire and rescue service vehicles	67	3. Corgarff Castle, Ballater	98
5.8	Properties in remote locations	67	4. Buchanan House, Fraserburgh	102
			5. Blackburn House, West Lothian	104
<b>6</b>	<b>PROPERTY MANAGEMENT ISSUES</b>	<b>69</b>	Useful Contacts	107
6.1	Insurance	69	References/Bibliography	110
6.2	Staff training	71	Definitions	115
6.2.1	Training for all staff	71	<b>ANNEXES</b>	<b>119</b>
6.2.2	Specialist training for certain personnel	71	Annex I A summary of some of the key principles from Historic Scotland's Scottish Historic Environment Policy	119
6.2.3	Fire warden training	72	Annex II Damage limitation planning and training at Lanhydrock House, Cornwall	120
6.2.4	Fire extinguisher training	72	Annex III Fire safety log book	123
6.2.5	Fire teams	72	Annex IV Worked examples of fire risk assessments	140
<b>7</b>	<b>EMERGENCY PLANNING AND DAMAGE LIMITATION</b>	<b>75</b>	Annex V Edinburgh Old Town fire, December 2002 – Case study illustrating the vulnerability of traditional buildings to fire	145
7.1	Principles of damage limitation	75	Annex VI Arson prevention	148
7.2	Damage limitation planning	75	Annex VII Daily, weekly and monthly fire safety checklists	150
<b>8</b>	<b>SPECIAL PROBLEMS</b>	<b>79</b>	Annex VIII Sample fire policy and fire instructions	151
8.1	Consideration for people with disabilities	79	Annex IX Sample hot work permit	153
8.1.1	Evacuation procedures for people with disabilities	79	Annex X Post fire structural stability	154
8.1.2	Staff with special needs	80	Annex XI Additional technical information	158
8.1.3	Organised parties with special needs	80	1. Installing a sprinkler system in a traditional building	158
8.2	Buildings used for sleeping or accommodation	80	2. Insulation from fire and use of flame retardant and intumescent materials	174
8.2.1	Buildings used occasionally for sleeping (‘Sleepovers’)	80		
8.3	Licensing legislation	81		
8.4	Special events	81		
8.5	Empty and vacant buildings	84		
8.5.1	Protecting vacant buildings	85		
8.6	Places of worship	86		
8.7	Buildings in remote places	86		
8.8	Buildings that are periodically unoccupied	87		
8.9	Multi-occupancy buildings	88		
8.10	Wilful fire raising and security	88		
8.10.1	Preventing wilful fire raising	88		
<b>CONCLUSIONS</b>		<b>89</b>		



# LIST OF ILLUSTRATIONS

- COVER During conversion to luxury flats this category A listed terrace in Glasgow was destroyed by fire
- 1 The aftermath of a serious fire in this category A listed terrace undergoing refurbishment
  - 2 A fully developed fire in a country house
  - 3 This charred timber door panel, illustrates the destructive and irreversible nature of fire
  - 4 In addition to the historic building fabric itself, contents are often also of great importance
  - 5 Variety of traditionally constructed buildings in Scotland
  - 6 The Georgian New Town of Edinburgh, a masterpiece in urban planning
  - 7 The 18th century Stanley Mills lay derelict for many years, but is now an award winning conversion project comprising a heritage centre and riverside flats
  - 8 Templeton Carpet Factory
  - 9 The striking modern addition to the rear elevation of the India of Inchinnian Tyre Factory makes allusion to airships and aircraft wings, both of which were made in that location
  - 10 Successful conversion of the redundant Old Royal Station at Ballater into a museum, restaurant, shops and tourist centre
  - 11 The Scotsman, former newspaper headquarters, now a luxury hotel
  - 12 The regeneration of the declining Blackness area centred on the conversion of several prominent 19th century textile mills including, as illustrated here, Tay Works
  - 13 Aerial view of Leslie House, a category A listed mansion, that was severely damaged by fire during sub-division to luxury flats
  - 14 The haphazard installation of services can compromise a compartment wall
  - 15 This compartment wall was compromised by a structural roof timber travelling through it
  - 16 The lack of stopping around service installation has adversely affected the compartmentation
  - 17 This post-fire image from a category A listed building clearly illustrates the gap that exists behind traditional lath and plaster walling (essential for ventilation)
  - 18 A traditional technique in early buildings was to decoratively paint the underside of floorboards. Although this offers little fire resistance, where such decoration survives it is important to retain it
  - 19 It is common practise in traditional buildings for floor and ceiling timbers to be built into supporting walls
  - 20 Original Georgian doors whose retention was facilitated by partial sprinklering of the property
  - 21 Doors in principle reception areas often can be elaborately detailed, so their retention is preferable
  - 22 In the upgrading of these double doors in a reading room at the National Library of Scotland, cold smoke seals were run along the stile
  - 23 In this heritage property doors have been carefully removed to go into storage
  - 24 Attic roof void with the additional fuel loading of a timber vaulted dome, Culross Palace, Fife
  - 25 Substantial hidden void above a combed ceiling in a traditionally constructed building. Voids can aggravate fire spread and should be considered when assessing risk
  - 26 Large attic spaces with no compartmentation are common and facilitate the rapid spread of fire
  - 27 A common occurrence in various types of properties is the storage of infrequently or unused items in attic spaces, adding to the fuel load in these vulnerable area
  - 28 Dumb waiters, often disused, provide a large hidden passage that can aid the rapid travel of fire between floors
  - 29 When notching structural elements, such as floor timbers, for the installation of services fire stopping must also be addressed
  - 30 A localised fire that has caused discoloration of the sandstone in the area affected by flames and the stone above has been covered by soot. The heat also caused fracturing of the stone and loss of material
  - 31 Fires have always been a threat - here the effect of a historical fire is evident by the severe spalling of the granite, especially around the windows
  - 32 These listed residential properties, one large scale, the other small scale, both illustrate that there is often a high timber component in traditional buildings - floors, panelled walls and ceilings
  - 33 Due to their thickness structural ceiling timbers can burn slowly and perform their function for a long period
  - 34 Fire initially attacks areas of weakness as seen in this furnace test where the thin door panels have failed early in the test
  - 35 The back of traditional lath and plaster showing the wooden lattice structure that provides a key for the applied plaster
  - 36 During a fire, expansion of the girders has caused movement in the walls of this listed property
  - 37 Expansion of the internal beams has applied pressure to the external walls, causing large cracks along a section of the stringcourse
  - 38 In industrial conversions, such as this pictured, it is common for the metal elements to be coated with intumescent paints. This is the Scottish Borders Enterprise business gateway in Ettrick Mill, Selkirk, 1836-1850, where steel was inserted around ground floor machinery in the early 20th century. The conversion lifted part of a timber floor to make a light reception area
  - 39 Thatched property in a traditional blackhouse village on the Isle of Lewis

- 40 Fire represents a serious risk for thatched properties. Here the design for a contemporary enclosure for a fire hose has employed random rubble stonework like that used in the adjacent blackhouses, a visually sensitive approach
- 41 In this heritage visitor attraction, this storage area presents a fire hazard
- 42 In this category B listed building, sub-divided into flats, a fire is believed to have been caused by faulty electrical services in the attic. Early detection restricted damage to the roof
- 43 Some major contributory causes of fire include; overloading of circuits, neglecting to undertake routine electrical equipment checks, church candles, deep fat fryers, combustible material in close proximity to heaters and blow torches
- 44 As illustrated in this unlisted thatched cottage, chimney flues require ongoing maintenance to prevent the build up of soot and grime, a cause of chimney fires
- 45 Regeneration of the centre of Hawick has focused on the conversion of Tower Mill into a variety of uses
- 46 The benefits of compartmentation: complete loss on one side of the compartment wall and fire door and on the other side only superficial fabric damage and minor smoke damage to an archive of rare books
- 47 Examples of fire stopping to improve compartmentation
- 48 Suspended ceiling in this church, a consequence of a decreasing congregation size, has created a large cavity above
- 49 Statistics suggest that traditional buildings are at greater fire risk during construction works and consequently additional controls and procedures should be implemented to minimise risk
- 50 Fire Service personnel amidst the rubble, following a gas explosion at Guthrie Street, Edinburgh
- 51 The sensitive introduction of fire measures into traditional measures can help prevent their destruction. This large country house, category A listed, has been totally devastated and recovery firm has been mobilised to remove the debris
- 52 Where fire extinguishers are required to comply with legislation, subject to agreement with the fire authority there is no reason why they can't be allowed to be free standing as opposed to being physically attached to the wall
- 53 A concealed sprinkler head has been installed immediately in front of the bird's beak, almost invisible to the untrained eye
- 54 With the approval of the manufacturer sprinkler pipes have been painted to blend in with the open timber ceiling
- 55 The wires have been fixed using cable clips rather than notching the timbers
- 56 Reversibility – In this highly decorated Austrian palace interior, a contemporarily detailed floor fixed 'pole' houses a sprinkler head, electrical services and emergency lighting – thus providing an innovative and reversible solution avoiding damage to historic wall finishes which conventional installations give rise to
- 57 Eliminating hazards can help reduce the probability of serious fires such as the Old Town Fire in Edinburgh, a World Heritage Site
- 58 Portable heater in office
- 59 A crumpled carpet preventing the opening of a fire escape door. It also presents a trip hazard
- 60 High intensity quartz halogen lights in a church surrounded by timber features
- 61 Storage of material in a back room of a heritage centre
- 62 Theatres often have high intensity lighting, upholstered seating, large open-plan auditoriums, combustible props, stage production areas and special effects, all of which can create a high fire risk
- 63 A category A listed University chemistry building is an obvious high fire risk
- 64 To control an identified risk, flammable liquids should be stored in a proper flammable liquid storage cabinet
- 65 The build up of storage areas such as these should be highlighted and removed

## Part 2

- 1 Morgan Academy, a category A listed school was gutted by fire in 2001
- 2 This category A listed terrace was severely damaged by fire during sub-division into luxury flats
- 3 Sound management should ensure that hazards and risks are eliminated or reduced, so situations like blocked fire escapes are avoided
- 4 Part of this listed terrace was badly affected by fire during refurbishment work and the spread of the fire was facilitated by the earlier removal of the doors
- 5 If detector heads are covered during works, or systems switched off, compensatory measures must be implemented during work hours. Temporary covers should be removed at the end of the working day
- 6 If heat producing equipment is used in a traditional property it is essential that it is managed by a hot works permit
- 7 The Bower building, University of Glasgow. Severe fire damage to the roof and interior of this category A listed teaching and laboratory building
- 8 In these examples, where services have transversed fire resisting walls, the openings have been fire stopped, firstly with intumescent caulking and secondly with intumescent pillows
- 9 A thermographic survey at Stirling Castle kitchen block unearths a redundant chimney flue at parapet level
- 10 Wherever possible historic hardware should be retained, and only upgraded for fire resistance as necessary
- 11 Destructive furnace tests to determine the fire performance of traditional doorsets, during and post-test
- 12 This image from a property undergoing refurbishment clearly shows the sizable gaps that can exist between a door frame and the supporting wall
- 13 Intumescent products are increasingly available in a range of colours. The timber laminate intumescent strips (the dark band that goes round the door hinge) seen here match the surrounding timber
- 14 A concealed overhead closer – a discreet solution
- 15 As seen here in the aftermath of the 1824 Great fire of Edinburgh, fire is not a new threat, but the technology available in the modern era to tackle the threat is constantly evolving
- 16 Manual call points can be located unobtrusively
- 17 1) Visual impact is minimised as the ceiling is so elaborate and the detector, to the base of the large panel, is white.

- 2) The positioning of this wall mounted beam detector has avoided disruption to the elaborate ceiling plasterwork
- 3) & 4) Discreet sampling holes through which air is drawn in
- 18 It is clearly seen in these two images the difference between careful consideration of the building fabric and a standard approach when selecting detection equipment
- 19 This is an example of bad design where the break glass call point and electric door release are too closely located
- 20 Example of an addressable wireless fire alarm system (wireless can be beneficial where hard wiring would be disruptive to the fabric)
- 21 Two listed properties, with extinguishers housed in purpose-made bases or free-standing rather than being physically attached to the wall
- 22 In an A listed property the hose reel has been carefully hidden in a cupboard
- 23 Historic fabric impact minimised by locating dry riser inlet valves beneath cast iron cover in footpath
- 24 A Norwegian example where a drencher system has been installed to the exterior of the building on the right to prevent fire spread from or to the neighbouring timber building
- 25 In Newhailes house, a visitor attraction, the fabric and contents are protected by a sprinkler system, sympathetically installed to minimise fabric impact
- 26 Parliament House in Edinburgh installed sprinklers, with pipework painted black to blend in with the elaborate ceiling
- 27 To satisfy the required volume of water for the sprinklers in the National Library of Scotland, two purpose built water tanks were constructed and housed in the historic vaults below the street
- 28 Sprinkler components such as water tanks, pumps and valve sets can sometimes be discreetly housed in outbuildings as here at Newhailes house
- 29 An example of a main stop valve for a sprinkler system, located out of sight in a basement area
- 30 Chlorinated PVC plastic pipework, a possible alternative to metal pipework
- 31 The operation of a sprinkler head
- 32 In any given installation, there may be a number of different types of sprinkler head installed, as here in one of the reading rooms at the National Library of Scotland
- 33 Two examples of discretely installed sprinkler heads in heritage properties
- 34 Recessed sprinkler head
- 35 Concealed sprinkler head
- 36 Water and gas-filled cylinders for a water mist suppression system in a basement area
- 37 A gas suppression system with high pressure gas filled cylinders
- 38 Sensitively designed escape signage
- 39 A range of approved signs for use in respect of fire safety
- 40 Temporary free standing exit sign in staffed tourist attraction – an alternative to standard signage which may be acceptable in certain circumstances
- 41 This totem pole is a novel solution – incorporating an exit sign and emergency lighting in addition to video surveillance, break call glass point and audio alerter
- 42 A water tender in attendance at a fire at a category A listed property
- 43 On occasions, in the event of a fire it may be more beneficial to locate to the rear of a property or as here, the service courtyard to the side elevation, due to proximity to such features as the gas shut-off
- 44 A damage limitation exercise at Duff House gallery
- 45 The fire database displayed onboard a fire appliance
- 46 A Grampian Fire and Rescue Service visit to Castle Fraser, Aberdeenshire
- 47 Each traditional building throws up individual hazards – either a door designed to blend in with the surrounding wall finish or a small domestic property with well worn narrow timber stairs
- 48 Glass slide pictorial representation of historical firefighting operation
- 49 Underground fire hydrant marked by metal cover
- 50 A hydrant marker that has become obscured by overgrown vegetation, a situation good management would address
- 51 An early fire pond at a country house estate
- 52 Insurance is important – fires do happen
- 53 The category A listed Morgan Academy in Dundee was devastated by fire in 2001. The facade was subsequently reinstated with costs running into millions of pounds
- 54 Staff receiving fire extinguisher training
- 55 Successful damage limitation in progress during a country house fire
- 56 During the fire illustrated on the previous page, the priceless contents of the library were successfully removed to safety
- 57 Members of a damage limitation team in action at Schonbrunn Palace, Vienna
- 58 Mobile trolleys at Schonbrunn Palace housing damage limitation equipment and supplies
- 59 This category A listed vacant warehouse suffered a serious fire. Dereliction of former industrial areas is a familiar problem and fires in vacant properties within such areas are all too common
- 60 A catering function in this historic house visitor attraction brings additional risks
- 61 Where erected for visitor events or functions such as weddings, marquees and tents should be subject to inspection
- 62 Large complexes of redundant institutional buildings like this former hospital, present particular security problems. Following a wilful fire raising-related fire, although the masonry external walls remain largely undamaged, the complete loss of the roof structure left the fabric open to accelerated decay
- 63 This redundant church in Orkney is lying vulnerable to the threat of fire and with timber floors, ceiling and pews has a high fire loading
- 64 Smailholm tower is hidden deep in the Scottish borders and is approached via a narrow road. With no hard standing for appliances in the immediate surrounds, the property is only accessible on foot
- 65 Five case studies that illustrate how fire safety can be successfully addressed within traditionally constructed buildings: Duff House, National Library of Scotland, Corgarff Castle, Buchanan House and Blackburn House
- 66 Duff House, Banff. To address the fire safety needs of this property during a conversion to an art gallery, sprinklers were sympathetically installed

- 67 Concealed sprinkler head in the ornate plasterwork in the vestibule ceiling (circle beside the bird's beak)
- 68 The National Library of Scotland installed a sprinkler system to compensate for deficiencies in the fire safety provisions in the property
- 69 Sprinkler head discreetly integrated into bookshelves in one of the public reference rooms
- 70 The new north staircase that was constructed to allow a direct fire exit route from the Reading Room and to provide a second stairway
- 71 During the refurbishment, all the collections were kept in situ, but encased in special fire-retardant sheeting
- 72 Sectional drawings of the George IV Bridge building, showing the complexity of the site with its sizable subterranean sub-structure
- 73 Sprinkler pipes running through the book storage areas (due to the low ceilings, note the protective cages over the sprinkler heads)
- 74 Corgarff Castle is remotely located in the hills of Strathdon
- 75 The water tanks and pumps were housed in a lean-to out-building, a former brew house
- 76 Water tank and pumps – the tank was assembled in situ
- 77 Concealed sprinklers do not distract from the original Jacobite graffiti on the ceiling of the former barracks room
- 78 Sprinkler and detection heads and exposed pipework have been painted to blend in with the timber ceiling
- 79 This category B listed care home is deemed a high risk property due to the nature of the usage
- 80 Pendant sprinkler heads, partially obscured by the ceiling beams
- 81 This A listed property lay derelict for many years, vulnerable to fire amongst other things
- 82 Post restoration
- 83 The highlighted areas show that concealed sprinkler head do not detract from the delicate ceiling plasterwork
- 84 As highlighted, an aspirating vent is visually unobtrusive
- 85 Sampling unit for the aspirating smoke detection system is hidden away in a hall cupboard
- 86 Dampening down the fire damaged area the morning after the fire
- 87 Firefighting operations were complicated by the fact that the buildings varied from five to seven storeys and the site was accessible from two different street levels
- 88 This image demonstrates the complexity of the site – five interlinked buildings containing thirteen premises
- 89 Broadstone House, Renfrewshire. Post-fire stabilisation works underway
- 90 Broadstone House. Although appearing precarious, substantially constructed traditional masonry can often be demonstrated to remain stable despite major loss of secondary structural elements
- 91 Broadstone House, wall-head dormer detail
- 92 Bulging and cracked external masonry caused by expansion of internal metal beam
- 93 Fire damaged timber safe lintels with masonry arch over
- 94 Tank landscaping at Duff House indicates that more careful consideration needs to be given to this aspect
- 95 Sidewall sprinklers and exposed pipework in the Laigh Hall, High Court, Edinburgh
- 96 Detail of sprinkler head, Laigh Hall, High Court, Edinburgh
- 97 Pipework in Corgarff Castle 'painted out' to blend with the background decor
- 98 In this out of view attic space, the pipework has been suspended from the ceiling timbers, so minimising impact on the fabric
- 99 Exposed pipework can often be incorporated in basement areas where the appearance of this system is less of a concern
- 100 The timber floor has been lifted to allow the integration of horizontal service ways
- 101 Hidden voids
- 102 Sidewall sprinkler supply pipe
- 103 The sprinkler supply pipe has been installed beneath the joists. The same care has not been taken to integrate the cable tray for electrical services without damaging the historic fabric
- 104 Sprinkler supply pipe installation
- 105 Timber floor reinstatement
- 106 Inappropriately located access hatch
- 107 Vertical pipe casework
- 108 Vertical pipe installation
- 109 Quick response sprinkler installed in a ceiling rose
- 110 Two examples of sensitively located sprinkler heads, one painted to blend in and the other a sidewall sprinkler installed above a cornice
- 111 Sidewall sprinkler pitfalls
- 112 Installed concealed sprinkler head, the vestibule, Duff House
- 113 Hole cut in ceiling, ready to receive concealed sprinkler head, the vestibule, Duff House
- 114 Sprinkler head mounted within a ventilation grille, High Court, Edinburgh
- 115 A limewash finish on a concealed sprinkler plate, Corgarff Castle
- 116 Protective grill placed over sprinkler heads in the low-ceiling book storage areas in the National Library of Scotland
- 117 Sidewall sprinkler head installed within cornice

## TABLES

### Part 1

- Table 1: Fires in Scottish listed buildings 2007-8  
 Table 2: Fires in Scottish listed buildings 2008-9  
 Table 3: Causes of fires in Scottish listed buildings, Scottish Fire and Rescue Services (Apr 2008-Mar 2009)

### Part 2

- Table 1: Colour coding of glass bulbs sprinkler heads  
 Table 2: Comparison of suppression systems that was undertaken prior to the decision to use sprinklers

## BOXES

### Part 1

- Box 1: Extract from BS 7913: 1998 Guide to the Principles of the Conservation of Historic Buildings, Section 7.4.3  
 Box 2: Conversion to which regulations apply

### Part 2

- Box 1: Stirling Castle – water mist system

## FIGURES

### Part 1

- Figure 1: Results of a radar investigation to identify flues and voids in the wall construction  
 Figure 2: Causes of fire loss to UK historic buildings (Jan 2002-June 2006)  
 Figure 3: Accidental fires to UK historic buildings (Jan 2002-June 2006)  
 Figure 4: The risk assessment cycle

### Part 2

- Figure 1: Organisation of fire protection measures  
 Figure 2: Available safe escape time – occupant response and travel time  
 Figure 3: Containment by smoke  
 Figure 4: Containment by construction  
 Figure 5: Active pressurisation  
 Figure 6: Natural release ventilation  
 Figure 7: Release cross-ventilation  
 Figure 8: A typical floor construction in an 18th or 19th century property – tongue and grooved floor boards, lath and plaster below and deafening between ('pugging' in England)  
 Figure 9: Construction of a typical glass bulb sprinkler head  
 Figure 10: Sprinkler heads: left to right: pendant (chrome finish), upright (brass finish) and horizontal (coloured finish)  
 Figure 11: Distribution patterns for sprinkler heads

## Annexes

- Figure 1: In addition to the main architectural plan, additional drawings/sketches can be useful  
 Figure 2: The exact location of sprinkler heads should be marked and if not obvious to the installing engineer, also the alignment of the yoke arms  
 Figure 3: Detailed drawings of the sprinkler heads may be required for installations in sensitive areas



# FOREWORD

Fire continues to pose a serious threat to Scotland's built heritage, capable of destroying a building and its contents in a matter of hours. Historic fabric lost to fire is lost forever. Often constructed without regard to fire safety, traditional buildings can be inherently vulnerable to fire due to a combination of factors including traditional construction techniques, undivided roof spaces, hidden voids, historic furnishings, high fire loads and a history of alterations and changes.

Concerned about the scale of loss, estimated at one major historic building in Scotland lost each month, since the mid-1980s Historic Scotland has been involved in fire-related research, often in collaboration with a wide range of external organisations. Four Technical Advice Notes (TANs) have subsequently been produced, dealing with fire protection measures, sprinklers, fire risk management and fire safety management.

In addition to the TANs, two noteworthy initiatives have been a four-year pan-European funded programme entitled *Cost Action C17: Built Heritage: Fire Loss to Fire* (Cost Action C17) which investigated the consequences of heritage fire loss and involved the participation of over twenty countries and the Scottish Historic Buildings Fire Database project (SHBFD). The SHBFD continues to encourage partnership working with Scotland's Fire and Rescue Services, improving the operational preparedness of firefighting crews. Under the umbrella of this project, a major achievement has been quantification of the real loss of heritage buildings to fire through the introduction of reporting measures. Statistics gathered by the Scottish Fire and Rescue Services on fire incidents in listed properties recorded 418 incidents between 2008 and 2009, a significantly higher figure than previously supposed.

Whilst the TANs have proved extremely useful to a wide-ranging audience, some aspects have become outdated. There have been a number of changes and developments such as the introduction of new legislation governing the provision of fire safety in buildings and building regulations, the increasing adoption of a fire engineered approach to fire safety and technical advancements in fire detection and suppression systems. This led to the decision to update and amalgamate the TANs into a single reference document in the series of Historic Scotland's Guides for Practitioners.

In 2005, the Fire (Scotland) Act became operational, followed shortly in 2006 by associated regulations. Part 3

of the Act is aimed at non-domestic properties (including houses in multiple occupancy and care homes) and has shifted the onus on the provision of fire safety to the owner of the property or those responsible for the property, as opposed to the fire service. The new fire safety regime is based on the principles of risk assessment: identifying risks, eliminating or reducing risks and the introduction of appropriate technologies to achieve an adequate level of fire safety.

The Building (Scotland) Act came into being in 2003 and the associated Regulations in 2004. The main change is that prescriptive standards have been replaced with expanded functional standards; what must be achieved when a building is in use. The move away from prescriptive to performance-based standards means that designers can adopt a more flexible approach to fire safety, thus catering more sympathetically to the needs of historic buildings. This Guide is intended to be read along with the Guide for Practitioners 6: *Conversion of Traditional Buildings: Application of the Scottish Building Standards* (Guide for Practitioners 6), produced by Historic Scotland in 2007.

A dilemma exists when attempts are made to introduce fire safety measures into traditional buildings to satisfy either the Fire Safety Regulations or Building Regulations. A balance must be achieved between the historic value of the fabric and the fire safety measures introduced to protect that fabric. This publication aims to demonstrate how to find sensitive solutions and also the importance of sound management systems. Fire protection may be straightforward, but for more complex properties, a developed fire-engineered approach may be required. The Guide emphasis is that a building must be addressed holistically and that each traditional building is unique. Experience indicates that traditional buildings can be protected from fire in a sensitive manner and this is encouraging in view of the national drive towards sustainability; retaining Scotland's huge stock of traditional buildings is central to this drive.

The safety of building occupants remains of paramount importance, but to look beyond the immediate requirements of life safety and encompass the building fabric and contents as well, will undoubtedly have a positive knock-on effect to life safety.

This Guide draws together the legislative viewpoint of the various agencies involved and, as the attached formal letter from the Chief Executive of the Scottish

Buildings Standards Division indicates, this Guide legally sits alongside other guidance documents. It serves as a reference document that will be useful to building and fire enforcement officers, building professionals, heritage organisations and owners/managers.

**David Mitchell**  
**Director**  
**Technical Conservation Group**  
**Historic Scotland**  
**March 2010**





Chief Executives – Scottish Local Authorities  
Copy to: Local Authority  
Building Standards Managers

**Directorate for the Built Environment**

Building Standards Division  
Bill Dodds@scotland.gsi.gov.uk  
Telephone: 01506 600400  
Fax: 01506 600401  
Our ref: QTO 2/4  
31 March 2010

Dear Chief Executive

**Building (Scotland) Act 2003 – Notice Under Section 4(2) and 4(4) Relating to Guidance Documents**

Under the provisions of Section 4(1) of the Building (Scotland) Act 2003 (the Act), which came into force on 1 May 2005, Scottish Ministers may issue guidance documents for the purpose of providing practical guidance with respect to the requirement of any provision of building regulations and may issue revisions of the whole or any part of any guidance document.

Guidance documents issued under Section 4(1) of the Act take effect in accordance with a notice issued by Scottish Ministers under Section 4(2) of the Act. This letter, issued on behalf of Scottish Ministers, constitutes such a notice.

From 1 April 2010 the following document is added to the guidance documents for purpose of building regulations:

***Guide for Practitioners 7: Fire Safety Management in Traditional Buildings***, issued by Historic Scotland.

The guidance documents are issued with respect to the provision of Regulations 1 to 15 of The Building (Scotland) Regulations 2004.

As provided for by Section 4(3) and 4(4) of the Act, this document will cease to have effect in relation to building warrant applications when notice is given by Scottish Ministers.

Yours sincerely

**Bill Dodds**  
**Head of Building Standards Division**



PART 2:  
TECHNICAL APPLICATIONS  
AND MANAGEMENT  
SOLUTIONS



*Illus 1 Morgan Academy, a category A listed school was gutted by fire in 2001 © Crown Copyright: RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk)*

# 1 INTRODUCTION AND SCOPE

As has been explained in outline in Part 1, when a workplace in a traditional building is addressing fire safety issues under the fire safety legislation or undergoing adaptive conversion, consequently falling under the building legislation, there is invariably a need for additional fire protection measures to be provided. This application of systems and equipment in conjunction with sound management is intended to provide a systematic approach to the protection of people and

premises, using a combination of structural materials, building components and protective systems.

This part of the Guide provides information on the extent of the systems and equipment which are available and describes how they can be used to augment good management practices in the protection of people and property in traditional buildings.



*Illus 2 This Category A listed terrace in Glasgow was severely damaged by fire during sub-division into luxury flats*



*Illus 3 Sound management should ensure that hazards and risks are eliminated or reduced, so situations like blocked fire escapes are avoided*

## 2 PRINCIPLES OF FIRE SAFETY MANAGEMENT

'Fire safety management' can be defined as the application of a disciplined plan using normal management techniques to ensure that the risks of and from fire are minimised and to further ensure that:

- A comprehensive fire risk management process is in place to ensure a high level of safety for persons and property
- Fire safety problems that arise are quickly and effectively contained and resolved
- The dutyholder/owner/occupier complies fully with their legal obligations in relation to fire safety appropriate training and information is provided on fire safety to occupants, employees and others.

All buildings should have a formal plan which sets out the way fire safety is to be managed. This fire safety plan will detail the responsibilities for fire safety management, and the accountabilities of individual staff members. The plan will also detail in general terms the steps which are to be taken to prevent fires starting, as well as the procedures for responding to outbreaks of fire.

Section 8 of BS 9999: 2008 *Code of Practice for Fire Safety in the Design, Management and Use of Buildings (BS 9999)* might also be referred to as this firmly sets out the way fire safety should be managed within the context of fire engineering. It is essential that fire safety in all traditional buildings, regardless of size, be managed in a systematic way. This section sets out the various elements that should be incorporated into a structured fire safety plan which will then allow fire problems to be managed methodically.

### 2.1 Legal Compliance

In addition to listed building legislation as it applies to the external and internal fabric of most listed buildings, other than purely domestic premises all traditional buildings are likely to be subject to further legal controls on account of their use, the Fire (Scotland) Act 2005 (the 2005 Act) or if they are undergoing conversion or alteration, the Building (Scotland) Act 2003 (the 2003 Act) and other legislation such as health and safety regulations (refer to Part 1, Section 5).

Most non-domestic premises will be subject to the requirements of Part 3 of the 2005 Act. This Act and the Regulations made thereunder impose a duty on employers and other dutyholders (which may in certain

cases include property owners) to provide adequate fire safety measures in relevant premises in case of fire. The regulations make explicit the requirements to undertake and review a fire risk assessment. The assessments should take account of firefighting equipment, any fire detection, emergency routes and exits and their maintenance. The dutyholder should also include in their assessment consideration of employees, visitors and other occupants who may have special needs or may be unfamiliar with the evacuation strategy or the escape routes. This requirement applies to most workplaces and other non-domestic premises (houses in multiple occupancy and care homes) and will include buildings to which the general public have access.

The employer is also required to arrange any necessary contacts with external emergency services, particularly with regard to rescue work and firefighting. The fire and rescue authority for the area enforces these regulations in most (but not all) types of occupancy.

Don't overlook the duty to undertake, compile, review and maintain a suitable and sufficient fire risk assessment for the premises (refer to Part 1, Section 8).

Conversion or alteration of existing buildings will usually necessitate obtaining statutory approval under the Building Standards legislation (the 2003 Act) in addition to the relevant planning permissions and listed building consents where applicable. When considering fire performance upgrading works, it should be acknowledged that Building Standards legislation and the Regulations (refer to Part 1, Section 5) made thereunder have been framed primarily to deal with proposals for new buildings. When formulating proposals for historic buildings a more flexible approach is often called for and this will include a rigorous assessment of the need for proposed works and an exploration of alternative strategies, set against their likely impact on the fabric of the building. In most cases such an approach will enable a sympathetic solution to be developed meeting the spirit, if not the full requirements of the regulations, whilst minimising impact on the historic building.

It should be noted that compliance with Scottish Building Standards, (SBS) fire safety legislation and other statutory requirements provides a very basic fire safety benchmark. Building owners and managers must understand that mere legal compliance guarantees nothing more than verification that the life safety provisions of the building meet the legal minimum, but that protection of fabric

may be limited. Further measures are likely to be necessary to provide the optimum level of protection for the building itself against the effects of fire.

To reiterate, even where fire safety improvements are needed to comply with legislation, this does not absolve the owners of listed buildings from applying for and obtaining the necessary listed building consent.

## 2.2 Fire Safety Policy

Each organisation, company or institution should have a written fire safety policy. The policy should reflect their intentions to provide a safe and controlled working environment and should be signed off at the highest level. Fire safety policies should form part of the organisation's fire safety manual (refer to Section 2.4) and should be posted in prominent locations. Effective internal mechanisms should exist to ensure that the policy is communicated to employees, subject to regular review and takes account of special or occasional events. In larger organisations with devolved management or many locations there may need to be additional local policy statements.

Sample fire policy statements can be found in Annex VIII.

## 2.3 Fire Safety Accountability

Each organisation should appoint an individual at senior level as the Fire Safety Manager with specific responsibility to implement the organisation's fire safety policy. The post can often be combined with similar functions such as security or safety, while smaller organisations may expect an existing manager to undertake this duty.

Where appropriate, particularly in larger establishments or multi-site operations, the Fire Safety Manager may be assisted by a full-time, specialist, fire officer. This individual can bring professional expertise in the areas of fire engineering and fire safety management skills and his role supplements the expertise and experience of the Fire Safety Manager.

Other tasks such as training staff in evacuation procedures, the use of fire equipment or in assisting in the evacuation of the building will be undertaken by specially trained employees who may be variously called fire wardens, fire marshals or departmental fire officers.

## 2.4 Fire Safety Manuals and Record Keeping

All properties should develop and maintain a Fire Safety Manual setting out the location's fire strategy and detailing plans for action in case of fire, and to act as a basis for training. The fire safety policy and fire risk assessment should be incorporated in the manual. Manuals will also contain detailed information about

the fire safety equipment and systems installed, operating and maintenance instructions, circuit diagrams, spare parts lists and so on. Floor plans detailing the location of extinguishers, hose reels, hydrant points, gas shut offs and wiring routes are useful.

All locations should also maintain a Fire Log Book, a day-to-day working document in which to record all fire-related events such as fire incidents, false alarms, training, drills, inspections by the insurance company or fire and rescue services and full details of when and by whom equipment maintenance has taken place (refer to Annex III for an example). The Fire Log Book effectively complements the reference document role of the Fire Safety Manual.

Record keeping is a fundamental requirement to enable an organisation to prove that it is fully compliant with fire regulations, and indeed perhaps, the only way to prove that an organisation has properly discharged its legal duties. Additionally, in these litigious times the value of comprehensive fire records cannot be over-emphasised.

There are check lists for daily, weekly, monthly and annual fire safety checks in Annex VII.

## 2.5 Physical Fire Safety Improvements

The fire risk assessment will have identified the structural features of the building that will create problems of fire or smoke spread. For large complex traditional properties, an investigative survey may also have been carried out. A plan for implementation of physical fire safety improvements should be drawn up identifying priorities for action which may include establishing or upgrading fire separation between areas, segregating areas of high fire risk and providing protected escape routes. Depending on the possible impact on historic fabric, work to effect fire safety improvements within listed buildings is likely to require listed building consent and early discussion with the local authority planning department is recommended when formulating proposals.

## 2.6 Fire Detection and Alarm Systems

The installation of a modern, reliable fire detection and alarm system should be seen as a high priority to ensure early detection (refer to Regulation 12, Part 1, Section 5.1). Even where not specifically required by law such systems provide a significant life, property and asset protection advantage and are always recommended by insurers. In most cases (and in all cases where buildings are located in rural or remote areas), the system should be provided with a communications link to the fire and rescue service via an approved alarm receiving centre<sup>1</sup> (for more information refer to Part 2, Section 4.1).

<sup>1</sup> Sometimes known as 'Call Receiving Centres'.



## 2.7 Manual Firefighting Equipment

Most buildings are supplied with firefighting equipment such as portable fire extinguishers, fire blankets and hose reels for use by occupants. A fuller description of the various items of equipment and their purpose is given in Part 2, Section 4.2.

## 2.8 Automatic Fire Suppression Systems

In certain instances it may be appropriate to install an automatic fire suppression system. These employ water mist, sprinklers or gas flooding discharge systems which operate locally to suppress or control a fire. Their use can be advantageous in historic buildings since they offer potential to both minimise fire loss and an alternative technological means of upgrading protection, with potential for reduced impact when compared to more conventional approaches which can be very destructive of historic fabric such as escape corridors and stair cases (for more information refer to Part 2 Section 4.3).

## 2.9 Firefighting Access and Water Supply Provision

It is not always possible to achieve the full requirements for firefighting access recommended by the building code due to site constraints. This could potentially impact on set-up time for firefighting operations and/or reduced ability to fight a fire and save lives.

In such situations the fire or building authority may consider the use of an Automatic Fire Suppression System (AFSS) as a compensatory feature as the fire is likely to be controlled to a smaller size than if the premises are not so protected. This takes into account fire service arrival times and potential fire sizes on their arrival.

Similarly, where it is not possible or uneconomic to provide a supply of firefighting water, the provision of an AFSS might be deemed to compensate for this.

## 2.10 Staff Training

Systematic and effective training programmes should be introduced to ensure that all staff (including contractor staff, part-time employees and volunteers) are aware of the fire safety measures installed, know how to minimise fire risks, know how to raise the alarm in case of fire and that enough trained staff are available to respond quickly to a developing fire situation. In addition to basic training for all staff, some groups such as security personnel, maintenance staff and the catering team, may require additional training which will include specific instruction in the safe and effective use of firefighting equipment.

The organisation should also appoint sufficient fire

wardens or fire marshals to ensure that fire evacuations can be carried out safely and efficiently (the terms are used interchangeably, but the term fire warden will be used hereafter). Fire drills, involving all staff, contractor personnel and any visitors should take place at least every twelve months.

## 2.11 Residential Accommodation and Staff Welfare Facilities

Where premises include any form of residential accommodation (including private apartments, staff apartments, holiday accommodation and other living spaces) these should be included in the fire risk assessment as well as in all fire audits and inspections. Staff rest rooms (official and unofficial) and any smoking areas should also be subjected to audit and inspection.

## 2.12 Control of Contractors and Maintenance Activity

### 2.12.1 Introduction

According to the Fire Protection Association (FPA) around 20% of fires in listed buildings result either directly or indirectly from construction or maintenance activity. In particular, inadequately controlled 'hot work' (that is, work involving heat-producing equipment such as welding, cutting, grinding, tar boiling and paint stripping) is responsible for millions of pounds in fire damage every year. While clear fire safety requirements should be included in all contracts for building, maintenance and other work, it is suggested that in many cases there are alternative ways of working which could eliminate the use of heat, for instance prefabrication of lead details to transfer welding off-site. If hot work is unavoidable, then in all but the smallest organisations a formal system of hot work permits should be put in place. Precautions to be taken include the provision of fire extinguishers, removal of combustibles and inspections at the end of the working day. Contractors must coordinate these measures with their sub-contractors and any restrictions which may be imposed from time-to-time and are responsible for ensuring full compliance.

It should also be noted that fires can occur even during what may be regarded as minor maintenance activity or work being undertaken by in-house labour. It is therefore essential to ensure that all such work is implemented safely and with due regard to the risk of fire.

While compliance with the statutory requirements of the Construction (Design and Management) Regulations 2007 (CDM Regulations 2007) is applicable to almost all construction work and offers some protection against the risks of fire, these basic requirements do not take into account the dangers posed to existing buildings.



*Illus 4 Part of this listed terrace was badly affected by fire during refurbishment work and the spread of the fire was facilitated by the earlier removal of the doors*

### **2.12.2 The Joint Code**

Greater protection against fire risk is offered by adherence to the more onerous requirements of the *Joint Code of Practice on the Protection from Fire of Construction Sites and Buildings Undergoing Renovation*,<sup>2</sup> (the Joint Code) first published by the FPA in 1992, now in its seventh (2009) edition. When procuring larger works (say with a value of £500,000 or over) a proper contractual responsibility should be imposed which requires compliance with the Joint Code. There may be some merit in considering adopting the terms of the Joint Code for all structural work in historic buildings – including the requirement in initial enquiries or in specifications which will ensure that contractors fully understand the seriousness with which the owner of the building views the need for proper management of fire safety.

All current UK building and construction standards (including the CDM Regulations 2007, the Joint Code, and guidance for Crown owned and occupied premises) suggest a managed approach to the problems of fire safety on construction sites as follows:

- Design Phase: the risk from fire resulting from the proposed works should be properly assessed and minimised
- Construction Phase: a plan, detailing responsibilities for: fire safety, site fire precautions, fire detection

<sup>2</sup> Seventh edition, May 2009, published by the Fire Protection Association and the Construction Confederation.

and alarm; control of hot work, site accommodation (including the design and location of temporary buildings), site evacuation procedures, liaison with the fire and rescue service, staff training, security measures against arson, safe storage of materials (including flammables and gases) and safe use of energy.

The Joint Code also provides useful guidance on related issues including temporary methods of fire protection, temporary protection of finished surfaces and the management of waste.

In some circumstances, particularly if the works contract value exceeds £5 million, the contractor's own insurance company may make compliance with the Joint Code a requirement for continuing insurance cover.

### 2.12.3 Crown Premises

In the case of Crown premises, an equivalent document to the Joint Code entitled *Standard Fire Precautions for Contractors Engaged on Crown Works* by the Department of the Environment, 1995, as well as the guidance contained in the Property Advisors to the Civil Estate (PACE) Fire Safety Guide could be applicable (although now out of print).

### 2.12.4 Typical Fire Hazards to be considered during Construction Works

Propane and butane bottled gases are commonly used in construction and maintenance activity and they should be carefully handled. Cylinders should only be used when chained or secured upright. When not in use, cylinder valves should be shut off. Hoses and connectors should be fitted with flashback arresters and checked for wear regularly.

Care should be taken in the use of flammable liquids – especially adhesives for laying tiles or flooring materials and paint thinners and cleaning solvents. These are all likely to contain flammable liquids with low flash points. Their vapours are also generally heavier than air and thus may accumulate to form an explosive concentration. Vapours heavier than air vapours may travel considerable distances before being ignited. In one recent fire, vapour travelled more than 80m from a kitchen before being ignited by a boiler pilot light. All such substances pose serious fire hazards and where used must be stored in purpose-made metal storage cabinets.

There is also a risk from certain types of temporary electrical connections and lighting units. A number of fires in historic buildings have been caused by high intensity quartz halogen lights – their use should not be permitted except under strict controls as the heat produced by these lamps can quickly ignite nearby combustible materials. Quartz halogen lights must never be left switched on in areas after work ceases or when there is no one around.



*Illus 5 If detector heads are covered during works, or systems switched off, compensatory measures must be implemented during work hours. Temporary covers should be removed at the end of the working day © Stewart Kidd*

All electrical installations (including temporary arrangements) should comply with the latest edition of the Institution of Electrical Engineers' Regulations for Electrical Installations 1995 (commonly referred to as the IEE Wiring Regulations) and the Electricity at Work Regulations 1989. Temporary wiring installations should be of a higher standard than permanent installations due to the rough treatment they may have to withstand and should be inspected and tested at intervals – at least every three months.

Where possible, contracts for construction works should specify the use of 110 volt electrical equipment using approved transformers and supply cabling. Such systems are safer for personnel and the equipment is designed to withstand rough handling so is much less likely to provide an ignition source for a fire due to damage.

The burning of rubbish in or near a traditional building can be extremely hazardous and should be prohibited by contract conditions. Under no circumstances should fireplaces ever be used for rubbish burning. However on certain very large contracts where there are adequate facilities, and where an exemption has been granted by the Scottish Environmental Protection Agency, rubbish burning may be permitted if it can be demonstrated that this can be done in complete safety.

The possibility of false fire alarms resulting from dust and smoke generated by construction work should also be considered and care should be taken to ensure that fire detection sensors, sprinkler heads, hydrants, extinguishers, fire alarm call points and other fire equipment are both suitably protected and kept free of obstruction. If smoke detectors or sprinkler heads are to be covered for the duration of work then a procedure must be put in place to ensure that the covers are removed at the end of each working day.

**2.12.5 Control of Hot Work, Permits and Procedures and Presumptions against Hot Work**

Any construction process or activity which uses or produces heat is referred to as hot work and includes the use of:

- Blowlamps (including hot-air equipment) as used for plumbing, paint removal and the like
- Welding or cutting equipment
- Grinding or cutting equipment which can create sparks or large quantities of heat
- Direct application of heat or flames as used in brazing copper piping or in lead work
- LP gas when used for tar and bitumen spreading or for the installation of waterproof membranes in roofs and elsewhere.

Wherever possible hot work should be designed out and banned on-site, for example by specifying compression rather than soldered plumbing fittings or prefabrication of lead details to transfer welding off-site. Specifications should avoid methods such as ‘burning off’ and contract conditions should be written to minimise fire risks. Where on-site hot work is unavoidable, a formal hot work control procedure should be put in place to ensure that such works are only permitted under strictly controlled circumstances and Method Statements demanded from the contractor.

These permits should set out procedures to be adopted requiring (as far as possible) that any combustible materials are removed from the immediate area before work starts. The permit should also require fire extinguishers to be immediately available and the staff undertaking the work to be trained in their use. The work area should be monitored both during the work and for at least one hour after work ceases. This will ensure that there is no smouldering material or potential for fire to develop. A sample hot work permit can be found in Annex IX.

**2.12.6 Method Statements**

As a further means of exercising strict control over works, the person responsible for administering the contract should consider requesting the submission of formal statements detailing the way in which parts of the wider project, and specific processes or operations are to be managed. Statements should make it clear what tools and equipment are to be used, how the work is to be carried out and by whom. Details should also be submitted of the materials to be used including information on their fire properties as well as possible interaction with other substances. Submitted for comment, revision as necessary and final approval prior to works being implemented, method statements afford a means of ensuring that risks are identified so that they can be satisfactorily addressed or eliminated. The final agreed statement then provides clear guidance for personnel implementing the work on the methods to be adhered to.



*Illus 6 If heat producing equipment is used in a traditional property it is essential that it is managed by a hot works permit © Stewart Kidd*

### **2.12.7 Site Briefing and Induction of Contractor Personnel**

Prior to any work starting, even on small contracts, all contractor and sub-contractor personnel should be familiarised with the premises and the procedures to be followed in the event of fire. Before commencing work they should be instructed on the layout of the building, how to sound the fire alarm, and the nearest means of escape. A check should also be made to ensure that appropriate fire-extinguishing equipment is available and that all are familiar with its method of operation.

On very large or complex projects it is worthwhile considering whether site inductions could be assisted by the production of a video programme introducing the building and project to the workforce. This was successfully done for the National Library of Scotland's George IV Building project. Note that when a project is likely to last for more than several months the need for repeat inductions and regular safety briefings should be considered.

Where out of hours working is likely to be regularly undertaken, special arrangements for the supervision of site operatives must be considered and where necessary, the client or owner may have to provide this.

Where it is necessary to isolate or restrict the use of a fire detection system or isolate or shut off all or part of a fire suppression system, a procedure for the reinstatement of such systems must be developed and complied with. Under no circumstances should the whole of a fire detection or fire suppression system be impaired or isolated overnight.

### **2.13 Liaison with the Fire and Rescue Service**

All planning aimed at minimising the impact of a fire should include involvement of the fire and rescue service. For example, arranging for the attendance of fire appliances at a drill or exercise will benefit all parties and will ensure that crews from the local fire station are able to familiarise themselves with the site. Meetings should be held to ensure that the fire personnel are aware of forthcoming special activities such as major exhibitions and special functions, or of temporary changes in building layouts. Where there are significant changes, such as the long-term presence of contractors on a site, the fire and rescue service should also be informed immediately.

Larger organisations or those where there is a higher risk to life may receive a visit from a fire safety officer to gain a more in-depth appreciation of the property or an enforcement officer employed by the local fire authority. An enforcement officer will want to ensure that the fire safety risk assessment and the fire safety measures taken are appropriate in respect of the safety of the occupants as well as others who may be affected by a fire. This individual is primarily concerned to ensure that staff

and visitors are able to escape from the premises in the event of a fire and that activities on the site comply with relevant legislation including the undertaking of the fire risk assessment, preparation of plans, training of staff and keeping of records, etc

### **2.14 Business and Property Records**

Even the smallest organisation depends to a greater or lesser extent on its financial and business records and archives. All vital records and data should be duplicated and one set secured in a protected, off-site location. In the event of fire, swift access to such resources as building and engineering drawings as well as general files relating to the building and its insurance will be vital.

### **2.15 Coordination with Insurers**

The question of the insurance valuation to be applied to a historic building or its contents has created many difficulties in the past – getting valuations wrong can result in, at one extreme, paying too much for insurance, or at the other, being under-insured (or even having no insurance cover at all). In all but the simplest cases it will probably be cost-effective to obtain professional help in valuation. There are a number of reputable companies who specialise in the valuation of historic buildings.

In most cases it is likely that the cost of the valuation exercise will be greatly outweighed by either a saving in the costs of insurance or through the reassurance of better cover and the knowledge that problems arising from under-insurance should not become an issue in the event of a claim. Insurance brokers can also be a useful source of advice – particularly those who have an expertise in historic buildings and their contents. Insurers are always keen to support any measures that have the effect of reducing the probability and consequences of a fire. It therefore makes good sense to discuss any proposed upgrading of fire safety provisions with insurers. It should be noted that insurers have always expressed strong support for automatic fire suppression systems and where these are proposed for a historic building, possibly as a compensatory feature in respect of SBS, early contact should be made with the insurers. If the system is installed to their satisfaction a premium discount and waiver of excess may be negotiated.



*Illus 7 The Bower building, University of Glasgow. Severe fire damage to the roof and interior of this category A listed teaching and laboratory building © Crown Copyright: RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk)*

# 3 FIRE PROTECTION OF BUILDINGS

Fire protection has previously been described as a systematic approach to the protection of people and premises, using a combination of structural materials, building components and protective systems.

## 3.1 Fire Protection Measures

Fire protection measures in buildings are generally categorised into two main groups: ‘active’ and ‘passive’. This section describes the range of systems, measures and other facilities which can be used to:

- Contain fire and its products (ie heat, smoke and hot gases)
- Detect and warn of the presence of a fire
- Allow occupants of a building to escape from that part of a building which is on fire
- Extinguish or control the fire
- Assist the fire and rescue services in dealing with the fire and its consequences.

It is possible to depict the measures which can be taken in graphic form – each of the terms is explained fully later in this section (see Figure 1 below).

Passive fire precautions are defined as those aspects of a building’s fabric and layout which are intended to confine fires and their products in one part of a building, both to minimise the damage resulting from fire and to assist in allowing the occupants time to become aware of a fire and time to escape from the building in safety.

Active fire precautions are those measures which operate only after fire has already broken out, such as detection and suppression systems.

This main division in terminology into passive and active measures can sometimes be confusing. For example doors may be fitted with electrically operated closing devices that operate when a fire is detected, but are usually classified as passive devices due to their primary fire containment role. Similarly devices such as dampers in ductwork and shutters over openings also move or

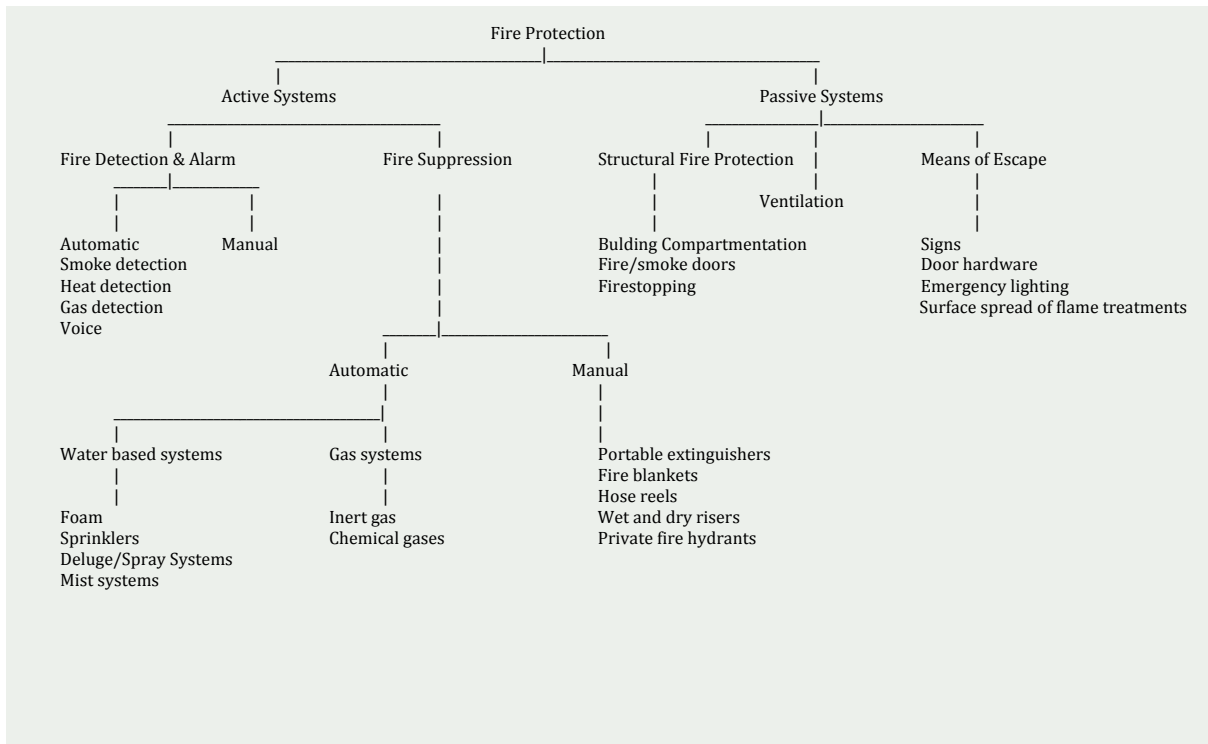


Figure 1 Organisation of Fire Protection Measures

change position automatically in the event of fire, but are still classed as being passive.

### 3.2 Installing Fire Protection Equipment in Traditional Buildings

Before commencing even to consider the installation of any fire protection equipment in a traditional building it is essential that full consideration is given to the conservation principles expounded in Part 1, Section 7. It would also be wise to draw these requirements to the attention of any building professionals involved with the project as well as all contractors.

#### 3.2.1 Tailoring a Fire Protection Project to the Building

When it has been decided that fire protection improvements are essential due to a building's use, or to ensure that the building complies with SBS as part of a refurbishment or conversion, or to prevent the risk of fire increasing where the occupancy or circumstances change, a number of factors must be carefully considered and evaluated before any work can begin to ensure that the proposed work will not cause unnecessary damage to historic fabric or contents.

The need to change a building or alter its structure should be last resorts rather than first thoughts. Imagination and lateral thought should be employed so as to determine the most appropriate approach (rather than, for example, the easiest or lowest cost approach).

For example, if a listed building were being converted into a hotel, conventional approaches to fire safety would dictate that the means of escape from upper floors would have to be protected by fire compartmentation and protected escape routes.

Alternative approaches might be:

- Enclose the main and secondary staircases in a fire compartment
- Upgrade bedroom doors to provide improved fire and smoke resistance
- Upgrade the fire and smoke resistance of doors leading from corridors to landings/staircases
- Provide a smoke extraction system for the staircase
- Provide a smoke pressurisation system for the staircase
- Provide an external fire escape staircase
- Improve levels of automatic fire detection and connect the fire alarm system directly to a central alarm receiving station and hence to the fire and rescue service control room

- Reduce the number of persons at risk or not using higher floors for sleeping accommodation.

Given the same example, where providing adequate means of escape to meet the criteria set out by the enforcing authority is problematic, it may be possible to reach a compromise solution by one or more of the following approaches:

- Reduce evacuation times/escape route lengths
- Provide additional escape routes
- Install/increase automatic fire detection
- Install a voice alarm system
- Provide more fire signs or better lighting
- Connect fire alarm to alarm receiving station and onwards to the fire and rescue service
- Install sprinklers or other automatic protection systems
- Better/more fire safety training
- Appoint fire wardens/fire officers
- A planned and rehearsed response to fires and other emergencies
- Reducing the numbers of persons to be accommodated.

Equally, it might be less intrusive to install a sprinkler system (either throughout the premises or just for the affected floor and its means of escape) rather than to enclose a staircase and landings and upgrade original room doors to meet SBS requirements.

Note that most of the possible steps to be taken will also impose an additional burden on management and it is imperative that where these are adopted that suitable safeguards must be in place to audit such activity and where measures are dependent on activities like training and hazard review, then adequate procedural steps must also be in place.

### 3.3 Structural Fire Safety (Passive Measures)

#### 3.3.1 Means of Escape

As explained in Part 1, Section 6, there are three approaches to providing a fire safety compliant building. The General Approach complies with official guidance documents or approved codes of practice. The Advanced Approach follows the guidance contained in BS 9999 while the Fire Engineering Approach uses fire engineering principles as laid down, for example, in BS 7974: 2001 *Application of Fire Safety Engineering Principles to the Design of Buildings – Code of Practice* (BS 7974).



Performance-based approaches utilise both the Advanced Approach and the Fire Engineering Approach.

Until recently, escape travel distances were limited to compliance with the General Approach, as laid out in prescriptive guidance<sup>3</sup> in order to minimise the time taken to reach an exit and hence for the evacuation of a building. Even in the move to performance-based standards there remains a reliance on established tables of door, corridor and stair widths.

A performance-based approach to means of escape design can take the form of a time-based analysis based on the Available Safe Escape Time, usually known as ASET:

- The time *required* to reach a place of relative safety is referred to as Required Safe Escape Time – RSET
- The time *available* for occupants to reach a place of relative safety prior to untenable conditions being achieved (ASET).

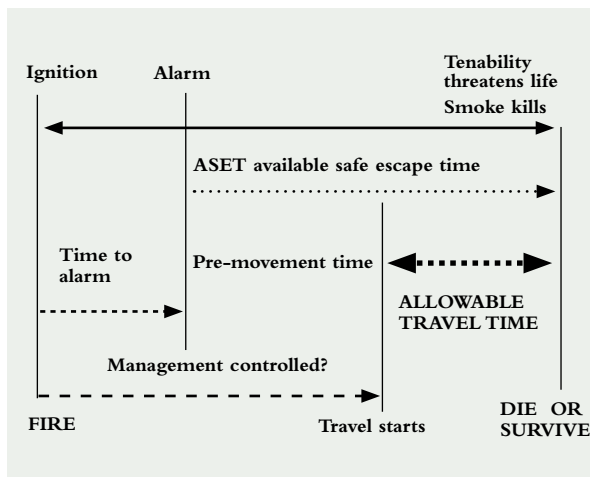


Figure 2 Available Safe Escape Time - Occupant Response and Travel Time

The aim of a performance-based design is for RSET to be less than ASET, to allow safe evacuation. A detailed explanation of the approach can be found in BS PD 7974-6: 2004 *The Application of Fire Engineering to Fire Safety Design of Buildings: Life Safety Strategies: Occupant Evacuation, Behaviour and Condition*. Extension of escape travel distances may be facilitated by the provision of an automatic fire suppression system (amongst other considerations). This is because sprinklers and water mist have the ability to control fire growth and hence ensure that conditions can remain tenable for longer than if the systems were not present. This allows extra time for escape and therefore it may be acceptable to travel further to an exit. This is particularly important in such

<sup>3</sup> For example, the 1989 Home Office Blue Book (*Guide to Fire Precautions in Existing Places of Work That Require a Fire Certificate*).

occupancies as hotels, hospitals and care premises where the building population may be asleep or have difficulty in evacuating themselves.

However, the key features of the approach and the impact of sprinklers can be summarised as follows:

- RSET is the sum of the fire detection/alarm time, the recognition/response time and the travel time to a place of safety. Sprinklers can help to reduce RSET by detecting a fire at an early stage
- ASET is determined by the onset of untenable conditions within the area being considered
- Untenable conditions can be caused by smoke toxicity and heat from fire and/or smoke
- Sprinklers can help to extend ASET by limiting the amount of smoke production from a fire and by reduced heat exposure. Trade-offs relating to travel distance are more likely to be realised if fast response sprinkler heads are provided. In a similar way, sprinklers could be used to justify a shortfall in the exit width provision in a building.

Other trade offs for travel distance and escape route widths can include increased ventilation, enhanced fire detection and alarm systems and the presence of high ceilings.

### 3.3.2 Rationalising Passive Fire Protection to Structural Elements

The ability of a structure to remain stable for a period of time in the event of fire is a fundamental prerequisite of building safety. Recommendations for fire resistance in the UK depend on the height, occupancy profile and potential fire load associated with any given building type.

The traditional approach for determining fire protection requirements is:

- To adopt the fire resistance periods recommended in the SBS (and the Building (Scotland) Procedures Regulations 2004 [the 2004 Regulations]) guidance
- Demonstrate compliance with this fire resistance period by way of standard fire tests conducted in accordance with the recommendations of the BS 476 series *Fire Tests on Building Materials and Structures* (BS476) and BS EN 13501 1-4: 2007 *Fire Classification of Construction Products and Building Elements* (BS EN 13501-1-4: 2007)
- Alternative approaches can be adopted providing the impact on the overall fire strategy is addressed and appropriate sensitivity studies are conducted. An alternative approach that has been applied to a number of UK projects over recent years is the 'Time Equivalence' method

- The time equivalence method is a series of calculations which compare the response of an element of structure in a real fire to that of a standard test furnace. The real fire conditions are calculated and the equivalent thermal dose in the real fire is related back to the equivalent exposure in the standard test
- To use the guidance offered in such documents as BS 9999.
- The limitation of the size of the potential fire so that it can be controlled more readily by firefighters
- The creation of spaces protected from the immediate effects of fire outwith the affected volume is a major benefit, not only to life safety but is a significant factor in minimising the damage or loss of historic fabric and contents
- Aiding access for firefighting
- The reduction of the likelihood of structural failure during a fire.

Therefore the equivalent period can be utilised to specify the required applied fire protection with the comfort of understanding that it will survive at least the same period as that assessed under the BS476/BS EN 13501 regime.

One way of calculating time equivalence is detailed in BS EN 1991-1-2: 2002 *Eurocode 1. Actions on Structures. General Actions. Actions on Structures Exposed to fire*. The approach includes various factors which allow for appropriate increases or decreases in the calculated period of fire exposure (and hence passive fire protection requirements) depending on the building design.

One such factor is for the presence of a sprinkler system in the building. Sprinklers have well documented advantages in limiting fire growth and have been shown to have a high degree of reliability. Thus, if sprinklers are provided in a building there is a much-reduced risk of flashover fire occurring. For these reasons, the time equivalence value may be reduced by a factor of 0.61 compared to an equivalent non-sprinklered building. This can sometimes allow a reduction in passive fire protection that would not be possible without the provision of sprinklers.

### 3.3.3 Compartmentation

Fire compartmentation remains the simplest and most cost-effective way to restrict the spread of fire and hence risk to life and damage to buildings. Present day requirements for size of compartments are set out in the various technical standards, particularly the 2004 Regulations, and depend on the activity being carried out in the building. Generally, the building regulations are not applied afresh to traditional buildings until a change of use or physical alterations are under consideration, but a knowledge of the requirements may be a starting point for an assessment and will be essential if, as is quite common, relaxations from the regulations are sought, in order to minimise changes to the fabric.

Compartmentation involves the sub-division of a building into smaller volumes by fire-resistant floors, walls and other divisions and is a major part of passive fire protection and serves several purposes:

- The limitation of damage from fire and smoke

While the simplest way to prevent or limit the spread of fire is to subdivide a building into the smallest practicable fire-resisting compartments, in practice traditional buildings present many difficulties by the nature of their construction and in terms of passive fire protection this may only be achievable at unacceptable cost to historic fabric. Before any decisions are taken in respect of such work, it is essential to ensure that all other alternative measures are properly considered.

Assessment will involve analysing the construction of the building to look for its strengths and weaknesses. Many traditional buildings are built of cellular masonry construction, with quite small volumes, although frequently fire resistance is compromised by voids, openings and the presence of combustible materials.

In many buildings the completeness of the original construction has been lost due to later alterations, poorly installed services or careless repair and much can be done to improve the fire performance of the construction while restoring or conserving these original elements. Unfortunately, it is also common for the original construction to contain openings or other weaknesses. It may be possible to deal with these in a non-intrusive way but there may be a point at which steps to improve compartmentation may conflict with conserving the integrity of the original construction. This situation may require a balance of other measures (management, detection, suppression, etc) and the adoption of a fire engineering approach.

The use of spaces will also be a major consideration. For example, at General Register House, Edinburgh, unique, irreplaceable records are stored in small individual rooms, each of which is a fire compartment. In an intensively occupied building such as a school, life safety and the protection of escape routes may be the first consideration.

Where improvements in compartmentation are to be made and be effective, the structural measures should be designed to contain the fire and its products for a predetermined period; at the same time, ensuring the stability of the rest of a building's structure under fire conditions. Existing features such as walls and floors should be used where possible as the basis for the



*Illus 8 In these examples, where services have transversed fire resisting walls, the openings have been fire stopped, firstly with intumescent caulking and secondly with intumescent pillows*

introduction of fire barriers and must exhibit both completeness and fire resistance. All that may be required to upgrade an existing feature is the introduction of inert material below the floor or above the ceiling.

Equally, in certain areas it may be possible to introduce modern materials into voids or between floors to form new, additional fire barriers. For example, sheets of gypsum board only 8mm can provide more than 30min of fire resistance. Modern flexible materials such as silicone foam sealant will upgrade the levels of fire resistance in a gap between two compartments and also provide a fire resistant barrier around cables, pipes or ducts.

A good example of this particular approach can be found in the measures adopted in the conversion of Duff House (refer to Part 3, Case Studies) to a gallery using a sympathetic combination of modern and traditional materials to upgrade levels of protection.

The important role which air movement plays in keeping the fabric of traditionally constructed buildings healthy must not be overlooked in the pursuit of fire safety. Where spaces are being compartmented and barriers are being introduced into voids, expert advice should be sought

to ensure that alterations do not compromise ventilation arrangements to such an extent that conditions which could give rise to rot or mould problems are created.

Care too must be taken to ensure that any fire compartmentation in roof spaces or voids does not in any way harm a population of roosting bats. Current legislation<sup>4</sup> covering the whole of the UK makes interference with bat populations illegal. In particular, it is a criminal offence to intentionally or recklessly damage, destroy or obstruct access to any place that a bat uses for shelter or protection. This is taken to mean all bat roosts whether bats are present or not.

Part of the risk assessment of a given building is to establish the boundaries of each compartment, whether required by regulation or as a common sense approach to fire precaution measures ie identify the compartment walls, floor and ceilings. In some cases, sub-compartments will be required or may occur naturally. In each situation it is these compartment boundaries that should be closely examined for fire resistance qualities. The other walls and floors that do not need to be compartment boundaries are not the first concern.

<sup>4</sup> See earlier references to bat roost protection in Part 1 Section 3.1.5

### 3.3.4 Survey and Assessment

Fundamental to the risk assessment and appraisal of each building's compartmentation is the need to understand its geometry and construction in three dimensions. Important steps in this process involve:

- Appraisal from original and subsequent plans, records and archive material, including, for example, Dean of Guild or Building Control records and similar sources to give an understanding of the changes and development of the building. Early records may lack detail and knowledge of the construction methods employed at different periods (and in different areas) can prove to be extremely valuable
- Dimensional surveys and the preparation of plans and sections accurately locating walls, floors, hearths, doorways, windows, staircases, etc are essential. Discontinuity of construction may indicate weaknesses of construction and potential fire paths
- Assessment of the construction to include appraising the extent of masonry walls, likelihood of built-in timbers, presence of voids, flues and other openings.

Traditional buildings have often changed and developed over many years and can exhibit different types and qualities of construction. Even very thorough surveys will not identify all the potential weaknesses and fire paths within the building. Some careful physical exploration may be necessary. Endoscopy is a technique where small holes are drilled into the building fabric and can yield information on the location of cavities and voids. However every effort should be made during survey work to minimise damage. The special demands of recording a traditional building are explained in the Historic Scotland Guide for Practitioners 4: *Measured Survey and Building Recording*.

Also, a number of non-invasive investigation and recording methods are detailed in TAN 23, *Non-Destructive Investigation of Standing Structures* 2001. Some currently available non-destructive survey techniques include:

- Electromagnetic methods such as thermography and radar. Radar surveys are particularly good at identifying flues and other voids within walls and floors
- Television surveys using remotely controlled mobile cameras can be extremely useful in showing the condition of flues, shafts and ducts.

Tests could include air pressure tests, which can reveal the integrity of volumes and smoke tests of chimneys, flues and ducts.

The measure of fire resistance is the outcome of a standard test procedure. Therefore establishing the fire resistance

of historic construction can be difficult in practice, particularly in terms of satisfying local authorities. The National Fire Protection Association (USA) have published a code<sup>5</sup> containing extensive tables of the fire resistant properties of many types of construction. These may be acceptable to local authorities if the description in the document matches the construction of the building element and the published test results are to recognised standards. Alternatively, some fire engineers are able to assess the existing construction and assign a fire resistance. Fire testing of equivalent or sample elements is a further possibility, particularly where works are being carried out and samples can be obtained.

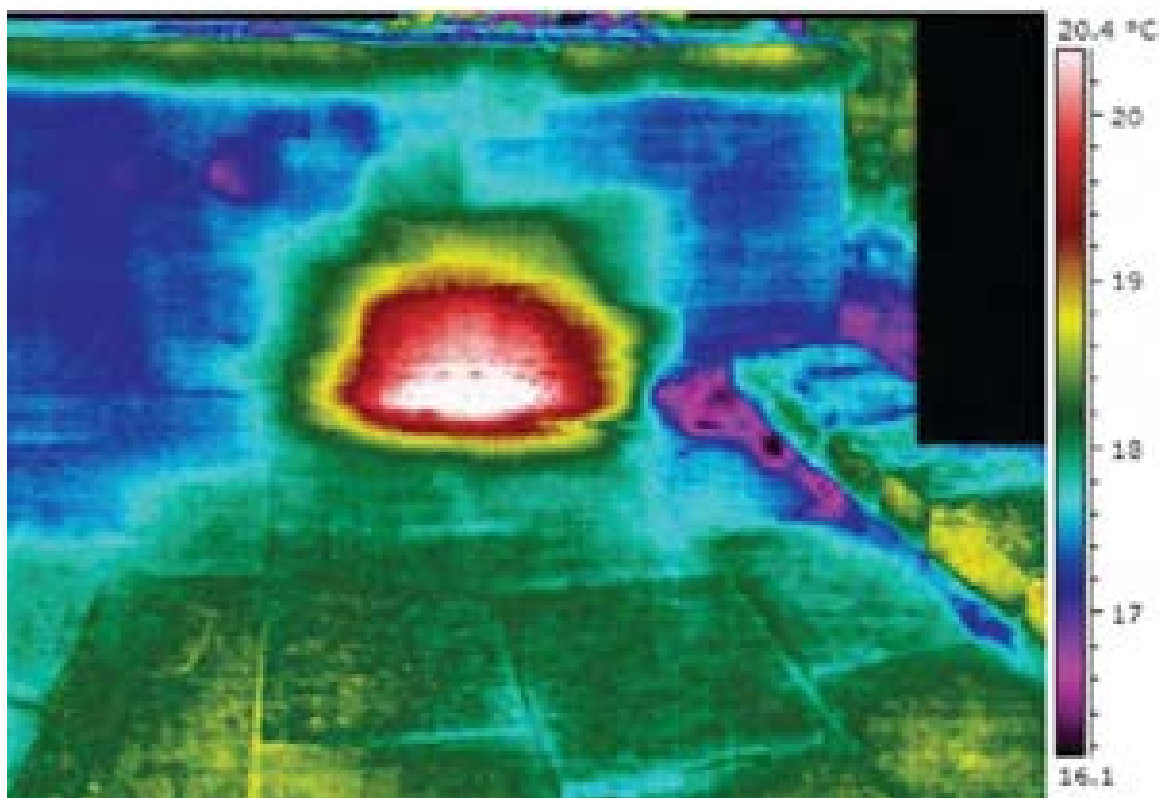
### 3.4 Smoke Control

Fires produce significant volumes of smoke in addition to heat. Statistics show that 60% of fire victims have succumbed to the effects of smoke and toxic gases. Smoke is made up of particles and gases produced by burning fuel, diluted with the other gases present in air and has a pervading nature, spreading easily through a building if un-checked. Some materials in particular, such as rubber, plastics and other synthetics, produce enormous quantities of smoke during combustion; all of which can be both toxic to life and corrosive. There are also safe visibility limits through gas and particles, beyond which escape will be difficult. The presence of smoke can delay or prevent evacuation and also hamper the positive actions of those fighting the fire.

Smoke damage to the fabric and contents of a historic building may be long-lasting and often permanent. It is therefore essential to understand the effects of smoke during a fire when considering fire risk. Apart from the most obvious surface deposits of soot and grime, the acidic nature of smoke may cause permanent degradation of many materials. The range of effects will depend on the distance of the smoke from the materials that are being burned. Plastered walls, stonework and wooden surfaces that are only briefly immersed in smoke can be washed clean; however, the penetrating effect of the 'heavy' constituents of smoke may also have occurred, and this can result in more long-term damage becoming apparent many months after immersion. In historic buildings valuable surface treatments such as wallpapers and paint and contents such as upholstery, floor coverings, wall hangings, paintings and muniments can be damaged. The cleaning techniques required in such cases will demand highly specialised skills. In post-fire evaluation, the effects of smoke damage should not be underestimated.

The principal concepts of smoke control are containment and release (ventilation), achievable by a combination of active and passive techniques. Specialist advice on smoke control techniques will often be required, for example

<sup>5</sup> NFPA 914 (2010) *Code for the Fire Protection of Historic Structures*.



*Illus 9 A thermographic survey at Stirling Castle kitchen block unearths a redundant chimney flue at parapet level*

fire consultants can calculate anticipated smoke flows and design methods of its control or dispersal. Smoke control systems are designed to contribute to life safety and damage limitation. During an assessment of risk of a historic building, the degree of vulnerability and value of the building and contents should also be considered. The purposes of smoke control can be set out as follows:

- To enhance the standard of life safety
- To reduce the potential for damage to contents
- To reduce the potential for damage to building fabric
- To assist firefighting
- To enable effective post-fire purging of accumulated smoke.

#### 3.4.1 Smoke Control Methods

The main features of a space or spaces to be considered are volume, geometrical complexity and criticality. Volume is a simple measurement of the cubic content of the space. Geometrical complexity allows for uneven smoke spread in a space, for example, the presence of a balcony under which smoke may be contained within a larger space. Criticality is based on an assessment of values, including life safety and historic value of fabric and contents. In making recommendations that involve physical changes to the building, these must be carefully considered in relation to the likely benefits obtained in reducing the overall risk. The following containment techniques may be considered:

**Containment by smoke filling** (fig 3) – This is the simplest technique which essentially allows the room in which a fire starts to fill with smoke (usually from the ceiling downwards). A common example is the use of smoke doors to isolate corridors or stairwells. The technique allows sufficient time for occupants to escape, but sacrifices the fabric and any contents of the space to the full effects of smoke damage. It is desirable to have available some method of removing (purging) smoke during and after the fire.

**Containment by construction** (fig 4) – This technique is similar to ‘smoke filling’ but with recognition that smoke should not be allowed to escape into adjacent spaces. This requires careful assessment of the completeness of wall and floor construction, including any potential weaknesses such as hatches, doors, windows and ventilation openings.

**Active pressurisation** (fig 5) – This is a positive technique of smoke control which involves the generation of differential air pressures between adjacent spaces; higher pressure in the spaces to be protected and lower pressure in spaces to be sacrificed. Positive pressure fans can be installed to create an over-pressure in corridors and stairs to prevent smoke from adjacent rooms reaching

these critical areas. This has on occasion, been accepted as a compensatory feature in trade-off compromises where conventional escape route compartmentation cannot be achieved.

The principle of active pressurisation is simple, but in practice is made complex by leakages that occur through the separating walls or floor. In addition, the installation of pressurisation fans into historic buildings would require careful consideration.

#### 3.4.2 Release Ventilation Measures

In the past twenty years a great deal of research work has been undertaken on the use of smoke control by venting. The objective of smoke ventilation is to allow smoke to flow out of the top of the space that contains the fire. In order to achieve this the space must be immediately adjacent to the roof of the building and fresh air must be able to flow easily into the space either directly or by fan-assistance.

Smoke ventilation has the benefit of reducing the fire spread and improving the chances of occupants escaping safely. A further advantage is that reduced smoke logging allows speedier access to the heart of the fire by the fire and rescue service and hence earlier fire suppression. One possible disadvantage is that the area below the ventilation outlets often experiences a localised increased intensity of the fire and hence greater damage.

There are two types of smoke venting. Natural release ventilation occurs when the air in a space is changed with replacement outdoor air without the use of mechanical systems (fig 6). Forced ventilation uses a mechanical unit or fans to remove smoke from areas such as stairwells and escape routes.

Installing a glazing material in roof lights that is designed to fail at an early stage of the fire can offer a straightforward means of providing smoke ventilation in traditional buildings. Modification of a suitable roof light above an open well staircase along these lines should enable smoke to be vented before the fire is fully evolved and this will not only help to keep the staircase clear for evacuation but also limit smoke logging elsewhere in the building and reduce the possibility of flashover. Release cross-ventilation is a natural release solution that utilises windows or other openings that serve to disperse smoke (fig 7). This technique requires more complex calculations to allow for the effects of wind direction and strength.

Following a fire in the south transept of York Minster in 1986, the lead covered roof has been provided with hatches which will open when fusible metal links activate catches on reaching a predetermined temperature. Some historic buildings (especially in France) have long featured integrated smoke ventilation systems which automatically allow the release of smoke through roof vents.

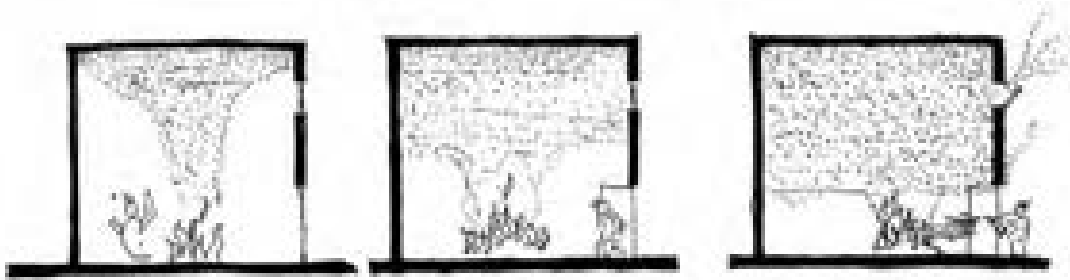


Fig 3 Containment by smoke

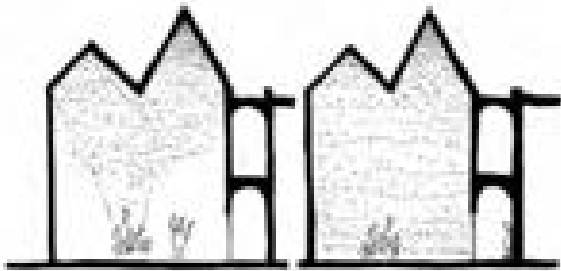


Fig 4 Containment by construction

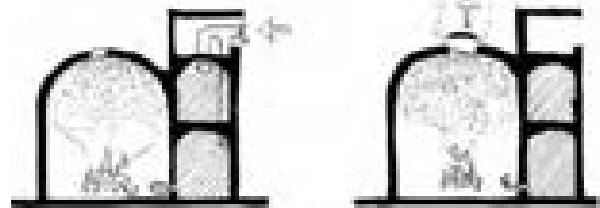


Fig 5 Active Pressurisation

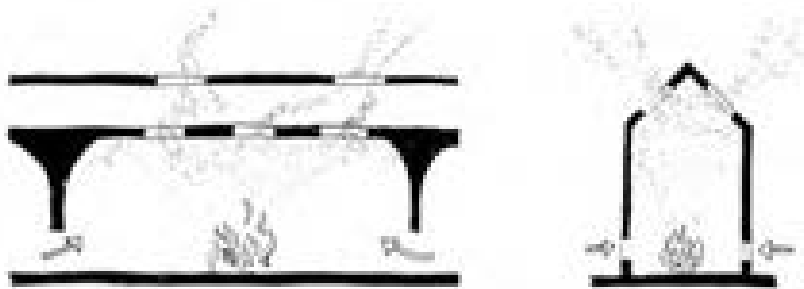


Fig 6 Natural Release Ventilation

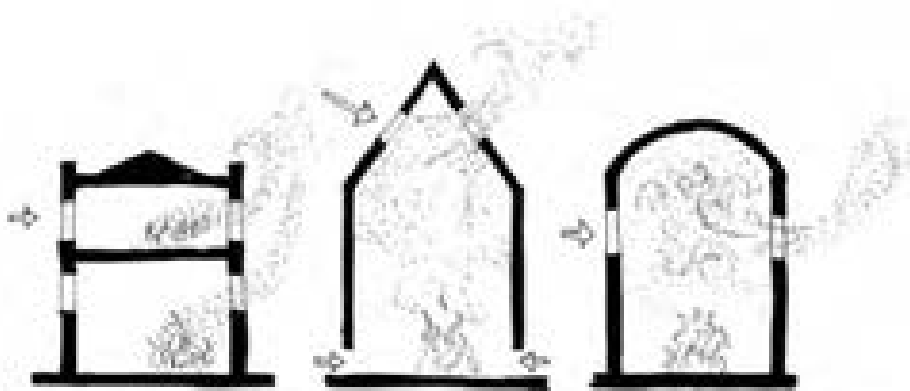


Fig 7 Release Cross-ventilation

**Fire suppression** – One of the beneficial side-effects of installing a fire suppression system is in the control of smoke yield. However, although both sprinklers and water mist systems are highly effective in smoke-scrubbing, the interaction between fire plume temperature and sprinkler system can be critical.

### 3.4.3 Introduction of Smoke Control Systems in Traditional Buildings

Where it is intended to utilise a smoke control system a full fire engineering study should be undertaken by a specialist fire engineering consultancy to guarantee the effectiveness of such an approach and to ensure that the smoke ventilation arrangements interact with other fire equipment (such as suppression systems) in a predictable way. Computerised simulations of the likely impact and movement of smoke can be extremely useful utilising computational fluid dynamics and for larger buildings, the cost of such studies may be a valuable investment. Careful collaboration between the fire consultant and other professionals is essential in order to minimise the disruption to the building fabric. For example roof hatches could be sized to fit between timber roof members and be located on less visible, inner roof slopes. It is also important that smoke control systems do not adversely affect the natural air-flow patterns within a traditional building.

### 3.5 Doors and Door Fittings

In terms of structural fire safety, doors may be the only combustible element in an otherwise fire-resistant wall and as such represent a fundamental weakness in respect of the containment of fire and smoke. Those which contain glazing or fabric panels or which have gaps in their construction may allow fire to spread between otherwise separate compartments. However all closed doors will provide some degree of resistance to the spread of fire and smoke and even very old timber doors will offer a level of fire resistance, perhaps delaying a fire for ten or fifteen minutes. In a furnace test on recycled doors recently carried out by Historic Scotland, a thin, poor quality, softwood panelled, utility door, without any intumescent treatment, lasted just under 16min. A better quality panelled door, coated with intumescent paint lasted 24min. Where such doors are set in a solid frame with a deep stile and rebate this period may even be extended and the delay in the spread of fire will make it possible to evacuate a building and summon the fire and rescue service.

Over the past twenty years a better understanding of the performance of doors in various fire situations has been developed through research, testing and particularly through post-fire examination. This has led to more confidence in making predictions of the likely

performance of a door in a real fire situation. In turn this has allowed proposed requirements to be carefully judged in relation to authenticity and historic value.

The fire performance of existing doors and their frames can often be improved, whilst maintaining their original fabric and aesthetic appearance using applied intumescent products. However, where a risk assessment or exercise to improve fire compartmentation identifies the need to upgrade the fire performance of key doorways to prevent the passage of fire for longer periods, for example 60min, replacement doors and frames may need to be considered.

Some doors may not be capable of improvement due to their method of construction or because their heritage value and authenticity makes alteration unacceptable. In such situations other ways of providing an acceptable level of fire resistance may be possible allowing the retention of the doors, such as improved evacuation procedures or suppression systems. It may also be that door frames and hardware can be upgraded unobtrusively to improve fire resistance without damage to the door leaf itself for example, installing a deeper fire stop.

Alternatively, new doors that replicate the appearance of the original doors in the building, whilst incorporating fire resistant materials can be manufactured. However the loss of authenticity resulting from the removal of original fabric and disruption, which the installation of new doors and frames will involve, must be considered and the necessary listed building consents obtained where applicable. Any heritage doors removed should be recorded and stored safely.

Hardware is an important contributor to a door's fire performance which demands effective latching or locking devices and hinges capable of withstanding fire for the required period of time. Original ironmongery of quality should be assessed and retained where possible, and this may involve the upgrading of certain elements such as intumescent around the lock case.



*Illus 10 Wherever possible, historic hardware should be retained, and only upgraded for fire resistance as necessary © Stewart Kidd*





*Illus 11 Destructive furnace tests to determine the fire performance of traditional doorsets, during and post-test.*

Too often the simple precaution of closing doors is not observed. Despite the inclusion of fire-resisting doors (often upgraded at great expense), in many large fires where heavy damage has been sustained, fire has travelled unchecked from the room of origin through doors which had been left open or, worse still, through self-closing doors which have been wedged open. Where it is desirable to keep doors open, automatic hold-open devices which retain the door in its open position and release it when a fire is detected can be considered for most locations. Such doors should still be closed at night or when the building is unoccupied. Regular closure also helps prevent warping of the structure and tests the mechanism. In premises with night porters, shift security staff or watchmen it is helpful to include in instructions a requirement that all doors should be closed during the first evening patrol and then opened in the morning prior to the premises being opened up.

### **3.5.1 Fire Rating and Upgrading Doors**

A fire door is expected to perform as a fire resisting entity including the door, the frame and its ironmongery. In considering how well a particular existing door will perform in a fire, the following aspects should be considered:

- Thickness and size of door
- Condition of materials (eg split panels or gaps between stile and frame)
- Method of construction (joints, etc)
- Type of materials (timber species and soft/hardwood)
- Size of any gaps between the door frame and supporting structure
- Presence of glass vision panels or other decorative materials, fabric panels or lining
- Type of ironmongery - method of latching, method of closing, removal of large parts of door fabric to contain lock cases, etc
- Any existing improvements in fire resistance (eg boarding, intumescent material or self-closers).

Before considering the range of options available, it will be necessary to decide on the appropriate levels of intervention. The requirement for a door to resist fire or the passage of smoke depends upon its location. It may be the weak link in an otherwise impenetrable wall; it may enclose a room containing a high fire risk, or



*Illus 12 This image from a property undergoing refurbishment clearly shows the sizable gaps that can exist between a door frame and the supporting wall*

may protect an escape route or valuable interior setting. As suggested earlier, key doors protecting escape routes should have priority in the levels of resistance achieved. Where it is decided that a door's performance in fire needs to be upgraded the primary objective should be to carry out alterations with the minimum physical effect on the fabric and with little or no visual alteration (refer to Part 1, Section 7).

Apart from those concerning glazed or fabric panels, where improving fire resistance directly has not been found possible, the two areas of potential improvement are (a) increasing the fire resistance of the constructional parts of the door or (b) by sealing gaps through which fire or smoke could penetrate.

The simplest and most cost-effective way to achieve an improvement in fire rating and fire resistance is to either increase the resistance of the elements which make up the door, sealing gaps through which fire or smoke can penetrate or to make sure that the door stays shut and in place for as long as possible. In assessing doors, it is essential to take a holistic approach. For example gaps between the door frame and supporting wall should also be rectified as an upgraded door will be ineffectual if such gaps are not addressed.

It should also be remembered that some doors are more important than others, with the best quality doors often

reserved for the principal reception rooms and this should be identified during the fire risk assessment. For example, in the conversion of a mansion or country house into a hotel, it may be that the bedroom doors themselves, where appearance is less important, could be upgraded with little heritage impact and with a better return in terms of life safety upgrading.

Test certificates or compliance with published standards of construction are frequently required by local authorities. Testing for guaranteed performance is to BS 476-22: 1987 *Fire Tests on Building Materials and Structures. Methods for Determination of the Fire Resistance of Non-loadbearing Elements of Construction*, but this is obviously a highly destructive process. In many cases an independent assessment by a recognised fire safety consultant experienced in working with historic buildings, taken in the context of other fire precaution measures, may lead to more sympathetic solutions which will also be acceptable to the local authority.

The following approaches (which can be mixed and matched) have been successfully adopted in a range of occupancies and are widely recognised as providing the necessary levels of improvement:

- Bed door panels into rails with intumescent paste and then coat panels with intumescent varnish, paint or paper
- Attach an intumescent veneer to the thinner parts of the construction such as the fielded parts of the panels
- Saw through each panel to split it in half, introduce an intumescent sheet between the halves and then re-fix and bed panel into rails with intumescent paste
- Split the entire door into two halves and introduce an intumescent sheet the width of the saw cut and then rejoin.

Where appearance is less important, the simple expedient of facing one or both sides with non-combustible boards, which can be fixed and later removed with minimum damage, may be satisfactory.

Advice should be sought from the manufacturers of the intumescent materials before any splitting or cutting is undertaken and their instructions on the use of their products must be followed if acceptable results are to be obtained. Where this advice requires removal of existing finished surfaces or paint then consideration will have to be given as to whether the fabric damage this will occasion is acceptable. It is recommended that a full scale trial of the proposed process with a non-heritage door or section is set up before full scale implementation.

Research indicates that applying intumescent surface treatments can improve the fire rating of a door to a nominal 20 to 30min fire resistance. This may be



*Illus 13 Intumescent products are increasingly available in a range of colours. The timber laminate intumescent strips (the dark band that goes round the door hinge) seen here match the surrounding timber*

adequate for many purposes but where a greater rating is deemed necessary then the same procedure augmented by intumescent and/or cold smoke combs on door edges and frames may achieve the desired objective.

### 3.5.2 Sealing Gaps in Doors

If the overall thickness of the door is sufficiently thick, sealing cracks in door panels and stiles can be undertaken using the methods described above. However where doors are badly fitting then other methods have to be adopted. Where the door cannot be modified to improve its fit then improved fire resistance can be achieved by grooving the edges and top of the door leaf and inserting preformed intumescent strip. These expand only when heated and will not restrict the passage of smoke at ambient temperatures, as will cold smoke seals.

### 3.5.3 Latches

Where doors form part of a fire compartment wall it is important that they remain closed and may be called upon to resist significant air pressure should a fire occur. Positive latching at all times is therefore required if a self-closing device does not keep the door closed.

Note that for all doors on escape routes it is a legal requirement that any locks or security devices must be capable of being opened easily, without the use of a key or any special tools and without the need for special knowledge. Conflicts between security and escape from fire can usually be resolved by careful selection of ironmongery.

### 3.5.4 Door Closers

As already stated, a fire door is valueless unless it is closed. Where door closers are in place management procedures need to be adopted to ensure that doors are not wedged open. There are five main groups of self-closing mechanisms currently available. These are listed below:

**Face-fixed overhead closers with lever arms** – These may be fixed on the door or the frame, and on either the opening or closing side of the door. It is generally recommended that they are fixed at the bead of the door. They operate principally through hydraulic or rack-and-pinion mechanisms and are manufactured in different sizes, each capable of closing doors up to a defined weight. They are adjustable to vary the force exerted and incorporate a checking action to avoid impacting violently on the frame. These closers are designed for new building work, but some varieties of closer may be suitable for installation in historic buildings. Fixing the closer is a simple operation, involving minimal screw holes in timbers. However, potential damage may occur to existing adjacent surfaces if the scope of movement of the parts is not fully understood.

**Concealed overhead closers** – They are similar in operation to face-fixed, but the barrel of the mechanism is hidden from view by forming a recess in the door or frame. The lever arm remains visible. There are minimum dimensions of door rail members into which this type of closer can be fitted. It may not be acceptable to consider cutting the door for this closer. Care must also be taken to avoid reducing the fire-resistance of the door by cutting it.



*Illus 14 A concealed overhead closer – a discreet solution*

**Floor springs** – These operate by means of an arm or shoe which is fitted to the bottom of the door at its hinge point. A hydraulic or spring-operated closer is contained in a casing which is sunk into and fixed to the solid structure of the floor.

**Jamb closers** – The mechanism consists of springs and a hydraulic unit contained within the cut out butt end of the hinge stile of a door (or corresponding part of door frame). Loss of material in cutting the door does not normally affect its fire resistance as the insulating properties of wood are good. Chains connect the unit to a fixed plate. This type of closer is closest to achieving a visually unobtrusive installation and may cause least damage to the fabric. There are limitations on the weight of door which can be satisfactorily closed and experience has shown there may be difficulties where differing air pressures exist on either side of a door.

**Other closers** – Tail sprung and flap closers are available but these are suitable only for the lightest type of door. They comprise a metal cylinder containing a coiled spring and the whole assembly is face-fixed to the door frame. A tail rod or flap bears onto the surface of the door and forces it closed under direct pressure. Rising butt hinges, which rely on the weight of a door to close it, will not generally be an acceptable choice.

There are also supplementary devices, normally in the form of a spring under tension and weight operated devices usually only found on sliding doors.

It is likely that in some cases, the visual intrusion of top-fitting devices, unless these are already in place, may preclude their use. Underfloor devices may be more acceptable especially when it is remembered that many of these permit a door to swing in both directions.

### 3.5.5 Door Holders

One solution to the problem of doors needing to be left open (for communication, ease of circulation, ventilation, etc) is the use of door holding devices. There are two main types of holders:

**Hold-open devices** – Used extensively in locations where normal usage of the doorway is heavy and a closed door would be a nuisance; and where doors are needed for compartmentation, but it is preferred for the door to remain open. They are usually operated by electro-mechanical devices. In the event of a fire being detected by an alarm system, the electric power to the magnet is shut down allowing the door to be closed by self-closers fitted to the door. These devices are preferable to the familiar image of a self-closing door wedged or propped open, which must not be allowed. Care is needed in locating the device as in some situations the action of the device working against the closing spring can warp the door, making it ineffective as a fire door (in addition to damaging the door). Ideally the hold-open device

and closing mechanism should be installed at the same height on a door.

**Free-swing closer** – These are useful where the occupants include elderly or disabled people. They allow a door to be used normally, ie without being automatically closed each time and capable of being left partially open, until the fire detection system triggers the closing mechanism after which it behaves as a self-closing door.

A number of these devices require cable connection to the detection/alarm system and some also require an electrical supply, usually a spur outlet, nearby to the closer. The disruption caused by installing these devices must be carefully considered against the benefits offered.

Recent developments include battery-powered hold-open devices actuated either by a radio signal or by the audible fire alarm signal have been developed, which have the advantages of not requiring any wiring and are simple and quick to install.

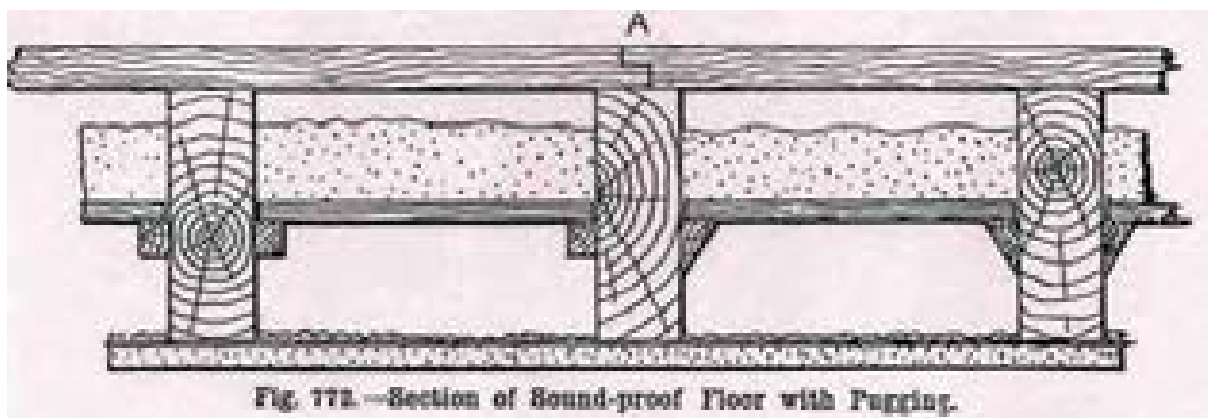
### 3.6 Enhancing the Fire Resistance of Floors

Reference has already been made (in Part 1, Section 3) to the vulnerability of traditional buildings to rapid fire spread via timber construction of floors.

Upgrading the fire resistance of a floor can be a difficult task, which may result in some loss of historic fabric, but there are a number of recognised methods of upgrading the fire resistance of floors. These are summarised below, but are discussed in detail in Section 2.2.3 of Guide for Practitioners 6

- Consolidate any deficiencies in the original construction
- Introduce mineral fibre quilt supported between or below the joists
- Insert intumescent sheet material over or under existing surfaces
- Insert intumescent material at the perimeter of the floor to close the link with the wall cavities in the event of a fire
- Apply intumescent coatings to ceilings
- Apply additional layers of fire resistant boards to ceilings
- Treating the timber elements with an intumescent coating will increase further their fire resisting capabilities.

It may be more practical in certain cases to consider concentrating on reinstating the integrity of walls, perhaps increasing the number of fire divisions in plan to compensate for the weaknesses in the floors, coupled with other fire precaution measures such as detection or suppression.



*Fig 8 A typical floor construction in an 18th or 19th century property – tongue and grooved floor boards, lath and plaster ceiling below and deafening between ('pugging' in England)*



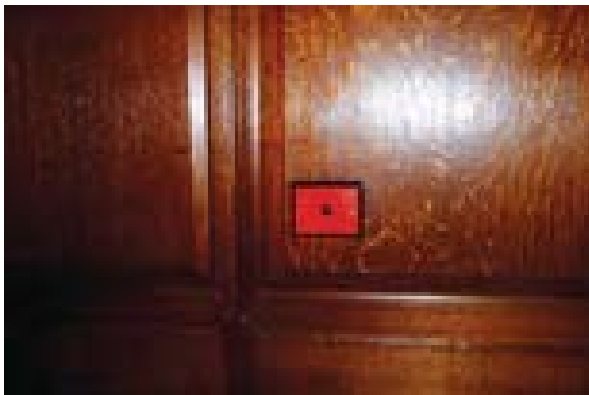
*Illus 15 As seen here in the aftermath of the 1824 Great fire of Edinburgh, fire is not a new threat, but the technology available in the modern era to tackle the threat is constantly evolving © Courtesy of RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk)*

# 4 ACTIVE FIRE PROTECTION SYSTEMS

## 4.1 Fire Detection and Alarm Systems

In all but the smallest properties a basic fire warning system should be installed and Automatic Fire Detection (AFD) should be considered as a means of giving early warning of fire. Automatic detection systems offer invaluable warning when fires break out at night, especially in less frequented parts of the premises or when the property is empty. Fire detection and alarm installations for buildings other than small dwellings should be designed and installed in conformity with BS 5839-1:2002 *Fire Detection and Alarm Systems for Buildings, Code of practice for system design, installation, commissioning and maintenance (BS5839-1)* while components should, in most cases, be manufactured in accordance with the recently introduced series of standards published as BS EN 54: *Fire Detection and Fire Alarm Systems*.

### 4.1.1 Classification and Application of Fire Alarm and Detection Systems



Illus 16 Manual call points can be located unobtrusively  
© Stewart Kidd

BS 5839-1 classifies fire detection systems as follows:

Systems for protecting life fall into six categories:

**Category M – Manual system:** This type of system does not incorporate automatic detection of fire but relies upon a manual call point (sometimes known as ‘break glass boxes’ or ‘break glass call points’) being operated, which causes the alarm to sound. Alarm call points are normally provided at all storey exits. Other categories usually add to this basic provision of control and indicating equipment, call points and sounders.

**Category L1 – Life 1:** This system provides total coverage of the building. Automatic detectors are installed throughout to provide the earliest possible warning of fire.

**Category L2 – Life 2:** The objective of this category is to detect a fire before it enters the escape route and at an early stage in specific areas of high hazard or risk.

**Category L3 – Life 3:** The objective of this category is to detect fires before they enter the escape routes. This generally requires, for example, detectors in rooms adjoining corridors, as well as in the corridors themselves.

**Category L4 – Life 4:** The objective is to enhance the safety of occupants by detecting fires in the escape routes.

**Category L5 – Life 5:** Detectors in this type of system are located to satisfy a specific, but limited fire safety objective, eg releasing particular fire resisting doors when a fire is detected in the vicinity.

Systems for protecting property fall into two categories:

**Category P1 – Property 1:** This system provides total coverage of the building, with automatic detectors installed throughout. Additionally, break glass call points are installed on all exits and between zones.

For all practical purposes, a category P1 system has the same cover as a category L1 system.

**Category P2 – Property 2:** This system has automatic detectors installed only in high-risk areas, such as plant rooms, storage facilities or any other area where there is a high risk of fire

Examples of the appropriate uses of each type of system are set out in BS 5839-1.

All automatic fire detection systems work by detecting the presence of heat, smoke flames or gases produced by a fire. The systems may then either sound a general signal to evacuate the premises or operate a sounder in a location such as security office. As an added safeguard it is simple, and relatively inexpensive, to also connect an AFD system directly to an alarm receiving station and a call is then made to the fire and rescue service’s own control room.<sup>6</sup>

<sup>6</sup> It is usually possible to utilise an existing telephone line connection if one is already provided for an intruder detection system.

#### 4.1.2 Sounders and Warning Devices

In order to comply with statutory requirements under the 2005 Act and the regulations made thereunder, it is likely that most non-domestic premises, and also care homes and houses in multiple occupancy will need a basic fire warning system in order to sound an alarm in the event of fire in the building. The fire warning signal should be clearly audible in all parts of the building and should be readily distinguishable from any other alarm.

Various methods of actuating alert or evacuation signals are possible:

- At the very smallest locations where evacuation is uncomplicated and easy or where only a very few people are likely to need to be evacuated, a bell, gong or other mechanical device operated manually when someone detects a fire may suffice to satisfy statutory requirements.

It is suggested however that there are likely to be only two choices in most traditional buildings that are publicly accessible or workplaces:

- A manually operated alarm system: where the sounders operate when a manual call point is activated by a person discovering a fire. Such systems should not be considered in circumstances where a fire could start unnoticed or where the building and its contents are of some importance. Purely manual systems should not be installed in significant buildings that are regularly left unoccupied.
- In larger premises or locations where there might be large numbers of visitors the alarm system should be capable of being triggered either automatically by the fire detection system or one of the manual call points. In premises where there are likely to be substantial numbers of people present, the system should be programmed to take account of the building's evacuation procedures, for example by phased evacuation (where occupants of only one floor are moved out of the building). Alarm delays which give a small window of opportunity for staff to verify the presence of a fire before the warning is sounded may also be possible. However, where this approach is being considered, it may be useful to seek the view of the fire and rescue service. The alarm control panel should still signal a fire to the fire and rescue service as soon as it is detected.

#### 4.1.3 Voice Alarm Systems

In very large premises, particularly those open to the public on a daily basis, public address systems linked to an automatic fire detection system can be used to broadcast live or prerecorded evacuation messages including those for fire and bomb threats. Such voice alarm systems are

considered as an appropriate alternative to electronic sounders or bells, particularly where a phased or staged evacuation is required, or to reduce panic in places of public assembly. Prerecorded messages are stored on computer chips and can feature different texts (for example: for alarm tests or for security evacuations) or can even be provided in a number of languages if required.

The coverage and audibility of voice messages is critical and it is suggested that specialist advice must be sought before specifying or installing such a component as part of a fire detection and alarm system. Great care should also be taken to ensure that all signals from the message generation unit and its amplifier to the loudspeakers are carried in fire resistant cabling or in cables installed in steel conduit.

The fire detection part of the system should comply with BS5839-1 while the voice part should comply with BS 5839-8: 2008 *Fire Detection and Fire Alarm Systems for Buildings. Code of Practice for the Design, Installation, Commissioning and Maintenance of Voice Alarm Systems* and BS EN 60849 (1998): *Sound Systems for Emergency Purposes*. It would also be advisable to ensure that the equipment also complied with BS 7827 (1996): *Code of Practice for Designing, Specifying, Maintaining and Operating Emergency Sound Systems at Sports Venues* particularly if the local authority is to be approached for a licence for events at which large numbers of the public may be present or at which musical or theatrical entertainment is to be offered or alcohol served.

#### 4.1.4 Remote Connections and Alarm Receiving Centres

While AFD systems are a major weapon in the fight to save life and minimise damage from fire it is essential that the warning of fire is responded to. In all but the smallest buildings and in all traditional buildings which are not continuously occupied this means that an alarm signal should be communicated automatically to the fire and rescue service.

There are now very few circumstances or situations where alarms can be connected directly to a fire station. Today most systems are therefore connected to commercially-operated alarm receiving centres (sometimes referred to as alarm receiving stations) which then pass the call on to the appropriate fire and rescue service control room. These centres also monitor security and intruder alarms so it may be possible to achieve savings by using the same communications circuits for both types of systems.

Some peace of mind may accrue from utilising the services of a listed/approved alarm receiving centre. LPCB/BRE Certification Ltd (formerly the Loss Prevention Certification Board) and the National Security Inspectorate (NSI) both operate approval and inspection schemes for such facilities.



#### 4.1.5 Fire Detection and Alarm System Components

The main components of fire alarm and detection systems comprise:

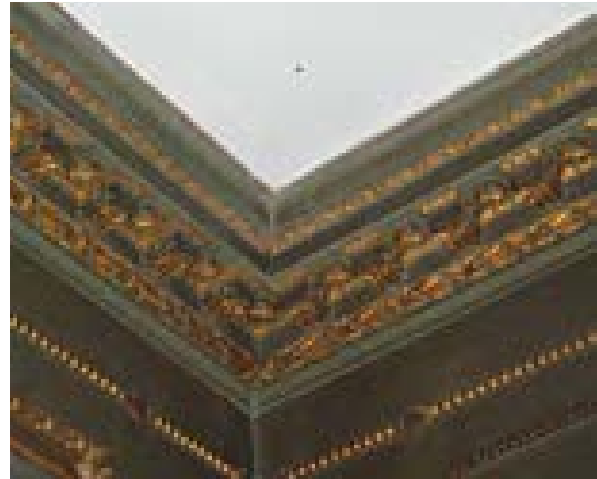
- A network of sensors or some other type of detection devices such as an air sampling system or a beam detection system
- Manual call points
- The control panel and power supply including back up battery
- Output devices (sounders, strobe lights, voice alarm systems and direct links to an alarm receiving centre.

Sensors can be of various types although increasingly there is a trend towards multi-sensor detectors, such as combining a photo-optical smoke sensor with a carbon monoxide detector in one unit. By combining different methods of detection in a single unit this can overcome some of the limitations of individual types and can filter out some spurious alarms:

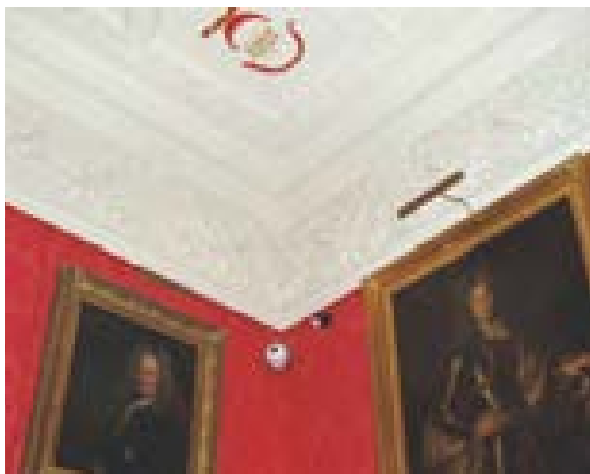
- Smoke detectors: either photo-optical or ionization types which detect the actual presence of smoke in the area of the detector. Both types are effective sensors but the ionisation detector is potentially better at detecting smoke from flaming fires which produce relatively small particles while the photo-optical sensor is much better at detecting smouldering fires. Ionisation detectors are prone to false actuations as a result of their sensitivity – commonly, such phenomenon as burning toast, dust, steam, aerosol sprays and small insects such as thrips have been known to cause false alarms.
- Heat detectors: either ‘fixed’ temperature or ‘rate of rise’(or combined) types, which monitor the temperature of the air within an area and give an alarm if this rises above a predetermined temperature or rises too quickly.
- Flame sensors: designed to detect the presence of a flame, either by its infrared, or ultraviolet emissions, or the unique frequency of the flame ‘flicker’.



1



3



2



4

*Illus 17 1) Visual impact is minimised as the ceiling is so elaborate and the detector, to the base of the large panel, is white. 2) The positioning of this wall mounted beam detector has avoided disruption to the elaborate ceiling plasterwork 3) & 4) Discreet sampling holes through which air is drawn in*

Reproduced with kind permission of the National Trust, for Scotland

- Beam detectors: which transmit an infrared beam across a space at a high level to a receiver sensor or to a reflector which bounces the beam back. If the beam is broken by smoke particles the receiver triggers an alarm signal.
- Aspirating Smoke Detection (ASD) systems (also known as air sampling systems) consist of a network of small diameter perforated pipes connected to a detector unit. These systems are stand-alone units but their fire warning signals can be connected to the main fire detection system control panel. The system draws air from the spaces protected through a small sampling hole and through the pipes to the unit where it is analysed and its constituents examined for traces of products of combustion.

Recent technological developments include multisensor detectors which utilise different types of sensor technology and are intended not only to broaden the scope of the types of fire products detected, but also to reduce unwanted alarms by cross-checking. The use of an ionisation smoke sensor combined with a carbon monoxide sensor, for instance, would reduce the probability of false alarms caused by such stimuli as steam or dust. Another relatively new development is the use of modified television camera technology to detect flames or smoke movement which may have uses in, for example, the protection of very long galleries or corridors.

When selecting and positioning sensor equipment in historic buildings, weight must be given to aesthetics and fabric impact as well as technical performance. Where sensors cannot be positioned in the location

specified in the relevant standard, designed to obtain the best coverage, it might be possible to compensate for this by, for example, installing two sensors rather than one. On some ceilings it may be preferable to locate detector heads in less than optimum positions whilst still providing an acceptable level of coverage. Other alternative approaches using a flexible, considered perspective may be adopted – for example avoiding damage to a decorated ceiling by mounting a sensor on conduit that is then attached to a picture rail or cornice. While in general sensor bodies must never be painted (especially without the consent of the manufacturer), all major manufacturers can usually provide a wide range of colours to special order.

In certain circumstances, the use of individual smoke sensors can be avoided by using equipment such as beam detectors which cover a large area and these can often be positioned in less conspicuous locations such as above a cornice or picture rail or even recessed deep in decorative carvings or mouldings.

#### 4.1.6 Manual Call Points

Manual call points are the primary method of sounding the alarm when someone discovers a fire. The call points used to consist of a glass cover plate which when smashed sent a signal to the fire control panel. Most modern call points now use a plastic sheet rather than glass for enhanced safety. For example, in hotels, care homes and hospitals where some occupants may evacuate in bare feet it would be preferable to minimise any risk of injury from glass fragments. In most fire detection



*Illus 18 It is clearly seen in these two images the difference between careful consideration of the building fabric and a standard approach when selecting detection equipment*



*Illus 19 This is an example of bad design where the break glass call point and electric door release are too closely located*

© Stewart Kidd

systems, call points are provided by fire exits or adjacent to fire points which usually contain a fire extinguisher or other equipment.

These locations comply with the requirements of BS 5839-1: 2002 which governs the design and installation of call points. The location of manual call points can also sometimes cause problems. While the relevant standard specifies that these should be red, there may often be room for some compromise in the provision of call point bodies which blend with the background. This compromise might also allow flexibility in terms of concealment (providing a flush mounted call point) and location (not necessarily placing the call point directly adjacent to a door). It may also be possible to agree with the building or fire authority, subject to guarantees regarding staff training, to install the call points inside cupboards or in recesses. Careful reading of the relevant guidance documents and regulations can also be useful.

In some buildings there may be a number of devices which look like call points but which are used to manually operate, for example, electric door releases or smoke removal systems. It is essential that such units are clearly marked with their function and, where possible, not grouped with the fire call point. Where such units are provided for the manual operation of gaseous fire suppression systems then in addition to clear marking a cover should be provided so that operation of the system requires two distinct operations.

#### **4.1.7 Fire Control Panels**

Modern fire control panels in all but the smallest premises are likely to be of the 'analogue addressable' type. This equipment is based on a microcomputer which is programmed to monitor not only the status of each detection device (the sensors) but also the fire call points, wiring, alarm sounders and any other devices installed. When the system identifies a fire condition (ie the presence of heat, smoke or an operated call point) it will operate the sounders. These systems can also spot where



*Illus 20 Example of an addressable wireless fire alarm system (wireless can be beneficial where hard wiring would be disruptive to the fabric) © Stewart Kidd*

a detector's performance is degraded by contamination and even signal for a service call.

Systems can also be set up to close automated doors, fire shutters and so on and to call the fire and rescue service. The panel of an analogue addressable system is able to give the specific 'address'; that is the actual location of the detector or other device that has activated, which is of major benefit in identifying exact position in the event of an outbreak of fire. Day-to-day fault-finding is also simplified with addressable systems which can detect and pinpoint faults such as smoke detectors whose performance is affected by dirt or other impairments.

The control panels incorporate a display window which will indicate, in clear language, the location and type of sensor and why it has activated. Printers can also be connected to provide a permanent record of activity. The conventional non-addressable 'zoned' panel by contrast is unable to distinguish between individual devices, and can only identify the wiring circuit or zone to which a number of sensors (perhaps as many as 200) are connected. When fire is detected or a fault condition occurs, the panel of these systems will therefore only give a general indication of the location by activated zone and, depending on wiring, this could be an entire floor or even an entire building.

Control panels are supplied with power via continuously charged batteries which will provide a back-up supply

in the event of mains failure. Panels should be located where they are visible to all who need to see their indicators and operate their controls and where the fire and rescue service can easily find them in an emergency. In buildings that are unoccupied at night, they may be located where they are visible from outside the building – for example through a vision panel or behind a door or other access point to which the fire and rescue service has access.

In larger buildings, ‘repeater’ panels, which give the same information as the main control panel, are often fitted near a secondary entrance or in a security control room or lodge. Careful consideration will likely be required to identify suitable locations where panels can be installed to meet these functional requirements whilst sympathetically respecting building aesthetic and fabric considerations.

#### 4.1.8 Managing Unwanted Alarms

The term ‘unwanted’ includes not just false alarms, but any signal other than that generated by a fire. Home Office Fire Service Circular 6/1994: *False Alarms Generated by Fire Detection Systems: Remedial Measures* had already recognised the serious and growing problem arising from these unwanted fire signals and it should be noted that it is an offence under Section 85 of the Fire (Scotland) Act 2005 to knowingly give or cause to be given a false alarm of a fire to the fire and rescue service. Attempts by the Chief Fire Officers’ Association (CFOA) and the Fire Industry Association to reduce the number and impact of unwanted alarms have led to some improvements.

Surveys show that 43% of unwanted alarms are attributable to human error or equipment malfunction. These unwanted alarms constitute a serious problem of misuse of resources, as while the fire and rescue service is dealing with such calls they are not available to tackle real fires. False calls also erode the confidence of end-users in the value and reliability of AFD systems and can cause costly interruptions to normal activities.

Although 90% of installed AFD systems give no problems and generate few unwanted calls, it is the rising number of unwanted fire signals from the other 10% of installed systems – the ‘rogue’ systems which need to be addressed. Notwithstanding the continuous upgrading of standards over time, advances in technology and the improved reliability of equipment, there is little indication that many alarm system owners have addressed the problem of unwanted alarms.

Repeated unwanted alarm signals can result in an alarm system being classified by the fire and rescue service as ‘an unsatisfactory system’ – this being defined in official guidance as:

*‘A system which produces two or more unwanted fire signals*

*in any period of four weeks, or three or more unwanted fire signals in any period of twenty-six weeks, and also systems where the cause of any unwanted fire signal has not been identified and remedied within seven days.’*

#### 4.1.9 How to Eliminate Unwanted Alarms

Following concerns expressed by many parties about the problem of unwanted alarms, a joint Working Group was set up consisting of representatives from the fire and rescue service, fire industry, end-users and insurers. This group recommended reinforcing the guidance already given to system users and fire and rescue services in order to reduce the number of unwanted fire signals resulting from ‘human factors’. In support of this a free booklet entitled *A Guide to Reducing the Number of False Alarms from Fire-detection and Fire-alarm Systems* has been produced by the Office of the Deputy Prime Minister (whose functions have now been replaced in England and Wales by The Department of Communities and Local Government). Other measures identified include the development of a Chief Fire Officers’ Association Policy that requires fire detection systems connected via central stations to meet specified performance criteria.

Careful consideration in specifying equipment can assist in reducing unwanted alarms. For example, when selecting sensors, it makes no sense to provide smoke detection in kitchen areas, as this will result in the fire and rescue service being summoned every time the toast is burnt! Under their integrated risk management plans some fire and rescue services may choose to limit attendance at premises where there is a history of frequent unwanted alarms. Other well-known stimuli for false alarms include insects, steam, dust and aerosol sprays. Detailed guidance on the design and maintenance of systems to minimise unwanted fire signals are provided within BS5839-1:2002.

Proper training of staff whose duties include setting or isolating alarm systems should be included in the fire safety management policy. The need to either isolate the alarm system when a test or drill is taking place, or advise the central alarm station and/or the fire and rescue service to alert them that the system may be activated, should also be included in the policy. Good record keeping will provide assistance in determining the nature of a problem and information on all alarm actuations should be recorded in the building’s fire safety log book, as should any changes to the system or its components. Where changes made to the alarm system are fundamental and permanent, details should be recorded in the building’s Fire Safety Manual.

When building maintenance or construction work, including painting and decoration, is to take place, advice should be sought from the alarm installation or maintenance company on what steps should be taken

to ensure that construction activities do not trigger unwanted alarm calls. These could arise for instance due to cables being damaged or as a result of dust created by the works. During work care should be taken to protect fire system components, particularly ceiling mounted smoke sensors, from dust, debris or paint spray. This may require the detectors to be protected by a temporary cover. When this is done it is vital that such covers are removed at the end of the working day so that the operation of the system is not impaired for longer than is absolutely necessary. In the case of longer duration of work which produces large amounts of dust it might be worth considering whether smoke detectors could be temporarily replaced with heat sensors. If the building is protected by a sprinkler or water mist system then these heads must also be protected by covers. If recessed or concealed sprinkler heads are installed then great care must be taken to ensure that the gap between the cover plates of the heads and the ceiling is not painted over.

Good standards of maintenance will help eliminate unwanted alarms. This can be achieved by ensuring that any maintenance contractor meets the exacting obligations as defined by BS 5839-1:2002 and meets the standard of quality service as defined by the Certificate of Registration with British Approvals for Fire Equipment (BAFE).

## 4.2 Manual Firefighting Equipment

### 4.2.1 Fire Classification

To ascertain what type of manual firefighting equipment needs to be provided, the types of fires likely to be encountered in the premises have to be considered as unfortunately, there is no one single universal extinguishing medium or item of manual firefighting equipment suited to all conditions. There are four main types of fire<sup>7</sup> determined by the fuel involved:

- Class A: Fires generally involving solid organic materials, such as coal, wood, paper and natural fibres
- Class B: Fires involving: liquids: petrol, fuel oil, solvents etc
- Class C: Fires involving gases: LPG, acetylene
- Class F: Fires in cooking oils and fats.

Fires involving live electrical equipment are not separately classed since although an electrical spark may be the source of the outbreak, the fuel will relate to Class A or Class B – perhaps the material from which the equipment is manufactured or flammable liquids used

<sup>7</sup> There is a fifth category involving fires in reactive metals such as magnesium, phosphorous and sodium for which special types of extinguishers must be provided. Advice should be sought from the supplier of the chemicals or the Health and Safety Executive.

to lubricate the equipment. Different types of fire are best extinguished with specific agents. For example, normal Class A combustibles such as wood and paper are best extinguished by cooling with water, while Class B flammable liquids are best smothered by foam or dry powder. Fires involving electrical equipment should be extinguished by the use of a carbon dioxide or dry powder extinguishers. In many cases, disconnecting the equipment from its electrical supply is sufficient to extinguish the fire but in all cases, it is advisable to switch off or unplug the appliance before tackling the fire.

The introduction of Class F, covering cooking oils and fats, simplifies the selection of fire extinguishers for larger kitchens. Most manufacturers now offer an extinguisher which will tackle both Class A and Class F fires. These extinguishers contain what the fire industry now calls 'wet chemical' agent specifically formulated for extinguishing fires in cooking oils.

Class C fires should not normally be tackled with portable fire extinguishers – the most effective action is to shut off the supply of gas. If this is not possible, then the fire and rescue service should be called while, if safe to do so, copious amounts of water are applied to the cylinder to prevent it from exploding. The area involved should be evacuated of all non-essential personnel and if the hose being used to cool the cylinder can be lashed to a structure then this should be done and the area completely vacated. Details of the various items of firefighting equipment available, together with the fire type application to which each is suited, are set out in the following sections.

### 4.2.2 Portable Fire Extinguishers

The most common form of firefighting equipment in buildings is the portable fire extinguisher. These are available in a wide variety of sizes and types containing different firefighting agents appropriate for particular types of fire.

Since 1 January 1997 all extinguishers sold in the UK should comply with BS EN 3: 1997 *Specification for portable fire extinguishers* (BS EN 3). This requires 95% of the extinguisher body to be painted red. Formerly, under BS 5423: 1987 *Specification for Portable Fire extinguishers, (BS 5423)* UK extinguishers had their entire external bodies colour-coded to indicate their contents. As a concession to UK practice, the new BS EN standard permits up to 5% of the body area to be colour-coded using the standardised colours from the former standard. Given that a service life of twenty years is not unusual for a properly looked after fire extinguisher, many extinguishers with full colour bodies will still be found in premises and, despite what some over-enthusiastic salesmen or service engineers might suggest, these are still legal and may continue to be used until they are no

longer serviceable. This means that some buildings will contain old and new fire extinguishers of the same type, but with different coloured bodies.

To avoid confusion, it is suggested that where possible, extinguishers manufactured to BS 5423 with full body colour-coding, should not be installed in the same buildings, floors or areas as units manufactured to BS EN 3: 1997.

Fire extinguisher colour coding, usually around the main label, follows the following system:

- Water (red): suitable for Class A fires involving ordinary combustible materials, such as wood and paper
- Dry powder (blue): suitable for Class B fires involving flammable liquids and fires involving electrical equipment
- Carbon dioxide (CO<sub>2</sub>) (black): suitable for fires involving live electrical equipment
- Foam (cream): suitable for small liquid spill fires (such as those involving cooking oil) where it is possible for the foam to form a blanket over the surface of the flammable liquid.

Foams are sub-divided according to their natures – the most common is fluoroprotein foam which will be effective on most liquid fires. Recent introductions of foam spray (usually grey) extinguishers are worth noting as these may prove to be suitable for a range of risks such as might be found in boiler rooms.

There is as at the time of writing no formally-agreed Class F extinguisher colour but most manufacturers appear to have opted for a yellow or orange label.

Halon (BCF 1211) extinguishers are still occasionally encountered (coloured emerald green or occasionally yellow or olive drab) although these are no longer permitted to be used in workplaces and should be withdrawn from use and replaced – probably either by dry powder (in non-sensitive locations such as boiler rooms) or CO<sub>2</sub> units.

Extinguishers with chromed or copper-coloured bodies are also available. However as these do not comply with BS EN 3: 1997, locations where compliance with British Standards is either desirable or mandatory may decide that these should not be used, even though some consider such units to be more aesthetically acceptable in a heritage context.

In the case of traditional buildings, especially those which may contain a wide range of historic artefacts etc, it should be noted that while dry power extinguishers are effective on both Class B fires and fires involving electrical

equipment, recent international research<sup>8</sup> suggests that the chemical used in most of these extinguishers (normally a mixture of monoammonium phosphate and ammonium sulphate) can have a damaging effect on delicate materials such as paintings, china, glass, silver and fabrics such as carpets, curtains and tapestries. In a recent incident where a dry powder extinguisher was maliciously discharged at the same time as two water extinguishers, the hygroscopic nature of the powder resulted in damage to a range of surfaces and contents resulting in a clean up bill in excess of £300,000. It is therefore suggested that dry power extinguishers should not be used inside historic buildings. Note that powder is also not a sensible choice in working kitchens<sup>9</sup> as in most cases the electrical units which may be involved in a fire can be isolated to permit the use of other agents.

#### 4.2.3 Hose Reels

Hose reels consist of a drum or reel around which is wound rubber hose of either 19mm or 22mm diameter permanently connected to the building's water supply. Reels are classified as either 'manual' or 'automatic'. Manual units have an on/off valve which has to be opened before the hose is unwound, while automatic reels operate by means of a valve mechanism inside the spindle of the reel which operates as the hose is unwound. Both types also have an adjustable valve on the nozzle used to control and turn off water flow and also usually provide a solid jet or a spray of water. The hose provided comes in lengths ranging from 15–30m. In some larger buildings which were provided with an internal fire main, the old hydrant points have been modified and connected to a hose reel.

Hose reels have declined in popularity, which may be surprising given their obvious advantages over portable extinguishers in terms of ease of use, low cost of use and long service life, and continuous supply of water. It is worth noting that a 9L water extinguisher will expel approximately 4–5L/min while a 19mm hose reel will jet or spray around 20L/min onto a fire.

That being said, there are however, disadvantages in the installation of hose reels and in many locations these are being removed mainly because of problems caused by leaks. Automatic reels can suffer gland leakage and this, together with maintenance costs, theft of nozzles and valve wheels, misuse and vandalism have resulted in many organisations removing them. In historic buildings their obtrusive appearance may pose aesthetic concerns but this can usually be addressed by careful siting or concealment in a suitably-signed cupboard.

<sup>8</sup> Jensen, G: *Manual Fire Extinguishing Equipment for Protection of Heritage*, Riksantikvaren/Historic Scotland, Oslo: 2006.

<sup>9</sup> In one case, in 2006, a fire in the restaurant kitchen of a country house open to the public resulted in a two day closure of the restaurant to permit a deep clean of the kitchen after a powder extinguisher was used to deal with a small fire in a waste bin.

There are also fears that once a hose reel has been deployed it will prevent fire doors in its path from closing and so permit the passage of smoke and heat. It should be noted that some fire and rescue services are actively discouraging the installation of hose reels on safety grounds in that occupants might decide to stay and fight a fire when they should be evacuating.

Hose reels should be manufactured and installed in accordance with BS EN 671-Parts 1-4: 2001 *Fixed Fire Fighting Systems: Hose Systems – Hose Reels with Semi-Rigid Hose*.

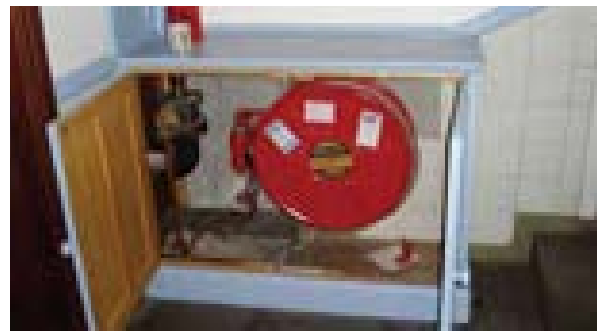
#### 4.2.4 Siting of Extinguishers and Hose Reels

It is essential that the type of extinguisher chosen should be appropriate to the risk – thus when selecting an extinguisher for an electrical intake or switch room a carbon dioxide unit should be specified.

For ‘general’ fires, which are likely to be of Class A type, extinguishers containing water or hose reels are most appropriate. A useful rule of thumb is that one standard size 9L water extinguisher should be provided for every 200m<sup>2</sup> of floor space, with a minimum of one per floor.

If each floor is provided with a hose reel that is of sufficient length to reach within about 5m of all parts of the floor then, subject to the approval of the authority having jurisdiction, water type portable extinguishers may be omitted altogether. Many experts are likely to suggest however that even with this level of hose reel provision, there should still be at least one portable fire extinguisher on each floor of all buildings.

Extinguishers should be installed in compliance with



*Illus 22 In an A listed property the hose reel has been carefully hidden in a cupboard © Stewart Kidd*

BS 5306-8: 2000 *Fire Extinguishing Installations and Equipment on Premises. Selection and Installation of Portable Fire Extinguishers. Code of Practice*. The standard suggests that extinguishers should be wall-mounted on escape routes or assembled in fire points. Notwithstanding this advice, many authorities and experts have suggested in the case of historic buildings that discretion should be applied to such a placement. In most cases, with the approval of the fire authority, there is no reason why



*Illus 21 Two listed properties, with extinguishers housed in purpose-made bases or free-standing rather than being physically attached to the wall*



*Illus 23 Historic fabric impact minimised by locating dry riser inlet valves beneath cast iron cover in footpath © Paul Beaton*

extinguishers should not be allowed to be free standing or placed on purpose-built bases.

Equally, there is no good reason, subject to the findings of the fire risk assessment, why extinguishers and hose reels should not be concealed in cupboards, wall recesses or inside panelling provided that appropriate signs complying with the *Health and Safety (Safety Signs and Signals) Regulations 1996* (Safety Signs and Signals Regulations 1996) are provided and maintained and that staff know where the extinguishers are located.

On occasion, representatives of the authorities may suggest or even require that signs be placed on the wall adjacent to fire extinguishers. Where this would be deemed aesthetically intrusive, careful examination of the situation may make it clear that such signage is superfluous as the only statutory justification for such signage is based on the findings of the fire risk assessment where the provision of signs relates to the requirements of life safety. Signs should however be provided where the risk assessment concludes that these are necessary for the safety of occupants (because for example, it is not clear that an extinguisher or hose reel is present at that location or what the type of extinguisher is or its means of operation).

A major tourist attraction on the Isle of Lewis is Garrannan Blackhouse village, a preserved crofting village. The village consists of a number of restored thatched cottages, which obviously pose a serious fire threat. Although hose reels were deemed essential to ensure adequate firefighting water, efforts were made to conceal the hoses in purpose-built shelters that imitated the random rubble stonework of the adjacent cottages.

#### **4.2.5 Fire Blankets**

Fire blankets are extremely useful appliances and should be provided in all kitchens/tea points including those in staff flats and holiday lets. Fire blankets are virtually maintenance-free and extremely cost-effective and can be used on all types of cooking fires, fires involving burning oil and clothing fires. Fire blankets should comply with BS EN 1869: 1997 *Specification for Fire Blankets*.

#### **4.2.6 Wet and Dry Rising Mains**

Many tall buildings and some larger commercial buildings are provided with a system of internal pipework to serve as firefighting mains providing facilities for use by the fire and rescue service.

'Wet' systems are supplied from an internal water supply. 'Dry' systems are intended to be pressurised by the fire and rescue service when they respond and are fitted with one or more fire service connections which are known as 'pumping-in points'. These are often visible outside the building, usually labelled 'Dry Riser Inlet', and located at convenient and accessible points. In the case of historic buildings care should be taken to ensure that these pumping-in points are located so as to minimise any visual intrusion.

Riser pipework feeds a series of single outlet points within the building each with a 65mm 'instantaneous coupling' compatible with fire service hoses, and is usually located in a fire enclosure such as a stairwell. Hence the outlets are frequently referred to as 'landing valves'. In traditional buildings where such systems are installed, it is often possible to find an inconspicuous location such as a cupboard for the valve.

These mains offer significant benefits for the property as they reduce the number and length of fire service hoses which may have to be brought into the building and hence minimise the extent of collateral water damage which may be experienced in a firefighting situation when hoses occasionally burst and where couplings frequently leak.

The location and position of inlets and landing valves is governed by BS 9990: 2006 *Code of Practice for Non-automatic Fire Fighting Systems in Buildings*.





*Illus 24 A Norwegian example where a drencher system has been installed to the exterior of the building on the right to prevent fire spread from or to the neighbouring timber building*

#### **4.2.7 Drencher Systems / Sparge Pipes/Water Curtains**

Risers (either wet or dry) may sometimes be connected to a system of pipework with open nozzles and these are referred to as Drencher Systems. Often originally found in bonded warehouses, along the ridges of roofs or above large doorways, drenchers (sometimes known as Sparge Pipes) are controlled by a manually-operated valve and have recently been installed on the exterior of a number of historic timber buildings in Norwegian towns. Similar systems are sometimes referred to as water curtains and these are mainly found protecting large areas of glass in locations such as shopping malls.

#### **4.3 Automatic Fire Suppression and Firefighting Systems**

Automatic fire suppression (AFS) and firefighting systems not only detect and notify the presence of a fire, but also actually fight the outbreak. A properly designed, installed and maintained system will, at the very least, contain a fire to a small area and consequently reduce the extent of damage. Indeed in many cases the system will often manage to extinguish the fire before the arrival of the fire and rescue service. The damage minimisation potential of suppression systems is especially beneficial



*Illus 25 In Newhailes house, a visitor attraction, the fabric and contents are protected by a sprinkler system, sympathetically installed to minimise fabric impact*

in the historic buildings context where historic fabric or contents may be irreplaceable.

There are a number of AFD and firefighting systems available employing different extinguishing equipment, techniques and firefighting media. The suitability of each type of protection system for particular circumstances will be determined by a number of factors including the type of fire likely to be encountered in the protected space (refer to Section 4.2.1 for details of fire type classification).

The three main types of automatic systems available, water-based, foam and gas systems, are discussed below.

#### **4.3.1 Water-based Systems**

As an inert, low-cost, extinguishing medium which is plentifully available with minimal impact on health and safety and the environment, water is probably the most readily recognised extinguishing medium suitable for the majority of fires. There are two main types of water-based systems; the first is the sprinkler system and the second the water mist system. They are radically different in design, cost and application and so will be considered separately.

#### **4.3.2 Sprinkler Systems**

Sprinklers are one of the oldest forms of firefighting technology; having been in use for over 140 years. The earliest recognisable installations were in British and US cotton mills between 1852 and 1860, whilst a primitive form of sprinkler system is known to have been installed in the Theatre Royal, Drury Lane, London as early as 1812. The first sprinkler system of modern design was installed in a piano factory in New England in 1874. The proven effectiveness and reliability of sprinkler systems since these early days and the advantages offered by water as an extinguishing agent – has led to their widespread installation to tackle many different types of risks.

Reliable records maintained in the USA, UK, New Zealand and Australia indicate that around 98%<sup>10</sup> of all fires in sprinklered premises are either extinguished or controlled by the sprinkler system. This figure is considered conservative since small incidents where sprinklers have extinguished a fire with no resulting property damage are not necessarily reported to the fire and rescue service, insurers or other appropriate organisations.

With the common sprinkler, operation is controlled by a glass or metal thermal element contained in each sprinkler head. This is designed to rupture or fail when

<sup>10</sup> These figures are achieved and exceeded by sprinkler systems which are fully operational and supplied with the necessary water supplies. When systems which are shut off or have no water are included or where the wrong type of system has been installed, their claimed effectiveness drops to 90-95%.

subjected to the heat of a fire; allowing a valve in the head to open and water to be discharged.

Often, objections are raised to the installation of sprinklers on the grounds of potential water damage. Contrary to popular perception, only the sprinkler heads in the immediate vicinity of the fire operate so the amount of water released to suppress the fire is kept to the minimum required. Water damage incurred from a sprinkler system reacting immediately to control fire growth, or in many cases to extinguish it altogether will be relatively tiny when compared to the later application of water from fire and rescue service hoses to fight a developed fire.

Concerns about water leakage from heads and distribution pipework are also frequently aired. In fact, a properly installed sprinkler system should be less likely to leak than any other water supply service within a building, as the components of the system will have been subjected to a rigorous quality assurance regime and are listed by a third party certification body. The designer and installer of the system will also have been subjected to the scrutiny and approval process of the appropriate certification body. As a final safeguard, systems are provided with an automatic alarm to give warning of water leakage from the system. This alarm is water-powered and so independent of an electrical supply. Most modern systems also have an electrically operated water flow alarm valve which is usually connected to the fire detection control panel so as to summon the fire and rescue service should the sprinkler system operate.

Care should be taken when deciding the detailed specification of sprinkler systems to ensure that the chemical content and nature of the sprinkler water supply has been taken into account. Selection of system materials must also ensure that no incompatibility of metals arises between components which for example, could cause corrosion through electrolytic reaction.

In some circumstances, the installation of sprinklers will be rewarded by more favourable insurance terms. Large discounts are likely to be offered for commercial risks such as hotels, care homes and offices as well as lower deductibles and extended coverage when properties are left empty for much of the year.

##### *4.3.2.1 Alternative Compliances with SBS Requirements and Fire Safety Regulations – Automatic Fire Suppression Systems<sup>11</sup> (AFSS)*

Elsewhere in this Guide will be found detailed examples of steps that can be taken to compensate for non-compliances in respect of SBS Requirements and fire safety regulations (under the Fire (Scotland) Act 2005). Perhaps one of the most important single approaches to

<sup>11</sup> Much of this section is extracted from *Sprinklers for Safety; Uses and Benefits of Incorporating Sprinklers in Buildings and Structures*, Arup Fire, 2006 by kind permission of the publishers, BAFSA.

successfully addressing fire safety that meets the intent of the legislation where the requirements would be impossible due to heritage protection constraints, is the use of an AFSS.

The value of AFSS has already been recognized in the SBS regulations and in the guidance produced to accompany the 2005 Act and a number of occupancies are already required to be fitted with such systems in Scotland. While the benefit of AFSS as a method of protecting buildings and contents is well understood, the wider application of systems such as sprinklers and water mist in protecting life safety is more recent but growing. In Europe, Scotland has pioneered wider use of AFSS systems in occupancies like high-rise accommodation and care homes, as well as in a number of significant heritage buildings.

The recognition of AFSS' contribution to life safety can be largely attributed to their good record in detecting, suppressing and controlling a fire to a much smaller size than would otherwise be the case without sprinklers. This advantage is first seen in increasing life safety outside the room or compartment of origin. Now, with fast response sprinklers, there is evidence that even in the room or compartment of origin, occupants have a high probability of survival when protected by an AFSS.

Most proponents of sprinklers recognise their limitations. There are however, clear advantages in their use, many of which should either reduce the overall building cost or which may allow the approval of a particular design which would otherwise be considered unsafe. For example, the evolution of drencher protected non-fire resistant glazing in fire walls for fire separation purposes increases the architectural flexibility of a project and as well as providing an alternative means of achieving compartmentation in a building. This topic has been subjected to a number of research studies. Specially designed sprinkler heads have now been developed for drencher protection of toughened glazing that have passed the American Society for Testing and Materials (ASTM) standard furnace test for a period of two hours.

#### 4.3.2.2 Use of Sprinkler Systems in Heritage Protection

Scotland has pioneered the use of water-based fire suppression systems to protect historic buildings and a significant body of experience has now been built up in relation to designing and installing these systems in a sympathetic and non-intrusive way. Some buildings known to be protected so far include Duff House in Banff, the National Library of Scotland in Edinburgh, Newhailes House in East Lothian and Broughton House in Dumfries and Galloway. In 2007 the first Scheduled Ancient Monument was protected when a sprinkler system was installed in Corgarff Castle, Banff. The case studies that can be found in Part 3 of this publication



*Illus 26 Parliament House in Edinburgh installed sprinklers, with pipework painted black to blend in with the elaborate ceiling*  
 © Crown Copyright: RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk)

provide additional information about some of these projects as well as Buchanan House which is partially protected.

#### 4.3.2.3 Installation Standards

Sprinkler systems should be designed and installed in accordance with BS EN 12845: 2009 *Fixed Firefighting Systems - Automatic Sprinkler Systems: Design, Installation and Maintenance*<sup>12</sup> (BS EN 12845: 2009). The former standard, BS 5306 Part 2, was withdrawn in October

<sup>12</sup> Note that a new version of this standard will be published in 2010 or 2011. These further changes will reflect mainly the correction of errors in the 2004 version.

2007 and should no longer be used for new installations or extensions to existing systems.

Domestic and residential properties (for example, care homes, hostels and school boarding houses) can be protected by sprinkler systems designed and installed to BS 9251: 2005 *Sprinkler Systems for Residential and Domestic Occupancies. Code of Practice*.<sup>13</sup>

Note that sprinkler systems in hotels and boarding houses and like premises should be installed to BS EN 12845: 2009.

In 1998 Historic Scotland published TAN 14, *The Installation of Sprinkler Systems in Historic Buildings* to provide comprehensive guidance on this subject. Much of the contents (updated to reflect changes to standards and certification requirements) of this TAN are reproduced in an updated format in Annex XI of this Guide.

#### 4.3.2.4 Hazard Classification

Determining the level of sprinkler protection to be employed in a building is important and is mainly influenced by the fire hazard within the building. The hazard classification is mainly a function of the likely heat release rate which in turn is related to the heat combustion of the contents (and in many historic buildings, parts of the structure) and the rate at which these combustible materials will burn. Factors such as the building structure, structural fire resistance, height of ceilings and adequacy of heating will all influence the sprinkler installation design. In addition, in historic properties, the installation design must also consider disruption to the fabric, aesthetical appearance and accidental discharge.

In BS EN 12845: 2009 the appropriate standard for non-residential sprinkler applicators, the following classification system is used:

- Light Hazard – intended for non-industrial occupancies with low fire loads and low combustibility and with no single compartment greater than 125m<sup>2</sup> with a fire resistance of at least 30min. Examples include offices.
- Ordinary Hazard – intended for non-industrial occupancies where the fire load is greater than that allowed for light hazard. It is also suitable for commercial and industrial occupancies such as manufacturing (and includes limited amounts of storage providing they are not likely to develop intense fires early in the initial stages of combustion). The ordinary hazard category is divided into four sub-groups depending on the level of fire load, combustibility and area to be protected.



*Illus 27 To satisfy the required volume of water for the sprinklers in the National Library of Scotland, two purpose built water tanks were constructed and housed in the historic vaults below the street*

- High Hazard – Includes those occupancies that are the most difficult to protect such as process and storage risks where fires can develop rapidly. The rating is unlikely to have to be applied to adaptive reconstruction of traditional buildings.

#### 4.3.2.5 Components of a Sprinkler System

A sprinkler system consists of a number of components, all of which require careful consideration when the system is being designed and installed in a traditional building.

Most sprinkler systems in non-domestic buildings will comprise: a water supply, a pump or pumps, an alarm valve, a mechanical local alarm, stop valves and test and drain valve, a gridded array of water supply pipes and sprinkler heads.

Fire suppression systems operate successfully in a very high percentage of fires (in the case of sprinklers, more than 97%) when the level of risk identified in the fire risk assessment can be counteracted by the delivery of a matching level of fire suppressant, in the case of sprinkler systems, water. Other fire protection measures introduced in the building will obviously contribute to this equation. A number of factors affect the quantity of water delivered. These include the volume of water delivered to each head by the sprinkler distribution pipework, the number of heads and the floor coverage pattern of the head type chosen.

#### 4.3.2.6 Water Supplies for Sprinkler Systems

In the past, insurers who were originally instrumental for requiring the installation of most sprinkler systems, used to insist on a water supply that was 'virtually inexhaustible'. This definition usually meant water from a lake, river or canal or a large tank with independently powered pumps. Today, a less prescriptive and risk

<sup>13</sup> Note that this standard is to be subject to a full review in 2010.

assessment-driven approach<sup>14</sup> is often adopted and water for sprinklers can be provided by any of the following:

- Private reservoirs
- Gravity or pressure tanks
- Automatic pumps and a tank
- Booster pump on a service main connection (this is subject to specific approval obtained from the water undertaking)
- Service mains (previously known as towns).

Supply via a direct connection to service mains providing a consistent flow and pressure<sup>15</sup> provides the lowest cost option for sprinklers. However where adequate flow and pressure is not available, even with the use of a booster pump if permitted, a mains connection on its own may not provide an adequate assurance of operational effectiveness. Alternatives range from private reservoirs to gravity tanks. A private reservoir, whether utilised as a primary or secondary supply source, must be under the sole control of the property protected. A gravity tank is a purpose-built container constructed on the site at an elevation sufficient to provide the required design pressure and flow characteristics.

A further option relies on suction tanks, again consisting of purpose-built containers constructed on-site with electrically driven pumps to provide the required pressure and water flow characteristics. A stand-by, diesel-driven pump may additionally be required to ensure continuously available pumping capacity where the sprinkler system is being installed primarily for life safety purposes. Alternatively it may be possible to utilise the output of a stand-by diesel generator.

Irrespective of from where the water is sourced, water supplies for sprinkler installations need to be reliable, at a suitable pressure and ideally be able to supply a sufficient flow of water for long enough to counter the largest fire anticipated. They should also be:

- Under the control of the occupier of the building (or their right of use should be guaranteed)
- Free from solid material which may cause a blockage in the installation.

<sup>14</sup> For example, in schools it has been agreed with insurers that where there are problems in providing a one hour supply of water, a reduced supply may be acceptable subject to (1) a direct sprinkler water flow alarm connection to an alarm receiving station, and (2) a suitable fire and rescue service response.

<sup>15</sup> As an example, most adaptive reuse projects would be able to benefit from sprinkler protection where there is a service mains connection of not less than 45mm with a pressure of 2.5 bars. Some smaller premises (eg care homes and conversions to domestic use may be protected by a mains connection of 35mm subject to flow and pressure).



*Illus 28 Sprinkler components such as water tanks, pumps and valve sets can sometimes be discreetly housed in outbuildings as here at Newhailes house (reproduced with kind permission of the National Trust for Scotland)*

A number of different types of water supplies are identified in the relevant standards publications, enabling users to grade and select the supplies in terms of their reliability. For insurance purposes the quality of the water supply will have a direct influence on any premium discount the insurer may offer for the presence of sprinkler protection. The following are typical examples of water supply:

- **Single supply** – This type of supply is usually considered suitable for light and ordinary hazard applications where the estimated maximum loss is not considered excessive. A service mains connection of at least 100mm diameter may be used depending on the pressure/flow characteristics and capacity of the source. Service mains are increasingly subject to leakage reduction strategies by water suppliers which may make them unsuitable for sprinkler protection purposes. A single storage tank and pump is also an acceptable supply.
- **Superior supply** – This type of supply is usually considered suitable for ordinary hazard applications and in some instances insurers may allow the use of a superior supply to protect high hazard risks. A superior supply is an improved form of single

supply which typically consists of one of the following: a more reliable service mains, two suction pumps drawing from a single tank or two booster pumps drawing from service mains.

- Duplicate supply – As the name suggests this is typically two independent supplies connected to a sprinkler system. Duplicate supplies are considered suitable for properties where either the estimated maximum loss is large or where the fire risk is high. It is most often used for ordinary hazard applications such as high rise buildings or high hazard warehouse or processing risks. Two independent service mains are allowed, but this is an unlikely solution due to the specified performance requirements. The most common arrangement of a duplicate supply is two pumps, one of which must be diesel driven, drawing water from one or two storage tanks, depending on their capacity.

It may also be possible, as previously stated to draw suitably filtered water from swimming pools, ponds, lakes, canals and rivers provided there is a guarantee that water in sufficient quantities will be available at all times. Elevated private reservoirs, gravity tanks and air pressure tanks may also be used.

In some locations, there may be issues with direct mains connections and experience suggests that some water companies are reluctant to provide suitable connections with adequate flow and pressure for sprinkler systems. Where water connections are metered this can also cause problems in restricting flow. It is recommended that early contact be made with the water company and advice be sought from the fire and rescue service who may be able to assist in such negotiations.

One area of confusion relates to the matter of 'life safety systems'. Part of the problem relates to the use of the term 'life safety (sprinkler) system'. All sprinkler systems will protect life and in the case of sprinklers installed in domestic and residential premises, the use of fast response sprinkler heads have proved to be able to protect the lives of occupants in the room of fire origin.

The problem arose when the use of sprinklers was first mooted as a measure for providing protection for large retail premises such as shopping malls. In order to make the presence of sprinklers fully acceptable, the fire and rescue service decided that such systems would have to be available at all times the premises were occupied. In order to achieve this objective, it was agreed, following discussions between the sprinkler industry, regulators and the Loss Prevention Council (who were then the publisher of the UK's sprinkler standards) that additional features could be incorporated into a sprinkler system to ensure that it was always available and that any 'downtime' for maintenance was minimised. Such features included duplicate pumps and tanks, alternative forms of pump

driver (for example, a second duty pump powered by a diesel engine), provision of duplicate valves and monitoring and security of valves. Thus, the 'life safety system' is rather an 'enhanced availability system'.

Most of the life safety requirements for sprinklers have been developed around the needs of large commercial premises and will not necessarily translate into traditional building applications.

#### 4.3.2.7 Pumps

In those sprinkler installations not capable of being pressurised by a service main, a pump or pumps draw water from a suction tank capable of supplying the maximum demand for at least 30-90min depending on the type of risk being protected.

Pumps are usually diesel or electrically operated with characteristics designed to meet the requirements of the installation. In some installations more than one pump may be required to improve the security of the water supply. Power for pumps must be available at all times, thus fuel tanks of diesel pumps, as well as the generator plant fuel tanks, should be kept full. Where the electricity supply is not taken from the public supply, details of the generator should be made known to the designer of the intended installation.

The pumps should be arranged to start automatically when a sprinkler head opens, this is normally accomplished by means of a pressure switch in the installation pipework. Manual start buttons are required for testing and maintenance procedures.

#### 4.3.2.8 Valve Sets



*Illus 29 An example of a main stop valve for a sprinkler system, located out of sight in a basement area*

Each sprinkler system has an installation control valve set which is the main control for the installation. The valves are of different designs depending on the type of system installed, but all incorporate a main stop valve and a sprinkler valve which includes an alarm function. The valve set should be easily accessible so that the fire service can turn the water off as soon as required. The room or compartment in which the valves are housed should be signed 'sprinkler stop valve inside'. After a fire, the main stop valve should only be turned off at the command of the officer in charge of fighting a fire on the premises (and only then when it is clear that the fire is under control or extinguished). If maintenance or repair work is to be carried out on the system, it is essential that it is appropriately authorised and the water is turned on again after the works have been completed.

The period when the system is out of action should be kept to the absolute minimum and the fire and rescue service and insurer of the building should be notified before the installation is shut down, and as soon as it is operational again. If the sprinkler system is to be completely isolated consideration should be given to the use to which the building is put and steps taken to minimise hazards.

The following need to be considered:

- Inform insurers and fire authority and other users
- Implement the planned shutdown procedures<sup>16</sup>
- Minimise the possibility of a fire occurring:
  - Patrol the area affected continuously
  - Subject all hot work to a permit system
  - Prohibit smoking and naked lights in the vicinity
- Minimise the possibility of a fire spreading:
  - Close fire doors and shutters
  - Make readily available fire extinguishers/hose reels etc with sufficient trained personnel available to handle them

The main components of an installation control valve set are as follows:

- The main stop valve – is operated manually and should normally be strapped and padlocked in the open position. If the valve is monitored, a microswitch assembly, which may be termed an anti-tamper switch, can raise the alarm at a sprinkler system monitoring and control panel if attempts are made to tamper with the valve.
- The alarm valve – is designed to prevent back-flow and allows water to flow to a water motor alarm gong to raise a local alarm. In addition, a pressure or flow switch can be linked to a sprinkler

<sup>16</sup> A useful summary of the necessary actions is contained in Technical Bulletin 203 of the 2009 edition of the LPC Sprinkler Rules (FPA).

system monitoring and control panel to raise the alarm and, in some cases, send a signal to a central monitoring station.

#### 4.3.2.9 Pipework

From the outset it should be understood that reliability of materials for sprinkler pipes are paramount. While a range of pipe materials exist, it is suggested that for most systems the majority of the water supply grid will be fabricated from galvanised steel pipe.

The sprinkler system will require relatively large diameter pipes to carry the water from the pumps to the valves. Further pipes of varying diameter convey the water from the valves to the 'range pipes' to which the sprinkler heads are connected. Vertical pipes are known as 'risers' as distinct from the horizontal 'distribution pipes'.

Pipe sizes are determined at the design stage either by a process of hydraulic calculation or by use of precalculated pipe size tables which are published in some sprinkler codes. Hydraulically calculated pipe systems will allow the use of smaller diameter pipework than the precalculated pipe sizing methods specify. The disadvantage of using hydraulically calculated pipework is that should any modifications be required to a system designed in this way, full calculations of all the elements would again be required to ensure the modified system will perform effectively.

In the case of Duff House, Banff, hydraulic calculations allowed the main feed pipes to be reduced from 100mm to 80mm diameter, risers from 100mm to 50mm and final distribution pipework from 65mm to 32mm and 25mm.

Steel is the industry standard for sprinkler pipework, but the full implications of installing this 'hard pipe'



*Illus 30 Chlorinated PVC plastic pipework, a possible alternative to metal pipework*

system should be considered before specifying it for a traditional building. Each deviation in the pipe run has to be jointed, which can mean a proliferation of joints in a complex retrofit project. Sufficient working space for jointing to take place needs to be allowed when plans are drawn up. Although screwed pipe fittings are the most common and the cheapest form of pipe jointing method, there are also many LPCB approved mechanical pipe couplings and fittings which can be used with steel pipes. These forms of pipe fittings do not rely on threaded pipes or fittings to make a joint but usually rely on a groove which is either cut or rolled into the pipe end. The advantage that these mechanical pipe couplings offer is that the fittings are usually bolted or fastened around the pipe and do not require the pipe or the fitting to be rotated to make the joint. The initial discharge from the sprinkler heads may be contaminated with iron oxide, and so this type of pipework may not be appropriate where books or other fragile artefacts are being stored.

In recent years, chlorinated PVC (CPVC) plastic pipework has gained approval for use in certain ordinary hazard and domestic risk situations. It has a number of advantages. It can, for example be cut to length easily on-site and joints and fittings be secured with a specially formulated adhesive, thus eliminating the need for time consuming threading or grooving of steel pipes. In addition, the pipes have some flexibility, which may assist when installing them in confined spaces. However, the pipes should never be left in a permanently stressed condition. It is good practice to install the pipes behind a suitable fire-resisting barrier, such as gypsum board, to give added fire protection. Should the need arise, CPVC pipe can be painted, but only with emulsion or water-based paints, as oil-based paints will cause cracking, a point that will need to be highlighted in the maintenance manual for the building. It also follows that the pipework should not be exposed to solvents or other deleterious chemicals.

The use of CPVC plastic piping should be subject to the agreement of insurers and permissions should be sought before a contractor is engaged to install a system. In addition, experience dictates that compliance with the pipe manufacturer's installation instructions is vital. The preparation of pipe-ends for jointing, the correct use of the specified adhesives and even the ambient temperature and humidity are all critical if proper joints are to be achieved. In addition, while CPVC pipe is very useful in certain retrofit situations, experience at the National Library of Scotland suggests that it can be very hard to remove sprinkler heads from an installed system so that internal building changes which might require moving pipe and heads can be challenging.

Copper pipe may be used in light and some ordinary Hazard systems and it is suitable for both commercial and

historic buildings. However, hot work such as brazing or soldering should not be allowed to take place on site. Hot work should not be tolerated in any traditional building in view of the many fires caused by such activities. The practice of bending copper pipe on site is prohibited by BS EN 12845: 2009 due to the possibility that the waterway might be narrowed.

All pipes need to be supported, thus pipe hangers may have to be installed at regularly spaced intervals. The sprinkler heads are supported by the pipework.

#### 4.3.2.10 Sprinkler Heads

Heads are manufactured with 10, 15, and 20mm thread sizes. Each of the sizes has a differing waterway dimension and therefore has a different water flow rate capability. These are respectively 57, 80 and 115L/min at 1 bar pressure. A sprinkler head has a heat-sensitive element which holds the waterway valve closed. The element fuses or ruptures at a specific temperature, opening the valve and releasing water. There are two commonly used heat-sensitive elements:

- Those operating by the rupture of a glass bulb, illustrated in fig 9
- Those incorporating a fusible element where the valve components are held in place by a eutectic alloy component (similar to solder).

At normal temperatures a sprinkler head glass bulb contains a coloured liquid which expands under the influence of heat, and a small air bubble may also be discernible. As heat is applied, the liquid expands and the size of the bubble reduces as the glass bulb internal pressure increases. Continued heating increases this pressure until the bulb shatters. This releases the valve covering the waterway, and the water that is released is broken up into droplets and distributed by a deflector.

The temperature rating of fusible element sprinkler heads is determined by the composition of the eutectic alloy used. The fusible link components are arranged to drop free and open the waterway when the appropriate temperature is reached.

#### 4.3.2.11 Sprinkler Head Temperature Rating

A sprinkler head will not operate until the heat-sensitive element reaches a predetermined temperature. Table 1 overleaf indicates typical operating temperatures of glass bulb sprinkler heads. The temperature rating is identified by the colour of the fluid in the bulb and is also marked on the sprinkler assembly. A range of temperature ratings is also available for fusible element sprinklers, although the nominal temperature ratings available are determined by the properties of the eutectic alloys used and differ slightly from the glass bulb ratings. The temperature ratings of fusible element sprinklers are marked on them and a colour coding system also exists whereby the





Illus 31 The operation of a sprinkler head © JOB Sprinklers

colour code is painted on the sprinkler frame. Colour coding paint is not usually applied on fusible element sprinklers with decorative finishes.

The selection criterion for sprinkler heads is that the nominal operating temperature should be more than 30°C above the highest anticipated ambient temperature conditions. For normal environments the 68°C glass bulb and the 74°C fusible element temperature ratings are most frequently used. Care should be taken to select the appropriate temperature rating in rooms, compartments or localised areas where there may be a build-up of heat from machinery or equipment such as boilers or where there may be solar gain beneath roof lights or beside windows.

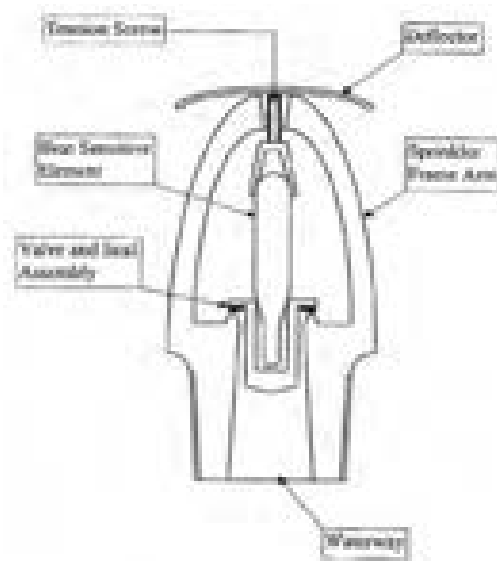


Figure 9 Construction of a typical glass bulb sprinkler head



Figure 10 Sprinkler heads. Left to right: Pendent (chrome finish), Upright (brass finish), and Horizontal (coloured finish) sprinkler heads

Nominal operating temperature	Colour of fluid
57°C	Orange
68°C	Red
79°C	Yellow
93°C	Green
141°C	Blue
182°C	Mauve

Table 1 Colour coding of glass bulbs sprinkler heads

#### 4.3.2.12 Response Time

Under fire conditions a hot gas layer forms at the ceiling and by the time a sprinkler operates the temperature of the gases at this point will always be higher than the nominal temperature rating of the sprinkler head. The time taken for the sprinkler to operate is a function of a number of variables. Sprinkler equipment approval authorities measure the thermal sensitivity of sprinklers and rate the sprinklers according to their performance. The rate at which the sprinkler heat sensitive element takes up heat from its surrounds is measured and calculated as a Response Time Index (RTI). The RTI scale used is 0 to 350, the higher the value the slower the sprinkler is to operate.

Measurement and calculation also determine the rate at which the heat sensitive element dissipates heat (usually to its supporting parts, which are at a lower temperature). This is called the Conduction Factor (C). The C scale used is 0 to 2, the higher the C value the greater the heat dissipation). Although the RTI and C are measured accurately, providing the sprinklers fall within the specified limits they are classified as one of the following thermal sensitivity ratings:

- Standard response (RTI >SO -200) (C >O -2)
- Special response (RTI >50 -80) (C >O -1)
- Quick response (RTI >O -50) (C >O -1)

The trend in recent years has been to manufacture sprinklers which operate more quickly. In the 1960s and 1970s glass bulb sprinklers usually had RTIs of 300 or more. Many are now classified as 'Quick Response' and have RTIs of less than 50.

This type of sprinkler is designed to absorb heat from the surrounding atmosphere more efficiently, thereby operating more rapidly at their preset temperatures. The response time for a conventional head can be as much as 3min while quick response heads can actuate in less than half this time, thus minimising fire damage.

The advantage of using quick response sprinklers is that they operate at an earlier stage in the development of the

fire than 'conventional' sprinklers. In many instances this should result in better fire control, with fewer sprinklers operating and hence less water discharged during a fire. Quick response sprinklers are also generally smaller than the other types, lessening their visual impact in traditional interiors.

Care has to be exercised in deciding whether to specify this type of head however, as there can be a trade-off between the speed of response and the fragility of the thermal element of the head. It is suggested therefore, that in locations where even limited accidental water damage would be unacceptable, conventional heads should be specified. This is an area where specialist advice should be sought at a very early stage as the selection and specification of the sprinkler heads can have an impact on a range of other criteria including water supplies.

Where a sprinkler system is being installed in compliance with Scottish Building Standards for life safety purposes then the sprinkler heads should be of a type designed and approved for use in life safety systems.

#### 4.3.2.13 Sprinkler Orientation

As illustrated in fig 10 sprinkler heads are designed, manufactured and assessed for use in specified orientations: pendent, upright and horizontal (related to the direction in which the sprinkler heads are mounted). The orientation for which they are suited is marked on the deflector. The orientation marking is usually combined with the sprinkler head type marking, for example Spray Sprinkler Upright will usually be identified SSU. Conventional sprinkler heads can usually be used in both the upright and pendent orientation and will therefore be marked CUP. Sprinklers should only be used in the orientation for which they have been made and approved. It is sometimes necessary to install pendent sprinklers beneath sloping ceilings or the undersides of staircases. Not all pendent sprinklers are suitable for use on an incline, for example some flush and concealed sprinklers may have ceiling slope limitations. The manufacturer's data sheet should therefore be consulted and any restrictions adhered to.

#### 4.3.2.14 Sprinkler Types

Sprinkler heads are arranged in an array at ceiling or roof level, designed to provide an even distribution of water onto the goods, furniture or floor beneath. The following sprinkler types are available (see fig 11):

- Conventional pattern sprinkler heads project about 50% of the discharge downwards and 50% upwards to the roof or ceiling and may produce comparatively large droplets. They may be installed in an upright or pendent position. Traditionally they have found to be of most use where the ceiling and its supporting structure are combustible.



Illus 32 In any given installation, there may be a number of different types of sprinkler head installed, as here in one of the reading rooms at the National Library of Scotland



Illus 33 Two examples of discretely situated sprinkler heads in heritage properties (upper image reproduced with kind permission of the National Trust for Scotland)

- Spray pattern sprinkler heads produce a hemispherical discharge pattern with at least 80% of the water directed downwards from the deflector, so little or no water reaches the ceiling. Different spray heads are manufactured for installing in upright and pendent positions.
- Sidewall pattern sprinkler heads are designed to be installed close to walls. They project the water downwards and away from the wall. Sidewall heads are used where it is necessary to keep the ceiling or ceiling void free from fittings or pipework. Sidewall sprinklers are manufactured in upright, pendent and

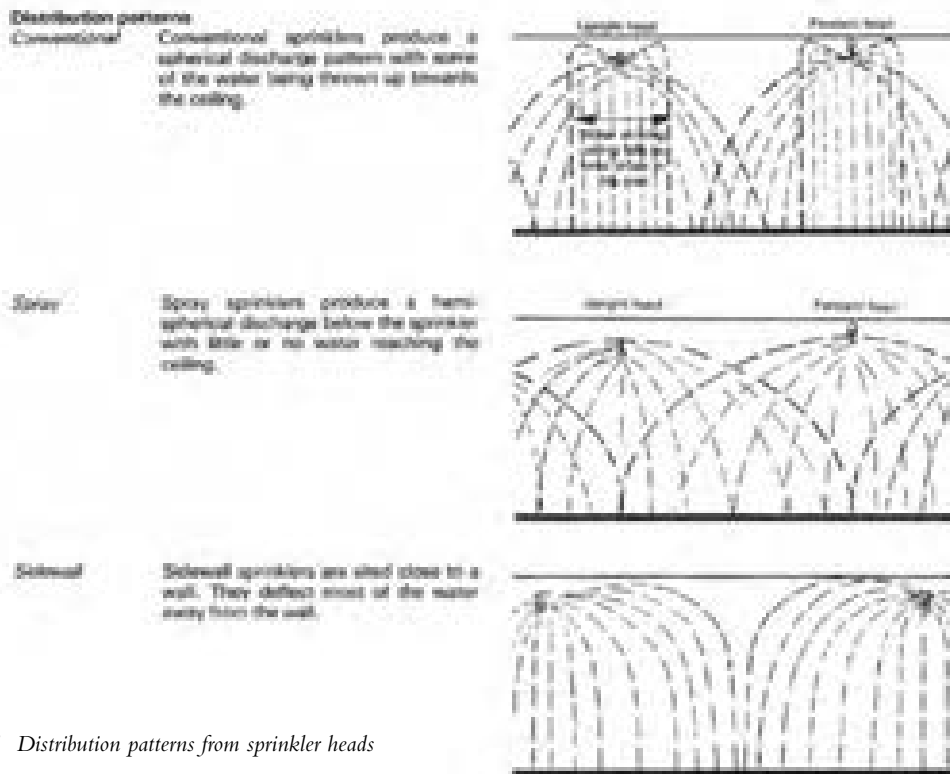
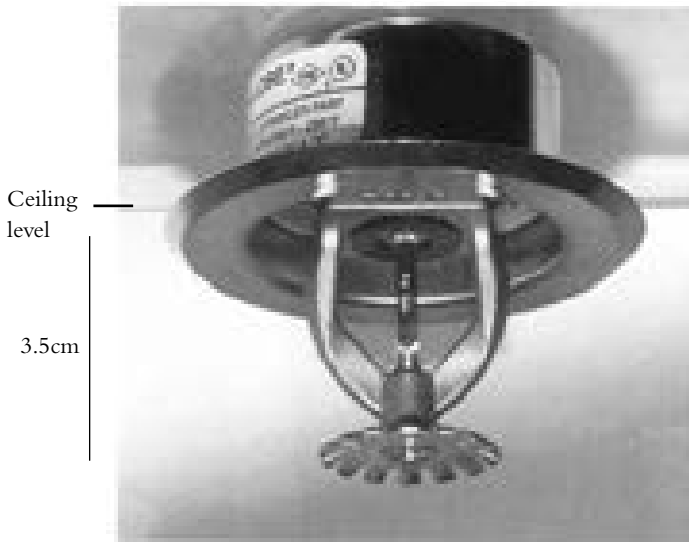
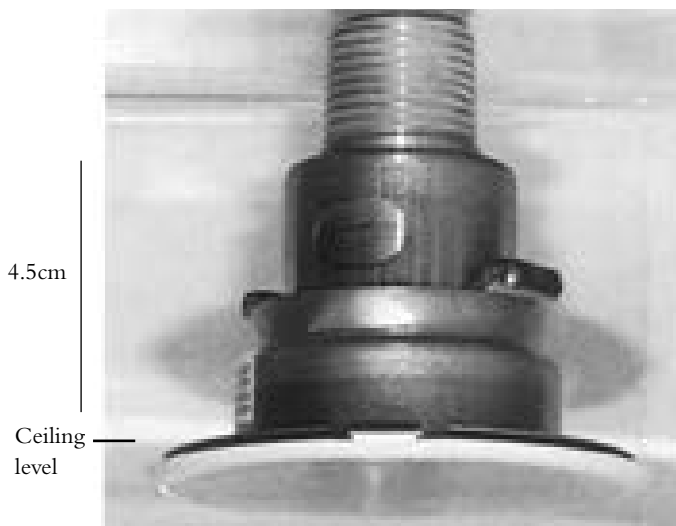


Figure 11 Distribution patterns from sprinkler heads



Illus 34 Recessed sprinkler head

- Recessed pattern sprinkler heads are another variation on the pendent spray pattern sprinkler. These sprinklers are recessed in the ceiling in a metal cup with the deflector protruding below the ceiling line (see illus 34) The same comments apply to the recessed sprinkler as were made about the ceiling and flush pattern sprinklers. Recessing sprinklers will however make the sprinkler even less responsive to the fire. If quick response heat sensitive elements are used this will improve the performance of the sprinklers, but at best they are likely to achieve the performance equivalent to a standard response exposed sprinkler head.
- Concealed pattern sprinkler heads are recessed into the ceiling and a circular plate covers the sprinkler (this is commonly called a concealer plate) (see illus 35). From below only the concealer plate can be seen. The concealer plates are attached to the sprinkler assembly by low melting point eutectic alloy tabs. When subjected to hot fire gases, the tabs fuse and the concealer plate falls away. Only when the concealer plate has fallen will the sprinkler head heat-sensitive element itself be subjected to the hot gases. Because of the design and position relative to the ceiling, concealed pattern sprinkler heads will be comparatively slow to operate and should therefore be used with caution. They also have more critical components than a standard sprinkler and this will influence their reliability and fault rates. Concealer plates can be provided in a range of different colours to suit the décor, or carefully painted, avoiding sealing the gap (first check with the manufacturer).



Illus 35 Concealed sprinkler head

horizontal version and are often used to protect corridors, narrow rooms and lobbies.

- Ceiling and flush pattern sprinklers are variations on the pendent spray pattern sprinklers and they are designed to fit closely to the ceiling line, and may therefore be appropriate in some historic interiors. However, there is a compromise on performance as a result of their low profile. When a hot gas layer forms at a ceiling during a fire, the gas temperatures and velocities close to the ceiling are relatively low. The highest temperatures and gas velocities occur about 150mm below the ceiling line and sprinklers will be most efficient if the heat sensitive element is at this position below the ceiling line.

Where the system is of either dry, alternate or preaction types, the heads should be installed in the upright position to ensure the complete draining of the pipework and thus eliminate the problem sometimes caused by residual water freezing in the sprinkler bores.

#### 4.3.3 Water Mist Systems

Apart from sprinkler systems, the only other water-based suppression system which would be appropriate for traditional buildings is water mist. Benefiting from recent research and proprietary development, water mist systems, employing heads discharging aerated water in a mist or fine spray, superficially appear very similar to conventional sprinkler systems. Indeed, these systems offer many of the benefits of conventional sprinkler protection.

Several proprietary systems are available ranging from very high pressure (up to 110 bars) systems producing a fine water particle mist, to low pressure systems providing a fine water spray extinguishing medium. The water is propelled either by pumps or by an inert gas and dispensed from nozzles that are designed to deliver water in fine droplets

to the area of fire. The suppression mechanism relies on a combination of cooling by the water, the production of steam that displaces oxygen from the area of the fire to a level that cannot sustain combustion, and inhibition of the chemical processes of combustion.

In comparison with sprinklers, water mist systems use comparatively small amounts of water to fight a fire and this means less water has to be stored which can result in substantial cost savings. The reduction in the volume of water which has to be stored may also offer benefits in respect of the storage space which might otherwise be required. Mist systems also offer potential for installation in locations which are too small to accommodate the pumps of a conventional sprinkler system. A further benefit, of particular interest in traditional buildings, is the minimisation of water damage in the event of activation.

Pioneering applications of water mist protection in heritage buildings include, one gallery of the National Portrait Gallery in London and a number of very old Norwegian timber churches which were at particular risk from arson. The largest heritage-related mist installation to date is now operational in the National Gallery of Art in Washington, DC. There are also a significant number of mist systems installed in large *palazzos* in Venice – although these systems reportedly only protect the roof spaces.



Illus 36 Water and gas filled cylinders for a water mist suppression system in a basement area © Stewart Kidd

### Box 1: Stirling Castle – Water Mist System

In 2008 Historic Scotland decided that a planned major refurbishment of the old Royal Palace at Stirling Castle should include the introduction of an automatic fire suppression system. A consultant was employed to review the options and it was decided that a water mist system offered some advantages in this particular case, as the water supply pipes feeding the mist heads could be kept to a diameter small enough to permit them to be installed in the very complex suspended ceiling which was to be installed in the King's Chamber and Queen's Chamber. Mist protection is being provided primarily to protect the building, its original fabric and contents.

The Stirling Heads, which arguably form the most important Scottish renaissance artefacts, will be housed in their own purpose-built gallery on the first floor of the refurbished Palace. The mist system will also protect the roof spaces of the building.

The mist system utilises an electrically-driven pump fed from 3m<sup>3</sup> stored water. Pipe sizes range from 35–18mm and the pipes are stainless steel.

The mist heads in the King's and Queen's chambers are semi-concealed (there are no fully concealed mist heads presently available) and provide coverage equivalent to a conventional sprinkler system.

At the time of writing, there are no British or European standards for water mist systems although a draft CEN (European) standard has been produced – prEN 14972: 2004 *Fixed Firefighting Systems – Watermist Systems – Design and Installation*. This was rejected by the British Standards Institute (BSi) as being inherently flawed in respect of a lack of independent test data relating to water application rates. BSi have therefore set up two working groups to produce draft BS codes of practice for mist systems in residential and domestic premises (BS DD 8458) and commercial and industrial premises (BS DD 8459). It is anticipated that these documents will be published and available for use in early 2010. The US National Fire Protection Association has published NFPA750 *Standard on Water Mist Fire Protection Systems* which gives useful general guidance on the application of water mist systems, but does not provide a design guide for individual risk applications. The limitations of water mist should therefore be noted.

Some research has been undertaken into the appropriate use of these systems in confined spaces and large volume areas. High ceilinged rooms with large floor areas may prove a significant problem in designing nozzle layout to ensure potential fire locations fall within the effective range of the nozzle distribution. There is also a problem

in using the bulb-type mist head in high-ceilinged areas as the delays in actuating the system can result in failure to extinguish a fire and the limited water supplies available to mist (as compared with sprinkler systems) creates a separate concern.

Tests have also indicated that the design of water mist systems needs careful consideration where the protected location is prone to significant air movement as this may impact on the effectiveness of the mist. Mist systems are also less effective at extinguishing slow, deep-seated fires in 'normal combustibles' than traditional sprinkler systems.

This and other limiting factors, such as personnel presence and detection parameters, require a careful risk assessment to be made before any conclusion is reached as to the type of protection needed. The assessment needs to take into account the fact that (unlike sprinkler systems) each mist system has to be specifically designed for the space it is to protect. In the absence of any recognised international standards for the design of water mist systems, care needs to be taken when deciding on the validity of manufacturers' claims – many of which are based on system technology and components developed for use in marine applications and so may not be directly relevant for building protection. Although these issues will be resolved in time it is suggested that, at the time of writing, caution should be exercised in specifying water mist systems for the protection of large areas or complete buildings until design and standards issues are resolved and the British Standards documents referred to above are published.

#### 4.4 Foam Systems

Foam fire suppression systems are principally used to protect high fire risk locations such as warehouses and processing areas where large quantities of combustible materials are present, or where flammable liquids are stored or used. In such locations where water would be ineffective as an extinguishing agent, systems using complex synthetic foams at concentrations of 1-6% of foam compound in solution with water, may be used.

It is unlikely that a foam system would be an appropriate agent for general use in traditional buildings. Foam systems may have limited application in traditional buildings for specialised local protection of, for example, larger kitchen ranges and deep fat fryers or for the protection of boiler rooms where fuel oil is burnt. In such locations the installation is likely to consist of cylinders containing 6-9L of firefighting solution and be self-contained requiring only power supply. Standards for foam firefighting systems are: BS EN 1568 *Fire Extinguishing Media: Foam* and BS 5306-6: 1990 *Fire Extinguishing Installations and Equipment on Premises: Foam Systems*.

#### 4.5 Gas Systems

Suppression systems are available that operate by discharging firefighting gases, which have the ability to permeate a volume, extinguish fire and to be simply ventilated out afterwards without causing damage to fabric. At face value, these would appear to offer the ideal fire protection solution for traditional buildings. Unfortunately the reality is that this is an overoptimistic view since the choice of an extinguishing gas is a complex balance of cost, levels of protection and problems of maintaining gas concentrations (which is likely to be difficult in many traditional buildings).

Gas systems are unlikely to be suitable for protecting large cubic volumes due to the quantity of gas required and the difficulty of maintaining the appropriate concentrations of gas within the protected space for the duration of a fire's life. It is therefore unlikely that such systems will be suitable for the majority of applications in protecting the interior spaces of traditional buildings.

However, gas systems can be ideal for providing specialised protection of smaller rooms or spaces such as transformer chambers and switchrooms, or other utility spaces perceived to be of high risk. In the heritage context gas systems have been successfully employed for the protection of archive storage areas, vaults and plant rooms at the British Library, London, National Library of Wales, Aberystwyth, the Library of Congress, Washington, DC and at the National Archives of Scotland's General Register House in Edinburgh.

Factors that should be considered when assessing the suitability of a risk for gaseous protection include:

- Cost of installation and future maintenance
- Volume to be protected
- Suitability of gas in relation to occupation by persons
- Type of risk
- Fire load
- Suitability of gas in relation to reaction potential with protected fabric and contents
- Plant requirements including storage space required, floor loading and feasibility of achieving sympathetic installation
- Likely frequency of operation and access for maintenance
- Future availability of gas/recharges.

Some of these factors are not unique to gas suppression systems and are a consideration for any type of suppression medium, but some are unique to gas suppression. In



Illus 37 A gas suppression system with high pressure gas filled cylinders © Stewart Kidd

In addition, wider environmental considerations further complicate the issues surrounding firefighting gas systems. In 1986 the two most effective firefighting gases (Halon 1211 and Halon 1301) were acknowledged to be major contributors to the depletion of the earth's ozone layer and as a result, these particular products are no longer available for general use.

#### 4.5.1 Inert Gases

Prior to the development of the Halon (chemical) gases most gas systems used carbon dioxide – CO<sub>2</sub>. This had the advantage of being inert, relatively cheap and also readily available. However, a CO<sub>2</sub> gas concentration of at least 50% has to be maintained within the protected area to achieve extinction of fire; a concentration which would result in asphyxiation of any people present when the system discharges.

Nowadays, on account of this risk, CO<sub>2</sub> fire suppression systems are mainly restricted to unstaffed areas such as electrical switchrooms or computer rooms. More recently, a number of proprietary inert gas mixtures have been placed on the market. These include products containing proprietary mixtures of nitrogen and argon eg Argonite. One particular gas mixture, Inergen, also has a small amount of added carbon dioxide. The carbon dioxide in this formulation makes it possible for humans to continue to breathe in a space into which this gas mixture has been discharged and has reduced oxygen concentrations to a point where fires are impossible.<sup>17</sup> In most cases, however, it is normal not to discharge the gases until the protected area has been evacuated.

<sup>17</sup> This is because as the addition of the carbon dioxide makes the lungs work harder to utilise the smaller amount of oxygen still present in the room.

Of course, given that CO<sub>2</sub> is the major greenhouse gas it may be that some organisations would not wish to be seen to be specifying or installing such systems. Reference should be made to: BS 5306-4: 2001 *Fire Extinguishing Installations and Equipment on Premises – Specification for Carbon Dioxide Systems*.

#### 4.5.2 Chemical Gases

The withdrawal of the Halon gases has triggered a great deal of research into alternative chemical firefighting agents but it is probably true to say that no gas yet marketed offers all the advantages of Halon 1301.<sup>18</sup> Many of the gases developed for industrial and commercial use have properties which render them inappropriate in the protection of traditional buildings. A number of these gases produce by-products which are corrosive and some are also toxic so can only be used in spaces which are unoccupied. It is suggested that none of these chemical gases should be specified for protection of traditional buildings use without specialist advice being sought as the characteristics of each gas need to be carefully assessed against the benefits offered in respect of the building (and where appropriate, contents) to be protected. New standards are currently being developed for the design of gas systems and their components. Reference can be made to: BS EN 12094 *Fire Fighting Systems: Components for Gas Extinguishing Systems* and BS ISO 14520 *Gas Fire-extinguishing Systems: Physical Properties and System Design*.

#### 4.6 Oxygen Reduction and Air Inerting Systems

A new technique to protect heritage buildings and artefacts from fire was evaluated as part of the COST Action C17.<sup>19</sup> Inert air, referred to as hypoxic air (reduced oxygen concentration), comprises slightly altered concentrations of components of air. Typically 5% of the oxygen content is substituted by nitrogen. Inert air has pre-determined oxygen levels and is safe to breathe, but prevents fire ignition in common materials. Inert air replaces the use of inert gases.

The development of inert air venting appears to be a promising method of fire prevention for heritage applications. Inert air prevents ignition of fire and initial smoke and fire spread. Storage rooms, laboratories and exhibitions may be protected, with sizes ranging from small closets to large volumes. There is generally no requirement for pipes, nozzles or any other invasive installation of equipment in the protected rooms. No room fans, room sensors, detection nor activation systems are required. The inert air is continuously generated on

<sup>18</sup> One recently-developed agent is NOVEC 1230 manufactured by 3M which appears to offer some of the benefits of the much-missed Halon 1301. NOVEC 1230 is claimed to have zero ozone-depletion potential and a global warming potential of one.

<sup>19</sup> Jensen, G. *Hypoxic Air Venting for Protection of Heritage*, Historic Scotland, 2006

site, thus a minimum of space is required. Generators are linked to the building's air conditioning system or to inlet air ducts. Fully reversible mobile units may be located in the rooms. Unlike gas extinguishing systems, there are no reservoirs to run empty or require re-filling. There is virtually no risk of secondary damage, environmental or corrosive issues. The inert air may positively contribute to diminishing the rate of normal deterioration of organic and non-organic objects.

While the concept and approach offer some potentially significant benefits over other types of fire protection systems before the technology can be applied more widely than the experimental systems (which are being used for archive or computer rooms) more research is required.

Challenges to be faced in implementing the wider use of inert air systems relate to:

- Energy costs which depend strongly on the air exchange rate and air leakage
- Compressors noise may upset neighbours and will require insulation
- Analysis must be undertaken to ensure that any substances which may burn at a low oxygen level are protected by other measures
- Legislation and employment regulations that may prohibit premises providing oxygen-reduced atmospheres.

## 4.7 Lighting and Signs

### 4.7.1 Fire Signs – General

There are a range of signs which have been approved for use in respect of the fire safety provision of a building (illus 39). These are covered by the Safety Signs and Signals Regulations 1996 or by BS 5378-2 *Safety Signs and Colours* and BS 5499 *Graphical Symbols and Signs*.

Locations where signs should be provided should be indicated by the output of the fire risk assessment but in general, signs might be expected to be found in the following locations:

- On doors which are required to be kept closed
- On doors which should be kept locked
- On either side of a door which must be kept free of obstructions
- To draw attention to the presence of a call point, extinguisher, hose reel, etc
- To indicate the way to a fire exit
- To indicate how a door is to be opened or accessed
- To indicate the presence of a fire hazard
- To prohibit certain activities.

The FPA produce a comprehensive guide to such signs: *Guide to Fire safety Signs (fourth edition) 2007*.

### 4.7.2 Exit Signs

In all buildings not used solely as dwellings there are statutory obligations under the Safety Signs and Signals Regulations 1996, where necessary, to provide 'distinctive and conspicuous exit signs to indicate doors and escape routes'. These signs are essential in premises that are likely to contain people who are not familiar with the layout of the buildings and need help in finding the means of escape provided.

Since 24 December 1998, all fire exit signs have had to be green and white and contain the 'running man' symbol, with appropriate directional arrows. Signs saying *Fire Exit* alone are no longer acceptable and should be supplemented with the appropriate pictogram.

Exceptionally early examples of exit signage may be of historic value and specialist advice should be sought in such circumstances.

However, it should be accepted that in heritage buildings (especially those which are not open to the public on a continuous basis), there is a case for taking a more flexible view of the need for and positioning of exits signs. Sensitivity to historic interiors should dictate the actual placement of the signs.

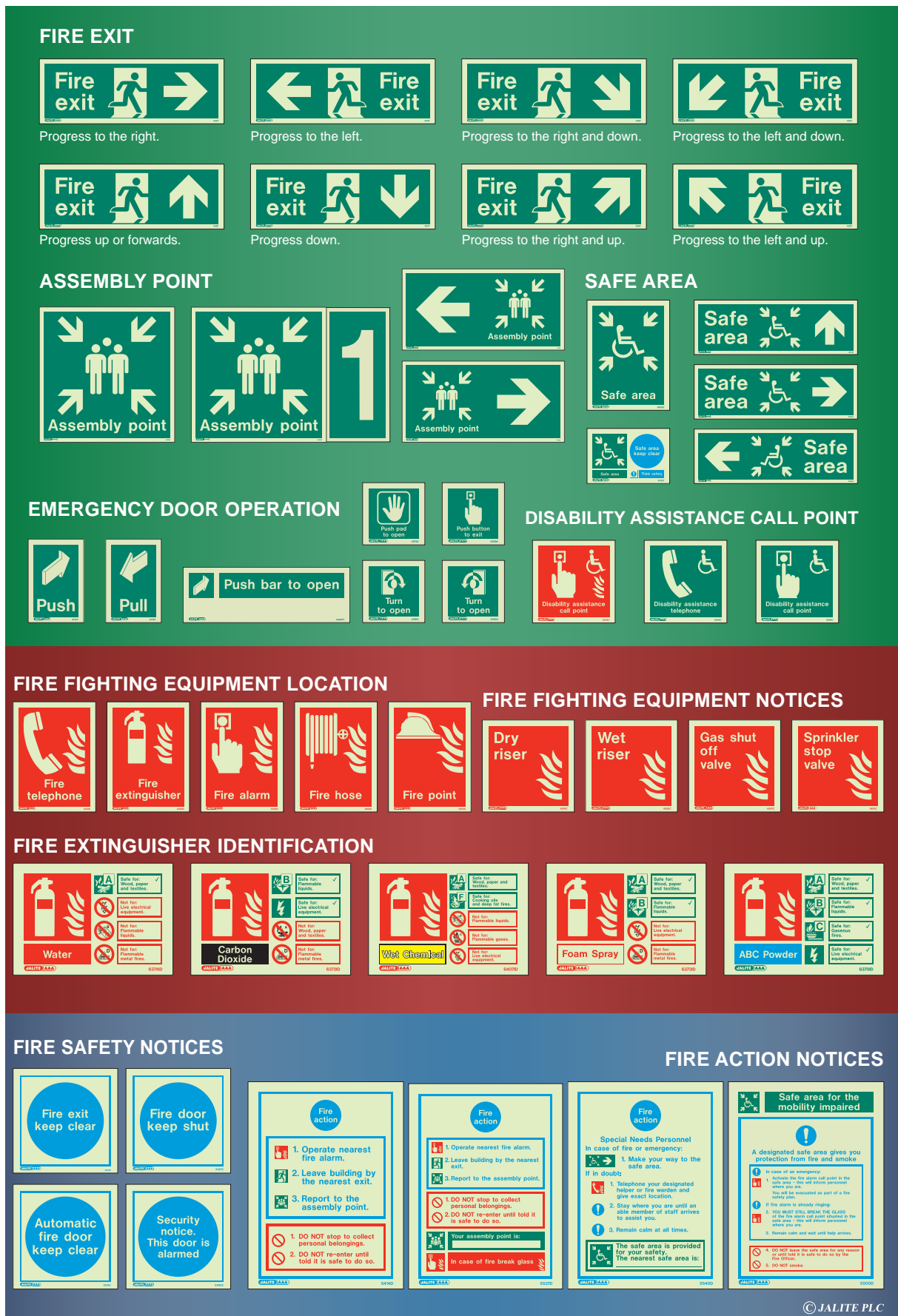


© Stewart Kidd



Illus 38 Sensitive designed escape signage © Ingal Maxwell





Illus 39 A range of approved signs for use in respect of fire safety © Jalite PLC



*Illus 40 Temporary free standing exit sign in staffed tourist attraction – an alternative to standard signage which may be acceptable in certain circumstances © Stewart Kidd*

Experience suggests that in some historic buildings, the authorities having jurisdiction have accepted the use of some non-standard signs and where the appearance of the interior of a building is thought to be of particular importance it may be possible to adopt an alternative approach to signage.

The skilful use of emergency lighting units to illuminate both exit signs as well as other safety signs should be encouraged and will not only minimise the disruption caused by the introduction of additional wiring and light units but could also save money. Photo luminescent signs are simple to install and although more expensive than conventional signs do not need supplementary lighting. However the period they require under normal lighting conditions to regain their luminescence and make them effective must be considered.

#### **4.7.3 Emergency Escape Lighting in Traditional Buildings**

Emergency lighting (often referred to as escape lighting) is provided in regulated buildings to illuminate escape routes and exits in the event of a power failure or loss of a building's main lighting. These systems ensure that there is uninterrupted illumination in areas where there are large numbers of people.

Emergency lighting units are normally located in accordance with BS 5266-1: 2005 *Emergency Lighting. Code of Practice for the Emergency Lighting of Premises*<sup>20</sup>. Reference should also be made to the Scottish Government's Sector Specific Guides to the 2005 Act and the regulations made thereunder and to the Industry Committee for Emergency Lighting 1008: *Emergency Lighting Risk Design Guide* (Revised February 2008).

<sup>20</sup> This standard should be read in conjunction with BS EN 838:1999, BS 5266-7:1999 *Lighting applications. Emergency lighting which give the luminosity requirements for emergency lighting*.

In addition, British Standards Institute has produced a new guide BS 5266-10: 2008 *Guide to the design and provision of emergency lighting to reduce the risks from hazards in the event of failure of the normal lighting supply* to reduce the risks from hazards in the event of failure of the normal supply. This document identifies a number of areas where additional risks should be considered, these include:

- Kitchens
- First aid and treatment rooms
- Refuge areas
- Plant rooms
- Areas containing fire alarm or security control panels
- Reception areas
- Exit door controls that need to be manipulated (such as crash or panic bars).

#### **4.7.4 Types of Emergency Lighting**

The most common type of lighting unit likely to be required to be installed in traditional buildings to provide escape lighting are the self-contained units which are wired into the building's lighting circuit. These provide a constant current charge to a battery which will provide power for one to three hours (or as specified). Should the mains fail, each individual lighting unit will light up automatically. These units are often supplied with appropriate fire exit signs already attached.

In larger buildings especially hotels, shops and the like which are open to the public, it is normal practice to provide what are known as either combined or maintained emergency lighting units on fire escape routes and exits. Combined units are fitted with two bulbs, one of which is illuminated by the primary lighting circuit, the other being powered in a supply failure from an internal battery. Maintained luminaries use the same bulbs for both normal and emergency operation – this enables the normal luminaries to also provide emergency lighting and also in addition tends to improve the aesthetics of the installation.

In selecting and specifying light fittings it is important to establish whether all of the control gear is contained within the fitting or whether provision has to be made to accommodate this nearby. Specification of the latter type of fitting will only be possible where a suitable void to house control equipment can be identified. Care should also be taken where such units produce heat, and steps taken to ensure adequate ventilation of batteries, chargers or transformers.

The presence of a stand-by generator does not eliminate the need for emergency lighting unless the system has

been appropriately designed to meet the full requirements of a safety system. Generators are unlikely to meet the requirements to provide escape lighting within five seconds unless a central battery is incorporated into the system to cover during the generator's start up period. With such centralised systems special fire resistant cabling must also be used to safeguard the supply from generator to the lighting units.

There are a number of ways in which the spirit of the regulations can be complied with and yet at the same time ensure that visual intrusion is minimised. In certain cases it may be possible to refurbish existing light fittings, to incorporate emergency facilities. This can be particularly successful where historic light fittings survive and are capable of conversion without compromising their integrity or appearance. However where this is not deemed possible the introduction of supplementary sympathetic fittings may be appropriate. The need for lighting is usually determined by the need for people to find their way to an escape route or fire exit under circumstances where the normal illumination is extinguished.



*Illus 41 This totem pole is a novel solution – incorporating an exit sign and emergency lighting in addition to video surveillance, break call glass point and audio alerter © Inval Maxwell*

#### **4.8 Equipment, Installers and Standards: Third Party Certification**

Fire protection systems can only be effective if they are designed, installed and maintained according to the highest standards. In order to provide some degree of comfort to specifiers, end users and regulators a number of third party certification schemes have been set up.

The liabilities which now attach to a property owner or employer in respect of ensuring that the correct fire protection systems are installed and maintained in proper working order in a building, mean that the most effective way of discharging this duty is to ensure that such work is only entrusted to companies who can demonstrate their competence and capability. The simplest and most effective way of doing this is via a third party certification scheme. This provides the necessary assurance that the claims by the installer can be substantiated through a rigorous certification scheme run by a reputable assessment body.

Credibility is provided through the third party certification schemes run by bodies listed by the Government's own supervision body, the United Kingdom Approvals Service (UKAS). UKAS approved bodies in the fire field include the following commercial organisations:

- LPCB/BRE Certification Ltd (the successor body to the Loss Prevention Certification Board)
- British Approvals for Fire Equipment (BAFE)
- Warrington Fire Research (WFR)
- National Security Inspectorate (NSI)
- BSi – British Standards 'Kitemark' scheme.

Contractors and suppliers who are not listed under one or other of these schemes should be asked to provide detailed information about their quality assurance arrangements.



*Illus 42 A water tender in attendance at a fire at a category A listed property © Crown Copyright: RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk)*

## 5 FIRE AND RESCUE SERVICE MATTERS

### 5.1 Statutory Framework – Fire and Rescue Services Operations in Traditional Buildings

The Fire (Scotland) Act 2005 prescribes the core duties of fire and rescue authorities.

Under Section 9 a fire and rescue authority must make provision for the purpose of extinguishing fires in its area and protecting life and property in the event of fires in its area.

Sub-section 9 (2) (d) of the Act imposes a duty on fire and rescue authorities to make arrangements for obtaining information required for firefighting purposes.

This statutory obligation requires fire and rescue services to collect and maintain operational intelligence on risks within their area. The nature and extent of the intelligence held can range from basic text information and a single line plan drawing held centrally, through to enhanced versions of this data such as dimensional plans, stored on electronic vehicle mounted data systems mounted in fire appliances. It is a matter for individual fire and rescue services to determine the nature and extent of information which they wish to hold and the way it is stored and managed.

Similarly, sub-section 9 (2) (e) of the 2005 Act requires every fire and rescue authority to make arrangements for ensuring that reasonable steps are taken to prevent or limit damage to property resulting from firefighting.

This statutory duty takes on additional significance when considering the potential financial and cultural loss resulting from fire in historic buildings. The value of historic fabric and the contents of historic buildings may not always be recognisable to the non-specialist and specific measures may be necessary to provide effective damage limitation during and after a fire.

From the earliest days of fire services and insurance companies, the recovery of contents from properties affected by fire has always been undertaken. However the more detailed planning now being undertaken by the owners or managers of many historic buildings will inevitably demand more of fire service personnel both in the preplanning of response and in operational implementation of damage limitation at the scene of a fire.

Since damage limitation at operational incidents is the responsibility of the fire and rescue service, the majority of first responding fire service vehicles to incidents carry

basic damage limitation equipment. The majority of fire services in the UK also have specialist vehicles, with additional and more sophisticated equipment, which are termed either salvage tenders or damage-control vehicles.

It should be noted however that no single definitive standard in the UK exists for damage limitation equipment. Additionally, mobilising criteria, operational procedures and expertise varies from service to service, even between neighbouring fire authorities.

### 5.2 Liaison with Fire and Rescue Services

In several places within this Guide there have been references to the need for high levels of liaison between owners or occupiers of traditional buildings and their local fire service. No apology is therefore made here for repeating this advice.

All activity aimed at minimising the impact of a fire on people or property must include regular, effective and amicable contact with the local fire and rescue. In the case of larger properties or sites, an invitation should be extended to the local fire station to visit the premises and gain valuable knowledge of the building, its uses and any special factors which might affect the safety of the occupants or the way in which the fire might have to be fought.



*Illus 43 On occasions, in the event of a fire it may be more beneficial to locate to the rear of a property or as here, the service courtyard to the side elevation, due to proximity to such features as the gas shut-off*

The following factors should be taken into account:

- Location of the building and signpost information – for example, is the building called one thing by the occupants but known as something different locally
- Access to the building: special problems with bridges, roadways and gates any of which might prevent the speedy arrival of fire appliances eg weight and width restrictions
- Entry to the building – may not always be at the front, possibly a rear service courtyard
- Water supplies – apart from hydrants where are there additional sources of firefighting water? Are open water sources such as rivers or ponds/lakes accessible?
- The activities undertaken – what is the building used for?
- Are the occupants likely to have problems evacuating themselves?
- The presence of flammable liquids, explosives, compressed gases or radioactive substances
- Locations of water stopcocks, meter bypasses, electrical substations, transformers and switchgear, gas shut-offs and the like.

Regular contact can be developed and other activities organised. For example, arranging for the attendance of fire appliances at a drill or exercise will benefit all parties and will ensure that crews from the local fire station are able to familiarise themselves with the site. Meetings should be held to ensure that the fire personnel are aware of forthcoming special activities such as major exhibitions and special functions, or of temporary changes in building layouts.

Where there are significant changes, for example if an access drive is temporarily closed or if there is a long-term presence of contractors on a site, the fire and rescue service should also be informed immediately.

The fire and rescue service should also be informed if the fire detection system or any firefighting equipment such as a fire suppression system is taken out of action for more than an hour or so.

### 5.3 Scottish Historic Buildings Fire Database

A groundbreaking project that focuses on liaison with the Fire and Rescue Services is the Scottish Historic Buildings Fire Database project. The database was established in 2002 as a partnership initiative; managed by Historic Scotland, co-ordinated by the Scottish Fire and Rescue Services and accommodated by the Royal Commission on the Ancient and Historical



*Illus 44 A damage limitation exercise at Duff House gallery*



*Illus 45 The fire database displayed onboard a fire appliance  
© Crown Copyright: RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk)*

Monuments of Scotland. Its key objective is to make available information on category A listed buildings in a format suitable for use by firefighting crews. The type of information includes building details, access and approach, areas/features of notable significance, water sources, location of services and how the building structure might affect the spread of a fire. Such fire risk information will help to improve the effectiveness of firefighting at incidents, consequently mitigating any damage caused. The database is solely used operationally by the Scottish Fire and Rescue Services and only deals with building fabric, not building contents.



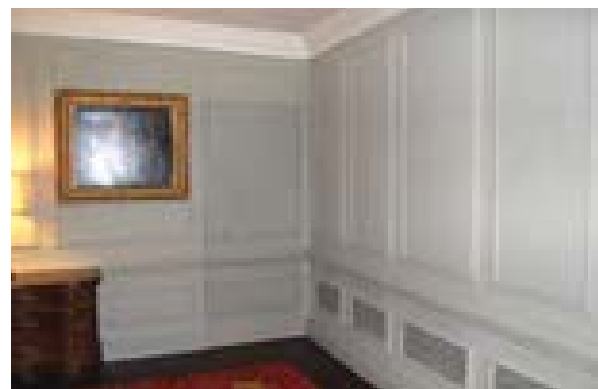
*Illus 46 A Grampian Fire and Rescue Service visit to Castle Fraser, Aberdeenshire © Crown Copyright: RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk)*

#### 5.4 Firefighting in Traditional Buildings

The hazards present at fires involving traditional buildings generally arise from:

- The building itself
- The contents of the building
- The nature of the fire situation
- The nature of the task to be performed
- Environmental considerations.

The first three of these topics must be taken particular account of when considering traditional buildings in general and are expanded upon in the sections that follow.



*Illus 47 Each traditional building throws up individual hazards – either a door designed to blend in with the surrounding wall finish or a small domestic property with well worn narrow timber stairs  
© Crown Copyright: RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk)*

#### 5.4.1. *The Building Itself*

Traditional buildings pose special problems for firefighters during a fire and can be summarised as:

- Hidden spaces where fire or smoke can travel
- Lack of fire separation (particularly in roof voids)
- Unusual patterns of fire spread and behaviour
- Difficulty of locating the fire.

Additionally, the way in which a traditional building is being used may have changed significantly from its original purpose and this may have been accompanied by past alterations to fabric which have compromised fire performance.

Traditional buildings which have been unoccupied for lengthy periods of time can present particular additional hazards. These include:

- Difficult external and internal access
- Unsafe floors and staircases
- Increased risk of structural collapse
- The presence of asbestos
- The possible presence of drugs paraphernalia.

It will be necessary to assess the risk to firefighters against the benefits of saving the building and the incident commander at a fire will need to decide whether to adopt an offensive or defensive mode of firefighting. In the case of derelict property or one where fire is well established the risks are likely to outweigh the benefits and a defensive mode of firefighting may have to be considered. Defensive firefighting means that fires are fought in the main without committing personnel to the interior of the building and where possible the fire is prevented from spreading to unaffected portions of the property or to nearby buildings.

#### 5.4.2 *Contents of the Building*

Although the hazards implicit in fighting fires in traditional buildings are little different from the hazards found in 'normal' firefighting, there may be additional risks to fire crews and others resulting from the types of materials stored or used in these premises. For example, it would be likely to encounter a wide range of hazardous chemicals in buildings used for the storage, display or preparation of natural history collections.

In all historic buildings, consideration should always be given to the need to mitigate damage and the operational approach adopted by the incident commander must reflect this. Damage limitation in historic buildings falls into two broad categories:

- 1) Limiting damage to the structure of the building and its constituent parts – including damage by firefighting activities, especially water
- 2) Limiting damage to the contents of the building – including recovery and relocation of furniture, fabric, fittings and works of art.

The hazards which may be present include:

- Manual handling problems (weight and size of individual items)
- Difficult access and egress
- Behaviour of occupants due to a fire situation
- Dangers implicit in large number of non-fire service personnel assisting with damage limitation/salvage

Fire service personnel must be aware of these hazards and consequently preplanning must incorporate liaison between the fire service and property owners to ensure awareness of all hazards likely to be present. During any preplanning visit or inspection, consideration should be given as to how damage limitation activities will impact on firefighting operations. When considering damage limitation of contents including, for example artworks and furniture, the manual handling implications and egress route of choice should be considered.

#### 5.4.3 *Control of Volunteers and Staff*

Additional considerations exist where there is the intention to employ volunteer members of staff (or the public) in a damage limitation role. Where such damage limitation teams exist, joint training exercises should be held in order to familiarise the teams with fire and rescue service procedures. During an incident teams must always act under the direction of the fire service incident commander who should assess what, if any, damage limitation work can be undertaken safely by them. The incident commander must maintain charge at all times over who is permitted to enter the building, areas where they can work and any control measures to be adopted.

### 5.5 **Fire and Rescue Service Operational Considerations**

In the event of a fire, the fire and rescue service's incident commander will have to decide on the operational tactics to be employed and quickly develop a plan for dealing with the incident. The following sections identify some of the likely operational considerations. Taking these into account during the preplanning stage, will greatly assist in the preparation of the Operational Plan which will be developed to manage the fire service's response to an incident.





*Illus 48 Glass slide pictorial representation of historical firefighting operation From the collection of Stewart Kidd*

#### **5.5.1 On Arrival**

The incident commander will:

- Proceed to a prearranged rendezvous point at the site
- Make contact with responsible staff, the owner or the owner's representative to obtain advice from the appropriate source
- Ascertain whether occupants, staff and public are all accounted for
- Ascertain the nature of the incident quickly
- Decide whether adequate fire services resources are on site or en route
- Consider the siting of fire appliances taking account of proximity to the building, hard standing availability (especially for aerial appliances) and the location of water supplies.

#### **5.5.2 Initial Operations**

The incident commander must consider the following issues during the initial operations at an incident:

- Consider the use to which the building is being put together with its structure
- Are there signs of a progressive or sudden increase in the size of the fire – is there a need for additional resources
- Method of entry – safety of crews, consider significance of building structure
- Are there signs of flashover and backdraught conditions? – If yes – withhold personnel
- Empty or derelict properties – offensive or defensive firefighting techniques
- Water supplies – resources required to secure adequate water supplies.

Property owners or managers can assist by taking account of the above considerations, and incorporating relevant information into their own fire safety plan where possible.

### 5.5.3 Developing Situation

In a developing situation it may not be clear what the total extent of the fire is or whether it is likely to develop rapidly. The incident commander will be considering both the firefighting element of the Operational Plan and whether it will be possible to undertake damage limitation (whether or not this has been the subject of preplanning), dealing with both aspects in order to manage the incident safely and effectively. In terms of firefighting, the following will be considered:

- Obtain plans of the building if available. Property owners or managers should have these available as part of their sites own plans
- Appoint safety officer(s)
- Cordon off area to safeguard public
- Verify whether gas and electricity are isolated if this is necessary. The location of shut-off valves and isolation switches should be included in the site's plans
- Use of aerial appliances – taking account of suitability of access routes and ground stability
- Liaise with police and other agencies on site.

When considering whether to undertake any activity in respect of damage limitation, the incident commander will take the following into consideration:

- Effects of firefighting on the structural fabric
- Removal/recovery and safe storage of building's contents
- Use of volunteers or members of the property's damage limitation team
- Liaison and control of damage limitation teams
- Resources required for damage limitation operations.

The extent and value of the damage limitation team's training will influence the confidence which the incident commander will have in it. This will directly affect the extent to which he will allow use to be made of the team. Teams which have been properly trained and are accustomed to working alongside firefighters and complying with their instructions will be much more effective than those which have not been so trained.

## 5.6 Water Supplies for Firefighting

An adequate supply of firefighting water is critical for the successful intervention and suppression of a fire. There is substantial evidence from fires across Europe to show that where there is insufficient water available then the fires are often allowed to burn out. An analysis of some 100 fires in historic buildings prepared for a European research project shows that a shortage of water was a key factor in the amount of damage incurred in more than 35% of the incidents. It is therefore essential that due consideration is paid to the need for an adequate supply of water and this is an item which should be included on the agenda of all fire and rescue services' liaison meetings. The fire and rescue service will wish to determine not only how much water is available (both from public and private hydrants) but also the location of private water supplies in the form of ponds, lakes, lochs and streams and the effect of any likely seasonal variation on supplies.

### 5.6.1 Public Water Supplies

Most water for firefighting comes from public water mains. External, underground fire hydrants allow firefighters easy access to a water supply, which can often be boosted by the water undertaker in the event of a major incident.

There are, broadly speaking, three types of water main:

- Trunk mains – up to 1.2m diameter
- Secondary mains – up to 450mm diameter
- Service mains – 75, 100 and 150mm diameter

Service mains supply individual properties through a service connection. In rural areas service mains may be relatively small and sized only to provide the basic water demands of homes and farms.

Underground hydrants are provided along the length of the service mains for use by the fire and rescue service. Fire hydrant locations are marked by standardised signs to BS 3251: 1976 *Specification. Indicator Plates for Fire Hydrants and Emergency Water Supplies*. The upper figures on the plate indicate the diameter of the main (in millimetres) while the lower figures indicate the distance in metres between the indicator plate and the hydrant. Some older plates incorporating imperial measurements in inches and feet may also still be found. Fire hydrants are of standardised pattern and should comply with BS 750: 2006: *Specification for underground fire hydrants*. Public fire hydrants are provided as a statutory responsibility by the water supply undertaker but the cost of their maintenance falls to the fire authority.

In the case of larger buildings or sites, there is often a water meter located at or close to the property boundary between the service main and the service connection.



Illus 49 Underground fire hydrant marked by metal cover  
© Stewart Kidd

Where the fire and rescue service might be required to draw off water from such a connection a meter bypass should be provided to allow full flows for firefighting. The bypass valves should be clearly indicated by a sign (also complying with BS 3251) and the necessary turnkey should be readily available for fire services use.

### 5.6.2 Private Water Supplies

Where no piped water supply is available, or there is insufficient pressure and flow in the public service main an alternative supply may be provided such as a private water main fed from reservoirs, wells or open water.

In some cases, for very large premises additional fire hydrants may have to be installed and these and their water supplies may be under the control of the premises' management. Where private hydrants or an external source of water is to be relied on then these should be provided with the appropriate 'H' or 'EWS' (Emergency Water Supply) signs. The local fire service can advise on this.

In taller buildings as already described a dry rising main may have to be provided. This consists of an inlet box on the outer face of the building in an accessible location (within 18m of the street or road or fire appliance parking area), where firefighters can connect a hose. This feeds a pipe running up or through the building (usually in a staircase) which is provided with outlet valves on each floor level to which can easily be connected lengths of fire hose. Even where a riser is not required under SBS it is worth considering as it makes the job of the firefighter much easier and reduces the time taken to get water to a fire. Risers will also minimise the risks of water damage caused by leaking or bursting fire hoses which have to run through a property.



Illus 50 A hydrant marker that has become obscured by overgrown vegetation, a situation good management would address  
© Stewart Kidd

Where water for firefighting water is to be provided from a private water supply:

- A flow of not less than 75L per minute from two hydrants at a pressure of 2 bars should be allowed for. Pipework should be of steel or cast iron or other Water Regulations Advisory Scheme approved material with an internal diameter determined by the flow and pressure required, but in any case not less than 65mm.
- Where water is being specifically provided on-site for fire service use, at least 60min demand (ie a minimum of 9m<sup>3</sup>) should be provided if at all possible.
- Hydrants, valves and bypasses should all be clearly marked and subject to a proper maintenance regime. This includes ensuring that hydrant and valve chamber covers are clearly visible and accessible at all times.

Wherever possible, underground water supply pipework should be arranged to form a loop or ring main around the property with appropriate isolation valves. This arrangement will reduce the chance of the system being put out of commission due to localised damage or maintenance activity.

### 5.6.3 Supplementary Water Supplies

Water for firefighting can be augmented from a variety of sources:

- Ornamental ponds
- Swimming pools
- Purpose built cisterns, ponds or canals



*Illus 51 An early fire pond at a country house estate © Stewart Kidd*

- Natural water features including, rivers, streams and lakes or lochs (where accessible and not seasonal in nature).

These locations should be made known to the fire service and noted on the information held about the property by the fire and rescue service.

Adequate access (refer to Section 5.7) should be provided for a fire service vehicle to these water sources. Purpose-built cisterns or ponds should also be marked with an EWS sign together with the capacity in  $L/m^3$  at the access locations. Natural water features such as rivers, lakes, lochs and streams also offer a valuable source of water for firefighting as an adjunct to designated water supplies, as does water which can be taken from ponds and canals – providing that the fire and rescue services are able to access these. If hard-standing is required for access, there are a number of low visual artificial paving systems that enables grass to grow through. Such systems have an open cellular matrix which gives the appearance of grass, but has the load bearing capability of a driveway. The easiest route to the water should be marked using the EWS sign, and undergrowth etc removed on a regular basis.

Where possible a permanent suction connection with strainer should be provided to enable swift access to the water. Provision of a pump arrangement at artificial or natural water features will also ensure easy and effective access to a larger volume of water.

Property owners or managers should ensure that identified locations are checked regularly (and dredged if necessary) and that the fire and rescue services are informed of any seasonal or other impairment. Any work undertaken to provide or improve water supplies or access to these should be carried out sympathetically and in accordance with planning and other statutory legislation.

## **5.7 Access and Signage for Fire and Rescue Services**

### **5.7.1 Access Signage**

Properties (especially in rural areas) should be identified by appropriate signs to assist fire crews responding to a fire. Even if there are regular liaison visits and meetings with the local fire station, it is quite probable that fire

crews from other stations (and even other fire and rescue services) may be called to attend so it is necessary to ensure that the name of the property is displayed where any drive or private road meets a public highway. If there is more than one entrance, then all access points should be marked unless a particular drive is unsuitable for heavy vehicles. Care should be taken to ensure that the signs provided are no larger than is necessary for this purpose and designed in appropriate manner for their context.

Before installing new signs a check should be made to determine whether listed building consent or planning permission is required. Properties open to the public will almost certainly already be adequately signposted.

In the case of larger properties, especially those where sizeable events such as pop concerts, highland games and so on regularly take place, it may be appropriate (after consultation with the emergency services as a whole) to provide 'Rendezvous Point' (RVP) signs for fire, police and ambulance. It is likely that such signs will only be required in properties in rural areas where there is more than one entrance or driveway.

#### ***5.7.2 Access for Fire and Rescue Service Vehicles***

The principal fire appliances responding to a fire will have a laden weight of between 13 and 17T and roadways with a surface appropriate for this weight should be provided to within 25m of a suitable access point to the property. The roads should be a minimum of 3.7m wide unless they form part of a well-defined one-way system in which case a width of 3m is acceptable.

A minimum clearance of 4.5m must be maintained where overhead cables cross these roads. Gateways through which access for vehicles may be needed should be not less than 3.1m wide with a clear height of 4m. The conventional 'fire appliance' (pump or water tender) needs a turning circle of 17m while larger vehicles such as a turntable ladder or hydraulic platform need a circle of 29m.

The fire and rescue service should be consulted where properties cannot meet these requirements. Where a gateway is too narrow or the load capacity of a bridge is inadequate consideration should be given to possible alternatives such as providing another access route or improving the easy availability of firefighting water supplies by installing pumps supplying a private fire main and hydrants so that the fire and rescue service are not dependent on the pumps in their vehicles.

Hard-standing near water pumping points or access to open water should be commensurate with the 13-17T weight noted above. Where appropriate this (and indeed, all access roads) may be constructed of more visually sympathetic materials.

#### **5.8 Properties in Remote Locations**

In areas such as islands or very remote locations where fire and rescue service response may take a significant time it may be appropriate to consider what alternative measures should be put in place. These could include:

- Establishment of a private fire service staffed by estate workers
- Formation of a volunteer fire unit under the direction and control of the fire and rescue service for the area
- Installation of an automatic fire suppression system.



*Illus 52 Insurance is important – fires do happen © Central Scotland Fire and Rescue Service*

## 6 PROPERTY MANAGEMENT ISSUES

### 6.1 Insurance

While the purchase of insurance for a new building is a relatively simple undertaking, there are additional factors which must be considered when procuring buildings cover for traditional, listed or historic buildings.

Many historically-valuable buildings are not covered by any insurance whatsoever. The main danger here is that no-one considers making sufficiently strong requirements for the building itself to be protected. This increases the risk to the occupants, building and contents. Many important buildings which are insured also carry insufficient cover in relation to their historic value. The insurance policies often determine that the damaged premises should be rebuilt to meet the practical requirements for indoor space at a standard which could be well below that which existed originally, or the indemnification of the insured is deemed to have been satisfied by the erection of a building of similar, but not exact, appearance, with a corresponding loss of authenticity and cultural value. As all too often the insurance companies are unaware that a historically-valuable building might be involved in the fire, the need for knowledge sharing is paramount.

Most property managers probably assume that the insurance companies are responsible for simply handing over the actual sum insured should a building be damaged or destroyed by fire, but with the many common forms of insurance, that might not be the case. It is the policyholder who is responsible for ensuring that the policy covers all the cost of any restoration. In the case of buildings where careful restoration using original materials and methods will be required, this must be made clear in advance, and the policy adjusted accordingly. The property owner should produce estimates of rebuilding costs, and a sufficient level of protection must be agreed with the insurance company before the premium is determined. This is particularly essential in cases of partial damage, where heritage laws and other circumstances could determine the need for an exact restoration.

Even at its simplest the insurance business can be confusing to the layman and this is especially true for those who have an involvement with historic buildings. This may be due in part to lack of understanding of the way in which the insurance industry is organised, and partly on account of the insurance business's recent shift towards direct provision of standardised policies, invariably inappropriate and unsuited to the peculiarities of historic buildings.

Many of the larger companies have moved away from detailed examination of the risks they are asked to provide cover for in favour of formulaic standard 'packages' policies. These are usually based on a computer model with little flexibility and are frequently sold by staff in call centres. Unfortunately, whilst offering the industry and some consumers economies of scale, these products are invariably incapable of accommodating the unusual requirements posed by historic buildings and their contents which can rarely be said to be in any way 'standardised'. Many insurers now will simply not consider providing cover for buildings constructed before 1900. This can lead to frustration on the part of building owners or occupiers trying to purchase cover directly.

What is important is to ensure that, in most cases, the property is covered on an indemnification basis – that is, the insurers agree to pay whatever it costs to restore the building to the condition it was in before the fire – this may bear little relationship to the actual value of the building. Depending on the listing which applies to the building and its importance in cultural, architectural or national heritage terms it may be that the listing authority will require a total reinstatement and the premiums for such cover are likely to be higher than a simple £x per £1,000 worth of buildings.

When purchasing insurance, there can be no substitute for expert assistance whether this is in agreeing a valuation for a house or major property or in finding an insurer who is prepared to provide cover for a particularly valuable painting. There are a number of insurance brokers and valuers who specialise in historic buildings and organisations such as the Historic Houses Association are a good source of advice to locate such professionals.

It should also be remembered that insurers assess the likely risks to which a building is exposed when calculating premiums. If a building has been subject to a proper fire risk assessment and if the appropriate fire safety measures are in place (including fire detection, compartmentation and good management) then premiums will be lower. If an automatic fire suppression system is in place then depending on the use to which the building is being put larger discounts may be allowed.



*Illus 53 The category A listed Morgan Academy in Dundee was devastated by fire in 2001. The facade was subsequently reinstated with costs running into millions of pounds Top: © Crown Copyright: RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk) and bottom: © Historic Scotland*



## 6.2 Staff Training

In large premises, where appointed, the fire safety manager will have responsibility for the management of all fire safety matters. Unless already skilled, he or she should receive training for this role which should be carried out only by a competent body – organisations such as the Fire Protection Association, the British Institute of Facilities Management, local fire and rescue services or the Scottish Fire Services College. Fire extinguisher maintenance contractors are often a good source of training in the use of such equipment, often utilising equipment which needs to be recharged or replaced.

All staff that have a role to play in the action to be taken in the event of fire, for example to evacuate guests or other non-staff members should be trained thoroughly in all aspects of that role. Selected members of staff, usually designated as fire wardens/marshals must also be aware of key property information, such as the location of firefighting water supplies, electrical and gas supply intakes, the operation of ventilation and security systems and so on. The fire training needs of staff in traditional buildings should not be entrusted to a trainer or training company which does not have experience of the special problems of fire safety in traditional buildings.

Where a property has a well-developed damage limitation plan then all staff with a role in the property's emergency plans should receive appropriate training.

### 6.2.1 Training for All Staff

All staff should receive basic fire training during their first week of work and should attend a properly structured fire course within three months of starting. This can either be an 'in-house' course or one run by an outside organisation – some fire extinguisher companies for instance run good training courses and will undertake to provide instruction on site.

In order to ensure that the training which is provided is fully compliant with legal obligations this should include:

- How to raise the alarm and what happens then
- Action to take upon hearing the fire alarm
- Procedures for alerting members of the public and visitors including, where appropriate, directing them to exits
- Arrangements for calling the fire and rescue service
- Evacuation procedures for everyone in the premises to reach an assembly point at a safe place

- Location and use of firefighting equipment
- Location of escape routes, especially those not in regular use
- How to open all escape doors
- The importance of keeping fire doors closed to prevent the spread of fire, heat and smoke
- Where appropriate, how to stop machines and processes and isolate power supplies in the event of a fire
- The reason for not using lifts (except those specifically installed or adapted for evacuation of disabled people)
- The safe use and risks from storing or working with highly flammable and explosive substances
- The importance of general fire safety which includes good housekeeping.

At least once a year a full evacuation drill of the premises should take place. In large or complex premises two such drills should take place annually. In the case of premises where the public have access this should, if possible include visitors.

For larger or more complex premises it is worth considering inviting the fire and rescue service to participate in an annual fire drill. Involving the firefighters likely to have to respond to a fire on the premises will allow them to exercise their own plans and test the level of coordination needed with the management and staff of the property. This approach will also help discharge the legal responsibility for liaison with the emergency services.<sup>21</sup>

### 6.2.2 Specialist Training for Certain Personnel

Some staff (such as the fire wardens already mentioned and managers) require additional training. It would be wise to extend this to other selected staff, probably including those who are most likely to encounter a fire at work. This group could usefully include: catering, engineering, maintenance and outdoor staff (craftspeople, gardeners, forestry workers etc), who should be provided with training relating to the particular hazards present in their areas and the fire equipment provided. Security personnel should receive training similar to that provided for fire wardens with additional emphasis on the use of fire equipment and calling the fire and rescue services.

<sup>21</sup> Each fire and rescue service have developed Integrated Risk Management Plans which set out their priorities for prevention, protection and intervention. Providing information to the local fire and rescue service will enable them to decide how to integrate this into their planning process.

### 6.2.3 Fire Warden Training

In larger premises fire wardens should be appointed. This can be a very cost-effective way of ensuring that all staff are properly fire trained. The fire wardens should be trained to a higher level than the rest of the staff to equip them not only for their responsibility for a designated area but also to enable them to provide ad hoc training for staff working in that area.

Fire wardens' training should reflect their important role as part of the premises' fire safety structure and should include:

- Legal duties
- Common causes of fire
- Action in the event of a fire
- Use of equipment provided
- Human behaviour in fire
- How to conduct an evacuation
- Location of evacuation assembly points
- Fire and people with disabilities.

### 6.2.4 Fire Extinguisher Training

Concerns are sometimes raised about the possible safety implications of training staff in the use of fire extinguishers, hose reels and fire blankets. These worries are rarely expressed in writing but seem to revolve around two main points:

- Staff should not try to fight fires but should be evacuating the building
- If someone is injured or killed as a result of firefighting would this render the employer legally liable?



Illus 54 Staff receiving fire extinguisher training © Stewart Kidd

While it is understandable that employers should take all possible steps to protect staff or employees from injury it is clear that there are legal obligations in respect of fire training which are spelt out in a number of pieces of legislation. In particular the Fire Safety (Scotland) Regulations 2006 in Regulation 12.3 there is a duty on employers, where necessary, to 'take measures for firefighting in the relevant premises' and to 'nominate competent persons to undertake those measures' and ensure that the 'training and equipment available (to the competent persons) are adequate'.

While it would not be reasonable to demand that all employees be prepared to fight fires, it is suggested that it is reasonable and appropriate to provide full practical training for those who are most likely to encounter a fire in the course of their work and for any others who might volunteer for such training. It should be stressed during the training that fire equipment should only be used when it is clear that to do so will not jeopardise the safety of the employee or others. The need for such practical training for any resident staff should be self-evident.

### 6.2.5 Fire Teams

Those responsible for larger premises in rural areas should consider the need for an on-site fire team, such as those in place at larger National Trust for Scotland properties and also the Volunteer unit at Gordonstoun School, Moray, which forms part of Grampian Fire and Rescue Service's resources. Given the implementation of Integrated Risk Management Planning<sup>22</sup> by fire authorities and the possible changes in deployment and levels of cover afforded by the fire and rescue services some degree of 'self-help' may become more important in more remote locations.

A well-trained and equipped on-site fire team can provide a very effective means of fighting or containing a fire until the fire and rescue service arrives. However in order to ensure that the premises do not breach health and safety legislation it is essential that all such teams and their members are properly trained and equipped. Many fire and rescue services will be supportive of such activity provided they are convinced that the initiative will be followed through and will be taken seriously by staff. It has been suggested that some fire authorities might even be willing to loan fire equipment to formally constituted volunteer fire teams. The FPA publish a *Code of Practice for Occupational Fire Brigades* which although aimed at more formally constituted bodies on large industrial sites may be useful as a guide.

<sup>22</sup> It is an over simplification, but this is best explained as the fire and rescue services focusing their primary efforts and resources on the areas where people actually die and are injured in fires. The socio-economic reality is that most fire deaths tend to take place in urban areas and especially in areas of social deprivation.

The *Management of Health and Safety at Work Regulations (1999)* require all employers to assess the risks to workers and any others who may be affected by their work or business. The objective is to identify preventative and protective measures and implement corrective action as appropriate. This requirement would apply equally to work undertaken by staff in an emergency, for example, staff may require training in assisting people with disabilities, including the use of specially designed evacuation chairs.



*Illus 55 Successful damage limitation in progress during a country house fire © Steve Emery/Oxford Fire and Rescue Service*

## 7 EMERGENCY PLANNING AND DAMAGE LIMITATION

Over the past twenty years it has become clear from the experience gained during incidents such as those affecting York Minster, Windsor Castle, Hampton Court and Uppark that there are major advantages in planning to deal with the impact of a fire on the fabric and contents of historic buildings.

### 7.1 Principles of Damage Limitation

Originally known as 'salvage' and owing much to the practices developed in wartime, the concept of preparing for and planning to deal with the consequences of fires or other untoward incidents is now well-established in the area of buildings and facilities management.

The primary purposes of damage limitation (in the context of fire) are to:

- Create a wider awareness of risk among staff members and contractors
- Reduce the loss suffered by the organisation by means of relocating vital or significant items of the contents of a building to a safe place by:
  - Minimising the impact of a fire by restricting the spread of smoke and heat
  - Minimising the impact of firefighting activity by reducing the collateral damage caused by firefighting water
  - Removing the contents of buildings at risk from fire, smoke, heat and water
  - Recovering important records or other key documents
  - Protecting damaged buildings against weather and intrusion and to prevent further loss or damage.

Annex II describes the steps taken at one National Trust property in Cornwall to address the issues and this can serve as a model for properties of any size.

### 7.2 Damage Limitation Planning

The Damage Limitation Plan forms the basis for all the work to be carried out after a fire (or other untoward incident) and should set out in some detail the organisation's response to the emergency. The Plan will include such information as:

- Full address of the premises including Ordnance Survey six figure grid reference and post code



*Illus 56 During the fire illustrated on the previous page, the priceless contents of the library were successfully removed to safety  
© Steve Emery/Oxford Fire and Rescue Service*



*Illus 57 Members of a damage limitation team in action at Schonbrunn Palace, Vienna © Stewart Kidd*

- A brief description of the premises and the use to which they are put
- A sketch plan showing access roads, drives, fire hydrants and such features as main gas valves, water stop valves and electrical switch rooms
- Details of any hazardous materials including fuel tanks and gas cylinders
- Identification of items which are to be removed in an emergency (The 'Snatch List') together with preidentified safe locations to which they will be taken
- Allocation of tasks to employees and others together with home/mobile phone numbers
- Duties of managers and supervisors

- Liaison with the fire and rescue service
- Names and addresses of resources such as contractors, conservation specialists etc.

Skilful utilisation of even restricted resources<sup>23</sup> can make a considerable impact on the extent, cost and impact of fire damage and also ensure that an organisation can recover more quickly from the effects of the fire. In the case of a historic building being run as a business, it is even more important that attention is paid to the need to have a Damage Limitation Plan in place.

<sup>23</sup> Note that most insurers will fully reimburse expenditure incurred in mitigating losses – the only major exception to this will be staff overtime which cannot be added to a claim. The cost of contractors and even temporary manpower however is reimbursable.



*Illus 58 Mobile trolleys at Schonbrunn Palace housing damage limitation equipment and supplies © Stewart Kidd*

More detailed information on this topic and the way in which a business continuity plan (essential for properties open to the public) can be developed will be found in Annex II. The National Trust is currently developing a pilot project to inform the wider process of bringing a more formal approach to bear on this whole subject and the value and benefits of integrating the wider concepts of managing emergencies, damage limitation and business continuity management has already provided tangible benefits in the 2007 floods which affected National Trust properties on the Wiltshire/Oxfordshire borders.

It is also worth noting that insurers are increasingly looking for evidence of a formalised emergency plan and business continuity preparedness when considering whether to provide Business Interruption Insurance. The Association of British Insurers have also funded the development of software<sup>24</sup> which may be helpful in developing a business continuity plan.

<sup>24</sup> Download this at no cost from: <https://robust.riscauthority.co.uk/>



*Illus 59 This category A listed vacant warehouse suffered a serious fire. Dereliction of former industrial areas is a familiar problem and fires in vacant properties within these areas are all too common © Crown Copyright: RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk)*



## 8 SPECIAL PROBLEMS

### 8.1 Consideration for People with Disabilities

The Disability Discrimination Act (DDA) 1995 prohibits employers from treating a disabled person less favourably (because of their disability) than a person who is not disabled. Since 2004, Part III of the DDA has required service providers to make 'reasonable' adjustments to the physical features of their premises to overcome barriers of access for the disabled. Planning Permission or Listed Building Consent may be required for alteration proposals in connection with DDA compliance.

When considering a traditional building an access audit is recommended to identify how access can be addressed in a manner that is also sympathetic to the building's historic fabric. In complying with the DDA, employers and building owners or managers must at the same time ensure that statutory requirements under fire safety legislation to provide adequate means of escape in case of fire for all building occupants are also met. When planning to improve access for the disabled to buildings it is therefore also important to consider their emergency egress at an early stage, bearing in mind that whilst only one route may be required to provide for access, means of escape provision will usually require at least two and often more alternative exit routes.

#### 8.1.1 Evacuation Procedures for People with Disabilities

Employers and property managers are responsible for evacuation of all occupants including those with special needs. Ensuring adequate means of escape for the disabled in case of fire can present problems. The following are some suggestions on how the safe evacuation of people with particular disabilities could be achieved by means of forward planning and the provision of special equipment.

In the case of employees, a thorough risk assessment should include a Personal Evacuation Plan for all those who are in any way subject to a disability (whether permanent or temporary). The assessment will often suggest a solution, for example, a mobility-impaired employee could have their work area relocated to a ground floor space. In the case of visitors or guests more general solutions should be sought:

**Mental Impairments:** Suitably-trained employees should be available to lead and assist people with mental impairments out off the building to a safe location and

to provide the necessary reassurance and supervision needed for the duration of any emergency.

**Impaired Vision:** Consideration should be given to providing brightly illuminated escape routes within the building. Trained employees should be available to lead and assist people with impaired vision out off the building.

**Impaired Hearing:** Consideration should be given to supplementing the audible fire alarm system by providing flashing lights to alert those with hearing-related problems or by providing vibrating pagers or in sleeping accommodation, vibrating pillows and/or high intensity flashing lights.

**Impaired Mobility:** Wheelchair users and those with impaired mobility should normally not be allowed to use lifts in the event of a fire, unless the lifts have been designed and protected in accordance with BS 9999:8 1999 *Fire precautions in the design, construction and use of buildings Code of practice for means of escape for disabled people*.<sup>25</sup> If staircases have to be negotiated, employees who have been suitably trained to carry those who need assistance should be made available specifically for this purpose. It should be borne in mind that some carers may themselves be elderly and relatively frail and may not be able to push wheelchairs up ramps or for long distances over uneven surfaces (such as gravel).

The safe evacuation of people with disabilities is the responsibility of the employer or other person having control of the building and not that of the fire and rescue service. People with impaired mobility should not be directed to remain in refuges awaiting the arrival of the fire and rescue service.

The employer or other responsible person should therefore make the necessary arrangements for the safe evacuation of people with disabilities from refuges. It is important that the location of any individuals who may be in refuge points is known, and communications between them and the member of staff in control of the evacuation maintained until they have been evacuated.

The use of evacuation chairs for mobility impaired staff or visitors should be considered, and staff trained in their use. Advice and information on training for those

25 BS9999 replaces BS5588 *Fire precautions in the design, construction and use of buildings Part 8: 1999: Code of practice for means of escape for disabled people*. BS9999 contains an extended section on means of escape for disabled people to reflect the requirements of the DDA Act and the principles of inclusive design.

who may have to lift or carry disabled people may be obtained from the British Red Cross Society, St Andrews Ambulance Association or the fire and rescue services. If it is felt that there may be specific problems in evacuating disabled people that cannot be resolved locally, it is good practice to consult the fire safety or community safety department of your local fire and rescue service or an organisation such as RADAR (Royal Association for Disability and Rehabilitation).

### **8.1.2 Staff with Special Needs**

Staff who may need assistance in the event of an evacuation should be identified in the building's fire safety plan and appropriate measures put in place to ensure that someone is detailed to provide whatever assistance may be needed. Consideration should be given to the development of a Personal Evacuation Plan and the selection of the most appropriate work location for each affected employee. If special equipment is needed such as an evacuation chair this should be procured and stored near the individual with the necessary training provided for those who have been detailed (or have volunteered) to assist.

All those who need special assistance (including those who may be temporarily incapacitated) should be listed on the evacuation roll so the fire and rescue service can be informed on their arrival. It should be noted that responsibility for making provision for the safe escape of these members of staff rests with property management and their evacuation must not be expected to fall to the fire and rescue service.

### **8.1.3 Organised Parties with Special Needs**

Where visits by organised groups with disabilities are a regular feature at the premises then the need for additional safeguards should form a consideration in the risk assessment and the decisions taken to minimise the risk should be specified in the building's fire safety plan. For example, the number of escorts which will accompany the groups, the need for escorts to be provided with training on the building's escape routes and the way in which the fire alarm operates.

One particular organisation always sends a radio-equipped security officer with such parties while another provides the group leader with an evacuation pager. It is essential that such groups are 'booked in and out' so that all can be accounted for in an emergency.

## **8.2 Buildings Used for Sleeping or Accommodation**

Where a traditional building is being used other than for domestic purposes (ie as family accommodation) fire safety would have to be addressed under Part 3 of the Fire (Scotland) Act 2005 (refer to Part 1, Section 5). Many

traditional buildings are or have been converted for use as hotels, hospitals, hostels, care homes and boarding schools and thus fall under the legislation. At present, all bed and breakfast establishments will therefore have to comply with the requirements of the Act and the Regulations made thereunder, regardless of the number of persons accommodated.

In the past, measures implemented in these buildings with associated sleeping risks, in the interests of fire safety, were sometimes crude and unsympathetic to historic fabric and aesthetic appearance. However, with care and imagination it is usually possible to meet the specific requirements of life safety legislation without major adverse impact to historic fabric.

No structural changes should be implemented in a listed building without first having obtained listed building consent – this applies even where a property owner has been told by a local authority department that such physical changes are necessary to comply with the law or obtain specific licences.

Where overnight accommodation is being provided, special consideration should be given to the needs of disabled people. In hotels or hostels for instance this might include:

- Allocating ground floor rooms to those with mobility problems and providing cards to be hung on room doors to indicate that the occupant may require assistance in an emergency
- Providing additional alarm notification (such as strobe lights or vibrating pillows) in rooms used by the hard of hearing
- Ensuring that night staff (porters, receptionists and security guards) are aware of the rooms used by those who may need additional help
- Providing information to the fire and rescue services on their arrival as to which rooms are occupied by those who are disabled.

### **8.2.1 Buildings used Occasionally for Sleeping ('Sleepovers')**

The following precautions should be observed whenever any traditional building is used for events that involve the provision of ad hoc sleeping accommodation. Such activities often involve providing accommodation for children in properties such as church or village halls, libraries, galleries and museums which are not designed for this purpose. Much of the advice here has been abstracted from guidance prepared for the various church insurers, the National Trusts and the Museums, Libraries and Archives Council (formerly known as Resource). The following is an outline of what needs to be considered:

- A risk assessment should be carried out by a competent person on every occasion it is proposed to use the building for sleepovers.
- There should be at least two routes leading directly from the area to be used for sleeping to the open air or a place of safety.
- If more than 50 persons are to be accommodated the doors on the escape route should, where possible, open in the direction of travel.
- Particular care should be exercised if a sleeping area for large groups is to be elsewhere than on the ground floor. In general, this should not be permitted where the building is not provided with an automatic fire detection and alarm system and emergency lighting.
- Fire orders or instructions (detailing how the fire and rescue services are to be called and the location of the assembly point) must be read out at the beginning of the event and then posted prominently together with a list of the names of those present.
- If there is no fire alarm system then there should be a suitably loud manually-operated alarm (such as a handbell or air horn).
- Exit routes and doors should be provided with temporary signs if these are not already in place.
- The final exit door (ie the door leading to the outside) must not be chained or padlocked while the premises are occupied. If, as is likely in most traditional buildings, the property is not fitted with an approved fire exit device (a 'panic bar' or 'crash bar') then no security fittings other than a simple night-latch ('Yale lock') should be permitted.
- All internal doors and serving hatches etc must be closed at night.
- Portable heaters using oil, paraffin or LPG must not be permitted inside the premises.
- Portable electric heaters with an exposed radiant element should be avoided, but if there is no alternative these must be switched off at night. Where possible, all heaters should be switched off at night.
- Smoking must be prohibited at all times in the premises.
- There must be at least two supervisory personnel in the premises at all times when children or young people are present. If there are more than 50 children sleeping there should be at least three supervisors.
- All supervisory personnel should have received

formal training in what do in the event of a fire and be able to utilise all the fire equipment provided in the premises.

- There should be at least two 9L water extinguishers and a fire blanket present in addition to any other extinguishers provided in the premises. The premises should be equipped with emergency lighting.

### 8.3 Licensing Legislation

Where an historic or traditional building is being used for purposes for which a licence is required, including for example the sale or provision of alcohol, music and dancing, theatrical entertainments, weddings or houses in multiple occupation, the licensing authority will consult a range of bodies including the fire and rescue authority.

Responsibility for enforcement of general fire safety duties in premises subject to such a licence and covered by the Fire (Scotland) Act 2005, lies with the local fire and rescue authority or other enforcement body. Licensing authorities *cannot* impose fire safety requirements where premises are covered by Part 3 of the Fire (Scotland) Act 2005, but where there are deficiencies in fire safety measures, such as numbers present exceeding that which can be evacuated in a reasonable time, the licensing authority can take this information into account and may, if it sees fit, refuse to grant or renew a licence on this basis.

### 8.4 Special Events

The following should be borne in mind and form part of the pre-event discussions with all interested parties:

- Event organisers should be aware that the event may be governed by legislation that would require a licence. Such events include:
  - A public entertainment event, as covered by the Civic Government (Scotland) Act 1982 requiring a public entertainment licence
  - A pyrotechnic or fireworks display, as covered by the same Act, and also requiring a licence
  - An event with the provision and sale of alcohol, covered by the Licensing (Scotland) Act 2005.

A risk assessment<sup>26</sup> must be carried out by a competent person and this should include consideration of the following:

- Number of persons likely to be present. In the case of very large numbers (eg more than 500) the emergency services require to be notified

<sup>26</sup> Even if the premises are in possession of a recent fire risk assessment, a special event is one of the triggers which requires the assessment to be reviewed, updated and amended as necessary.



*Illus 60 A catering function in this historic house visitor attraction brings additional risks*

- Number of supervisory personnel needed to undertake safe evacuation
- Activities which will take place (eg cooking, music and dancing, service of alcohol, fireworks etc)
- Need for additional means of escape (eg extra signs, lighting, additional trained staff)
- Need for additional fire extinguishers
- Power supplies (ie will a generator be used or a wiring extension from a property)

Based on the outcome of the risk assessment, appropriate precautions should be taken.

### **Seating**

If seats are being brought in, care needs to be exercised to ensure that these will not create any additional hazard. The 'medium hazard' grading for upholstered furniture in BS 7176: 1995 *Specification for Resistance to Ignition of Upholstered Furniture for Non Domestic Seating by Testing*

*Composites* can be invoked as a minimum. Aisles and gangways must also be provided in the seating plan to ensure that no one is seated more than 18m from a fire exit.

### **Catering**

If catering is not being provided 'in-house' then it is advisable to maintain a list of caterers whose safety standards are acceptable to the venue and impose this as a contractual requirement on event organisers. Deep fat frying or the use of portable, free-standing gas cylinders inside any buildings or tents should *not* be permitted.

It is the responsibility of the caterer to provide the necessary portable fire extinguishers, fire blankets etc. Fire equipment from the property should not be removed to serve catering locations.

Checks should be made to ensure that the caterer has completed a fire risk assessment for the event and that all catering and waiting staff have been trained in their duties in the event of fire.



*Illus 61 Where erected for visitor events or functions such as weddings, marquees and tents should be subject to inspection*

### ***Pyrotechnics***

Pyrotechnics and fireworks must only be discharged in the open air and only when provided and organised by a competent contractor. The owner or manager of the premises should ask to see the organiser's or contractor's liability insurance details. If the contractor is not known to the owner or manager it may be worth asking for references from other historic buildings where similar displays have been organised. All fireworks should be secured in shipping containers until the day of the event. If additional security is needed to prevent access into the restricted operations area that should be set up around the fireworks firing points, then this requirement should be imposed on the event organiser.

### ***Fabrics, Drapes and Curtains***

Where the event organiser is bringing fabrics into the premises, ensure that these have low combustibility characteristics. Drapes and curtains should, as a minimum meet Class B of BS 5867: 2 2008 *Specification for curtains, drapes and window blinds. Flammability requirements* while floor coverings should have a 'low radius of effect' as defined in BS 5287: 1998 *Specifications for Assessment and Labelling of Floor Coverings Tested to BS 4790*. This latter term refers to the area which can be ignited by an object such as a cigarette end and which will continue to burn even when the source is removed.

### **Tents/Marquees and Air-supported Structures:**

These structures should be subject to the ignitability and flame-spread hazards associated with the use of textiles and plastic materials. In addition, some plastics can produce highly-toxic fumes when subjected to heat. Efforts must be made to ensure that such structures are located at least 10m (but preferably further) from any building and that all are provided with portable fire extinguishers. Smoking should not be permitted inside any temporary structure. The flammability requirement for tented structures is BS 5438, Part 2, and the surface spread of flame requirement is BS 476, Part 7, Class 1.

### **Electricity Supplies and Lighting**

Great care should be exercised in the use of electricity and supplementary lighting. It is likely that in the case of filming, fashion shows etc that the organiser will bring generator trucks or trailers with them. Property owners or managers should satisfy themselves that the generators and their fuel supplies are located in as safe a place as possible and certainly not less than 50m from the nearest building. Cable routes should be agreed in advance and under no circumstances should permission be given to fix cables or wiring to any decorated surface or masonry. Spare fuel for generators or other plant should be stored safely and securely at least 10m from any building and 20m from any tent or marquee. Refuelling must *not* take

place while the equipment is operating. Where possible, double-skinned fuel tanks should be provided for all generators.

### **Smoking**

Smoking is, of course, banned by law inside all non-domestic buildings, tents and marquees and should be restricted within 5m of all buildings and 10m of tents and marquees. Large, sand-filled ashtrays or buckets should be provided at convenient points and these should be cleared regularly.

### **Naked Flames, Candles and Open Fires**

Naked flames should not be permitted inside, or outside within 10m of any buildings except as below:

- Open fires should be permitted only in fireplaces in continuously occupied rooms with recently swept chimneys which are provided with sturdy fire/sparkguards.
- Candles should be permitted only in candlesticks in rooms occupied at all times and not be allowed to burn too far down. Candles must not be incorporated into flower arrangements or displays involving paper decorations, greenery or other combustible materials.
- Naked flames should not be permitted except for filming situations where there is a trained firewatch standing by with a charged fire hose or extinguisher of appropriate type and size.

### **Thatched Buildings**

No naked flames or fire of any sort should be permitted within 25m of a thatched roof.

### **Patrols**

Patrols of areas where any naked flames or heat producing equipment (including film and TV lighting) should be made of all affected areas at the end of the event or activity or at the end of each day to ensure that no equipment has been left 'live' and that all sources of heat have been extinguished. A patrol should be commenced within fifteen minutes of activity ceasing and repeated hourly for at least three hours.

### **Filming**

Film and television crews and those involved in staging fashion shows etc have a poor record of respecting historic fabric and the contents of traditional buildings so they need to be properly managed at all times whilst they are in or near a building. While the fees from such

activities can be a welcome supplement to the income of an historic building, this should not blind the owner or manager to the potential risks.<sup>27</sup> The National Trust for example, require film crews to pay for at least two suitably trained National Trust staff to be on stand-by at all events. These safety crews (wearing high visibility clothing) have the authority to intervene in situations where the building fabric or contents appear to be at risk.

Additional information can be found in the *Practical Fire Safety Guidance for Places of Entertainment and Assembly - Guidance to the Fire (Scotland) Act 2005*.

## **8.5 Empty and Vacant Buildings**

Each year there are around 9000 fires in empty buildings to which the fire and rescue services are called. The Fire Protection Association (FPA) estimates that fires, theft and malicious damage in empty premises (including dwellings) cause losses in excess of £180 million each year. Many of these buildings are of traditional construction or listed or otherwise of historic interest. It has been suggested that each year, more than twenty empty or vacant Scottish buildings of historic value are lost due to fire.

Intruders into empty buildings may have a number of motives:

- They may try to use the premises for commercial purposes
- To squat on a permanent or semi-permanent basis
- For illegal drinking or drug taking
- To strip the premises of anything of value
- To vandalise the premises or burn them down.

The attractiveness of empty buildings to younger intruders as a playground should not be ignored. The potential danger to the intruders themselves, to firefighters and to the occupants of neighbouring buildings must not be overlooked. Even trespassers have certain rights and liability implications for owners and their representatives and can result in potentially significant exposure should anyone be killed or injured or if a fire should spread to nearby premises.

The safety and security of all premises, whether occupied or empty, is a management responsibility and must be subject to the same disciplines as all other aspects of management.

Empty premises in built-up areas and near to town centres create specific problems of security for owners of the premises and their insurers, the owners and occupiers

<sup>27</sup> A useful guide: *Film and Photography for Historic Houses and Gardens* is available from the Historic Houses Association. This covers all aspects of the subject from promoting properties to copyright laws.

of neighbouring premises, the local authority and the users of the town centre. Particular consideration should be given to the impact of:

- Fly posting
- Vandalism
- Graffiti.

These activities and their impact on the appearance of the building or site can begin a spiral of decline (sometimes known as ‘Broken Windows’ or the ‘Slide to Ashes’) which, if unchecked, can drive business away from the area and trigger the beginnings of a run-down of the area to the detriment of the whole community.

Repeated vandalism to buildings such as that caused when stripping out fittings and finishes or starting small fires may result in overall weakening of the structure of the building. Such vandalism is also likely to allow the entry of water which will inevitably give rise to timber decay and structural weaknesses with serious consequences for the safety of firefighters. It is stating the obvious, but none the less valid, to say that the best way to protect a building is to keep it occupied. It is clear from examination of the case studies produced by the FPA that a substantial proportion, probably 35%-40%, of the traditional buildings which are damaged each year can be classified as ‘empty, unused or derelict’ and in most cases, arson (wilful fire raising) is the cause of such fires.

#### 8.5.1 Protecting Vacant Buildings

Care should be taken to ensure that the physical security or safety precautions needed to safeguard empty buildings impact minimally on historic fabric. For example, boarding up must be done sympathetically to avoid fixings damaging original woodwork or glazing. The local planning authority should be consulted to ensure that proposed measures are acceptable and to determine whether listed building or other consents are required.

Maintaining ventilation throughout the building must be taken into account when carrying out such activities since air movement helps arrest mould and fungal decay. Regular checks on roofs, gutters and drains must be undertaken to ensure that the premises are wind and water tight. Guard dogs must not be allowed to run free inside historic buildings with intact contents.

Other steps which will help to minimise both the risks from intrusion and the consequences of a fire include:

- The draining down of all water tanks, pipes and apparatus, except those which may be required for specific purposes such as firefighting.
- Disconnection of all utilities at the incoming main, other than those required for fire and security



*Illus 62 Large complexes of redundant institutional buildings, like this former hospital, present particular security problems. Following a wilful fire raising-related fire, although the masonry external walls remain largely undamaged, the complete loss of the roof structure left the fabric open to accelerated decay*

protection or for other essential services such as security lighting or a controlled heating system. Disconnections should be undertaken in such a way that reconnection is not easily done.

- Immediate removal of all internal and external ignitable material such as furniture, waste, litter, flammable liquids and other non-essential combustible contents abandoned by the former occupants.
- Sealing up of letter flaps or, if impracticable, the rear of the letter box to be fitted with an enclosed metal box bolted in place, plus the frequent removal of any material delivered.
- Immediate disposal from the site of all external sources of fuel, including removal of rubbish and other combustible materials.
- The proper draining and purging of tanks and pressure vessels or pipework containing combustible or explosive liquids or gases and the implementation of approved safety measures to minimise the risk of ignition or explosion from residual vapours.

There are commercial companies who will rent supplementary, high security window and door barriers for vacant buildings and while these measures can prove highly effective, care should be taken to ensure that the fixing arrangements do not harm window or door frames. The use of this type of equipment may also require listed building consent.

More details on the management process including check lists and a full set of recommendations can be found in the *Code of Practice for the Protection of Unoccupied Buildings 2008* which is available from the FPA.

### 8.6 Places of Worship

Places of worship have always featured disproportionately in the UK annual fire statistics and a significant proportion of these fires are set deliberately – perhaps 50% of fires in churches and similar properties are as a result of wilful fire raising. Ecclesiastical buildings are at greater risk of wilful fire raising because of the generally poor levels of security and because many are left open and unattended for long periods of the day.

Useful guidance on fire safety management in places of worship can be obtained from the appropriate insurance company and also from a series of English Heritage publications developed for cathedrals. Chapter 10 of the US National Fire Protection Association's *NFPA 909 Code for the Protection of Cultural Resource Properties* (2005) also provides a useful overview of the subject.

### 8.7 Buildings in Remote Places

The protection of traditional buildings which are physically remote creates special problems. In rural areas of Scotland, firefighting services are usually provided by Retained Firefighters, that is, by part-time fire personnel who are summoned from their homes or other occupation by pagers or radios. In some parts of



*Illus 63 This redundant church in Orkney is lying vulnerable to the threat of fire and with timber floors, ceiling and pews has a high fire loading © Crown Copyright: RCAHMS. Licensor www.rcahms.gov.uk*



Scotland there is extreme difficulty of recruiting such people so fire cover may be provided by volunteers who, even with the best of endeavours, can never be as effective as those whose full-time occupation this is. In those parts of Scotland where the fire and rescue services depend on part time or volunteer personnel it may take hours rather than minutes to mount a major firefighting operation.

While there have been recent efforts to upgrade the levels of fire cover on some of the islands off the west coast of Scotland, it is clear that the fire service as a whole are under pressure from central government to allocate resources to the areas where most fire problems occur – and in Scotland these tend to be deaths in dwellings in urban areas. The impact of Integrated Risk Management Planning (refer to footnote 21, Section 6.2.1), which all fire authorities have been tasked with has resulted in changes in fire cover. It is possible therefore that properties in remote rural areas will not necessarily be able to anticipate levels of fire cover which would see any improvement in response times or weight of attack. When less than ideal levels of fire and rescue services intervention are combined with problems of weather and poor roads, owners or occupiers of remote buildings need to take a serious view of what steps should be taken to protect their buildings, occupants and contents.

The general advice contained throughout this publication will, if followed, greatly reduce the probability of fire occurring and broad compliance with a managed approach to fire safety, when coupled with sensible



*Illus 64 Smailholm tower is hidden deep in the Scottish Borders and is approached via a narrow road. With no hard standing for appliances in the immediate surrounds, the property is only accessible on foot © Crown Copyright: RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk)*

investment in fire protection equipment should result in major improvements in risk levels.

However, it should be accepted that where a property is more than 30min away from a fire station, there is a strong possibility that extensive damage will be done to much of the building and its contents before help arrives. The risk assessment process must factor this in and in some cases the resultant conclusion may suggest that there are really only three credible alternatives if the other measures proposed in this publication have already been implemented:

- Provide an automatic fire suppression system for the building; or
- Set up an estate fire team or local volunteer service; or
- Accept that there is a strong probability that the premises will be lost or seriously damaged should a fire occur.

None of these options is proposed lightly and providing the protection outlined in the first two points will not be cheap but it is difficult to see what else can be done. In the case of the fire team it is possible that some help including the loan of equipment and provision of training may be available from the relevant fire and rescue services at no or low cost.

### **8.8 Buildings that are Periodically Unoccupied**

As was outlined at the beginning of this section, there is a clear connection between empty buildings and higher fire risks. Where buildings are periodically unoccupied, say for more than four weeks, then as an absolute minimum the following should be done:

- Inform insurers (most domestic insurance policies do not provide cover for properties which are left empty for more than 21 to 28 days)
- Fit an automatic fire detection system with a central station connection
- Consider either providing a zoned electrical wiring system so that all but essential electrical supplies can be isolated or fit a residual current device which will automatically isolate mains power if a fault occurs. Advice on this sort of protection should be obtained from a suitably qualified person
- Consider providing an automatic fire suppression system
- Ensure that a strict routine of 'closing the building down' is followed each time it is to be vacated – use a checklist
- Never use portable heaters in an empty building

- If a low level of heating is to be maintained to prevent frost damage, ensure that a competent person regularly inspects the system
- Consider the risks from intrusion by burglars or others – fit an intruder detection system and upgrade general security levels
- Secure all outbuildings especially garages, workshops and fuel stores.

### 8.9 Multi-occupancy Buildings

Many traditional buildings house a variety of different uses under the same roof or in parts of the same complex. Additional risks arise when potentially hazardous activities are mixed with historic fabric and contents.

The problem is aggravated when a building is not in the single control of one owner or occupier. For example, many buildings open to the public incorporate a range of ancillary functions which usually include catering (in the form of a tearoom or restaurant), retail (gift shop) and often accommodation for staff or even letting apartments for the public. In addition, in larger properties there may be workshops. All of these activities tend to increase the possibility of a fire if only because they introduce additional ignition sources. They may also increase the fuel load. Conservation workshops, for example, utilise a wide range of substances, many of which are highly flammable.

Clearly, all of this leads to the conclusion that the risks of and from fire in multi-tenanted and multi-occupied buildings are higher than they would be if the whole property were under a single management. All of this should serve to make it clear that additional care must be exercised in these sorts of circumstances and that for measures to be effective, all parts of a building must be subject to the same standards of fire audit and fire management.

While those who own and manage historic buildings will always welcome any additional income generation, the question of whether the activity to be undertaken creates additional levels of risk for the property should always be considered. Some risks can be managed, some accepted and some insured against but it seems inappropriate to introduce an activity knowing that to do so may result in generation of additional risk which might result in the loss of the building.

### 8.10 Wilful Fire Raising and Security

Arson, which is legally termed *wilful fire raising* in Scotland, is now the single largest cause of fires in non-domestic buildings in Britain and there is a well-established correlation between the size of fires and the likelihood that they have been started deliberately. While wilful fire raising is a crime, the causes are not one but many and this makes it very difficult to provide protection against the consequences.

#### 8.10.1 Preventing Wilful Fire Raising

The only truly effective preventative measure is to keep the arsonists out of the building and while this can be done by judicious application of effective security measures this advice is somewhat academic where properties are open to the public. The following list should be considered as priorities to protect against arson:

- Ensure that the external security features are as effective as they can be
- Minimise the number of entry points
- Ensure that intruder detection systems are fully operational
- Consider automatic fire detection systems
- Consider the benefits of external security lighting
- If a response by staff or others on site is available, consider closed circuit television
- Do not leave ladders, tools and flammable liquids in easily accessible locations
- Secure bin stores and combustible waste
- For premises considered at high risk, fit automatic fire suppression systems.

Annex VI contains advice and checklists on arson prevention issued by the Arson Prevention Bureau.

## CONCLUSIONS

This Practitioner's Guide is being published at a time when stringent economics are the order of the day and when every building is expected to earn its keep. No economic imperatives, however, should be allowed to override our responsibility to future generations to maintain and retain as much of Scotland's traditional and historic buildings as we can.

The good news is that Scotland has learnt from the lessons of the past and that the Scottish Government and local authorities are mindful of the need to provide sensible guidelines for the adaptive reuse of traditional buildings, providing new uses and guaranteeing a future for structures which might otherwise be demolished, abandoned and allowed to decay.

Sympathetic and imaginative reuse should always be an option which is considered when a building is no longer needed for its original, intended purpose. A new use for a building is a building saved from the threat of loss.

This Guide, together with others in the series, has sought to bring together in one place easily accessible, relevant and impartial information which will enable

the practitioner to determine whether the application of well-established conservation principles can permit acceptable forms of alternative compliance. This will ensure that reasonable fire safety standards can be provided in traditional buildings to ensure the safety of occupants and in traditional buildings undergoing conversion.

If there is a single lesson, it is that there is almost always going to be a way in which a traditional building can comply with current fire safety legislation or undergo a change of use whilst still providing broad compliance with the various requirements of Scottish Building Standards. Imagination, creativity and a willingness to seek advice will all assist the practitioner not only in providing a building which is compliant but also one where the risks of fire to the property and its contents can be reduced.

Historic Scotland believes that there is no other publication offering the same range and depth of advice and commends it to those who work with traditional buildings as a unique source of information and advice on fire-related issues.



*Illus 65 Five case studies that illustrate how fire safety can be successfully addressed within traditionally constructed building: Duff House, National Library of Scotland, Corgarff Castle, Buchanan House and Blackburn House*

## PART 3: CASE STUDIES

## CASE STUDY 1: DUFF HOUSE, BANFF

### **Adaptive reuse of a derelict rural property.**

Duff House is a category A listed mid-18th century William Adam mansion in the baroque style, located between the towns of Banff and Macduff. Following a variety of uses and owners, the house lay empty from 1945. In 1990 a decision was taken to find a new use for the building by refurbishing it as an outstation of the National Galleries of Scotland and the new home of more than 180 paintings from the national collections as well as a range of important furniture, carpets and other furnishings. The building was to be jointly administered by the local council, the National Galleries of Scotland and Historic Scotland.

The refurbishment was intended not only to restore the fabric of Duff House to its original condition, but, for the first time in more than a century, to furnish its interior to match the richness of the exterior. Apart from the work

required to bring the building back into use after it had stood empty for more than 50 years, the project also had to consider the protection of the proposed contents of the property against the threats inherent in any gallery or museum.

Initial specialist advice suggested that merely providing the legally required levels of fire protection would not prove adequate to protect the fabric of the building and its contents.

Historic Scotland commissioned a fire risk assessment and this 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 structural problems were compounded by the isolated location of the property with the fire service response time of local appliances estimated at seventeen



*Illus 66 Duff House, Banff. To address the fire safety needs of this property during a conversion to an art gallery, sprinklers were sympathetically installed*

minutes and specialist back-up provision from Aberdeen at 45min. In addition, roads could often be dangerous and difficult to use in the winter months.

The fire risk assessment proposed a programme based on the following, all of which were accepted and implemented:

- Risk reduction and control to minimise the possibility of a fire
- Upgrading of fire barriers to contain fire in the zone of origin for at least 30min
- Upgrading of supplementary escape routes and emergency lighting
- Installation of a fire detection and alarm system which would take account of the aesthetics of the building (with air sampling as a strong recommendation)
- Installation of a dry riser for fire service use
- Installation of portable fire extinguishers
- Provision of a security system which would take into account the risks from wilful fire raising
- Consideration to be given to the benefits of an automatic sprinkler system.

The opening-up, necessitated by total reservicing of the property, afforded the opportunity to simultaneously upgrade compartmentation and install fire suppression and detection systems with less disruption to the building fabric.

Careful thought was given to the size and routes of the pipework to minimise disturbance to the fabric. Full hydraulic calculation was carried out to determine the minimum pipe sizes possible. The sprinkler main traverses the ground floor corridor concealed beneath movable floor slabs. Risers are taken to the attic from which pipework drops to serve individual rooms. The up and over layout overcame the potential problem of driving pipework through thick masonry walls. To further protect the sensitive historic interiors, risers were located in the former service areas of the building with horizontal pipe runs above ground floor level situated as far as possible between joists in the ceiling spaces.

The required supply of water was deemed not to be available from the mains supply, so a 10m<sup>3</sup> storage tank had to be provided. Housing the tank internally was unfeasible, so the tank and associated high pressure pumps and back-up facilities, were installed in a purpose built underground chamber external to the building. This did necessitate some visual features at ground level, such as hatches and vent pipes. The minimum requirement for the risk would normally be a single pump, but in view of the value of the house and contents, the lengthy



*Illus 67 Concealed sprinkler head in the ornate plasterwork in the vestibule ceiling (circle beside the bird's beak) © Ingvál Maxwell*

attendance time of the fire service, and the possibility of an electrical fault, it was also considered essential to provide a diesel engine driven fire pump for standby purposes.

In addition to the automatic sprinkler system an analogue addressable fire detection system, involving a mix of air sampling and point detectors, together with a manual fire alarm call system were installed.

The project provides a useful example of how a properly applied programme of fire safety improvements organised in a systematic basis informed by the fire risk assessment can bring new life to a building, which, given the statistical probability of the fate of many empty buildings, has saved an important piece of Scotland's national heritage and created a valuable local and regional asset and a tourist attraction of some importance.

Success was partly attributable to close liaison between the various parties involved, Aberdeenshire Council, National Galleries of Scotland, Historic Scotland, Grampian Fire and Rescue Service and the consultants. The level of disturbance of fabric caused during the installation of the systems was minimised by paying careful attention to the precise positioning of all the fire system components whether visible or concealed. This has been so successful that in 1998 Duff House was awarded a Europa Nostra Award 'for the nationally important restoration and cultural reuse of a major country house, in particular for the innovative fire protection measures'.

## CASE STUDY 2: NATIONAL LIBRARY OF SCOTLAND: GEORGE IV BRIDGE BUILDING

### **Fire risk improvements compensate for unsatisfactory structural design to guarantee continuing existence of a key part of Scotland's heritage.**

The George IV Bridge National Library of Scotland (NLS) building was purpose-built to house the collections. It is a category B listed building designed by Reginald Fairlie, constructed between 1934 and 1939 and completed in 1950-55. The building has a complex layout comprising three floors above the level of the George IV Bridge and seven below.

The contents of the building have an unique importance. A national library is, at its most fundamental, the repository of a nation's culture, ideals, experience and ethos. In such circumstances conventional approaches to risk management are inappropriate – for example, insurance or other forms of financial risk transfer are irrelevant: how can money replace the last letter written by Mary Queen of Scots hours before she was beheaded,

the Gutenberg Bible or the first book printed in Scotland, or the manuscripts of Robert Burns, Sir Walter Scott or Hugh MacDiarmid? The levels of protection which can be applied to some items of similar value do not apply to a library. Public access is crucial to the importance of the NLS collections – after all, what is the point of preserving the collection if it cannot be examined, looked at or read?

In 1988 the 'ownership' (and therefore the responsibility for managing the building) was transferred from the Crown to the NLS's Board of Trustees. Until then central government was responsible for all aspects of building maintenance, property management and fire safety. The Trustees appointed a Building Manager to carry out the work previously undertaken by the central government and it was revealed that building not only did not have a fire certificate but that previous fire safety improvements had been restricted to basic compliance with life safety provisions of fire regulations.



*Illus 68 The National Library of Scotland installed a sprinkler system to compensate for deficiencies in the fire safety provisions in the property*



An initial risk assessment of the George IV Bridge building was undertaken in 1989. The study made a number of recommendations which included the need to provide a number of structural improvements and the introduction of fire compartmentation. A further detailed survey was undertaken which revealed serious flaws in the design and construction of the building. These can be summarised as:

- Book stack upright supports in the core of the building were found to be supporting intermediate floors
- These intermediate concrete floors supported by the book stack uprights, were only 65mm thick
- A fire in a book stack could reach 1000°C in under three minutes and would result in deformation of steel stack elements
- Any fire would be likely to deform the stacks to the extent that within eight minutes they would collapse, leading to progressive collapse of intermediate concrete floors and the loss of the national collection.

NLS's management acknowledged the serious risks and the fact that even a relatively small fire could result in the loss of a major part of the collections and very significant damage to the building itself.

The studies prepared in respect of both the fire risk and the structural risk made specific recommendations by which to eliminate some hazards. These were acted on rapidly:

- The outdated fire detection system (using bimetallic strip sensors) was replaced by a modern analogue addressable detection system
- Intrusive and potentially hazardous use of stack areas for non-storage purposes (offices and computer room, for example) was prohibited to reduce the risk of ignition
- 'First-aid' firefighting equipment (portable extinguishers) was increased and upgraded
- A programme of staff training in procedures to be taken in the event of fire was implemented.

However, the situation became more complicated when the way in which the fire service would be expected to fight a fire was examined. Satisfactory access ('facilities for the fire and rescue service') for firefighters to tackle a fire at, or near, its source would be hampered by the absence of windows to give access to the stack floors which form the heart of the building. Also, staff offices running across the back of the building created a barrier to the inner core of the building

These features would create an inevitable delay in



*Illus 69 Sprinkler head discreetly integrated into bookshelves in one of the public reference rooms (located towards the top of the bookcase to the centre)*

beginning firefighting operations, thus allowing a fire to grow to the point where serious structural damage would be unavoidable.

After consultation with the fire authority, it was decided to classify the George IV Bridge building as a 'dangerous structure', which in turn meant that great caution would be exercised in committing firefighters to working in the building. The worst-case scenario facing the NLS was that firefighters could only prevent the spread of fire to adjacent properties while the interior and its contents were ravaged by fire.

The NLS was thus faced with the realisation that:

- The physical structure and layout of the George IV Bridge building were 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 as constituted did not comply with contemporary 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.

The discussions that followed looked at two possible alternatives:

- To vacate the building, ie relocate the archive/ storage functions to another site – unrealistic and incompatible with the Library's mission and objectives



*Illus 70 The new north staircase that was constructed to allow a direct fire exit route from the Reading Room and to provide a second stairway*

- Provide protection for the building, its contents and occupants by installing an active firefighting 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 to prevent structural collapse.

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

With an agreed programme and significant funding from the then Scottish Office, work commenced in 1992 and was phased to minimise the impact of the works on the provision of public services.

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. This staircase significantly enhanced the life safety protection for those who work in or visit the library and greatly simplified the way in which firefighters can access this part of the building – with consequential benefits for the protection of the collections and the way in which salvage and damage control can be carried out.

Other incidental benefits from Contract 1 included the creation of additional space at the same level as the Reading Room – now used as the Catalogue Hall. This,



*Illus 71 During the refurbishment, all the collections were kept in situ, but encased in special fire-retardant sheeting © Bill Jackson*

in turn has allowed a complete reorganisation of the layout of services in the Issue Hall, the main point of contact with readers.

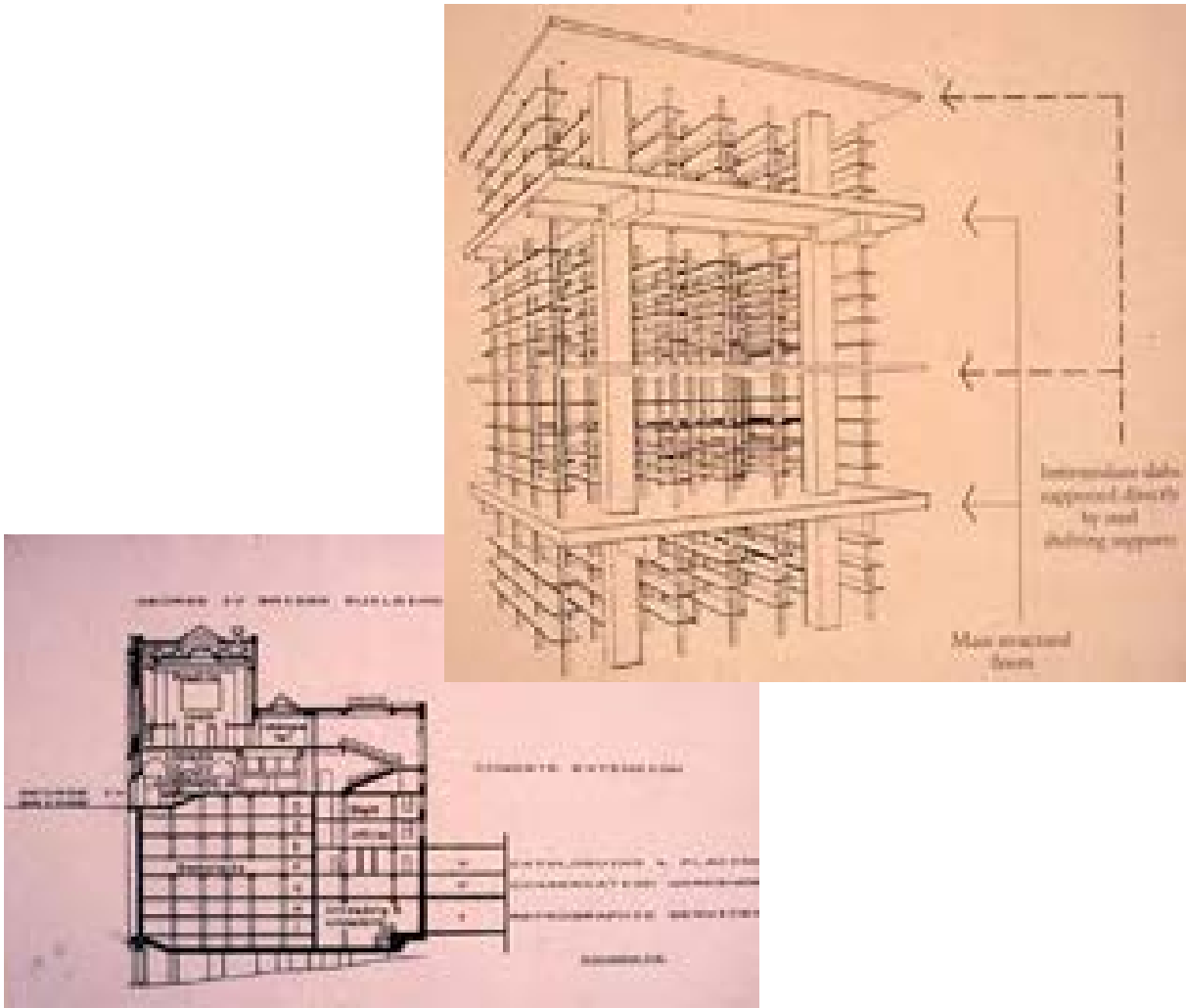
Contract 2 involved installation of a second external fire evacuation staircase running the full height of the building, installation of a sprinkler system on all stack floors and public spaces, and renewal of electrical, heating and ventilation plant and lifts.

Additional benefits provided under Contract 2 included the creation of a new rooftop space (made possible by the relocation of new ventilation plant on the roof itself) giving the opportunity to be fitted out at a later date to extend services to users.

The problems of working on a very complex and restricted site were exacerbated by the NLS's decision to remain open to the public throughout the work programme. The collections therefore had to remain on the stacks and the various contractor trades had to work around them. Given the relatively fragile nature of the collections and the (occasionally) destructive nature of contractor operations, it was decided to cocoon the stacks in a special fire-retardant sheeting in order to protect the books from physical damage and dust from the building works, and to limit the spread of any fire or smoke damage which might take place during the period of the works. The wrapping process had the additional benefit of protecting items in the collection from removal by curious hands.

Leaving the collections in situ was an impediment to the progress of the works, but the huge effort and danger implicit in decanting, transporting and then reinstalling so many items could have added significantly to the cost of the project. Additionally, providing the necessary space for temporary storage would have been both difficult and expensive.

Although disruption to the NLS's public services was significant, every attempt was made to minimise the effects on readers and staff. Wrapping the book stacks had the obvious consequence of making the books unavailable for use. As the rolling programme of sprinkler installations proceeded from floor to floor, readers had



*Illus 72 Sectional drawings of George IV Bridge building, showing the complexity of the site with its sizable subterranean sub-structure*  
 © Bill Jackson

to be kept informed of stack restrictions which made books inaccessible. When work moved to the public areas, the reading rooms and reference stack (some 25,000 items) and the Reference Services Division staff were transferred to the Library's Causewayside building for a period of eighteen months.

The installation of sprinkler systems in a national library is not new (the systems in the British Library and Building 3 of the National Library of Wales both pre-date the work done at the NLS's George IV Bridge building). The NLS project was unique, however, in that a major civil and mechanical engineering project was undertaken in an occupied heritage building which continued to operate during virtually the whole contract period.

The NLS was faced with serious legal and practical problems which had persisted for many years and which were not of its own making. The use of the risk assessment technique to identify and then address these problems has resulted in a building whose layout is more efficient to use than before and in the safeguarding of Scotland's written and printed heritage



*Illus 73 Sprinkler pipes running through the book storage areas (due to the low ceilings, note the protective cages over the sprinkler heads)*

## CASE STUDY 3: CORGARFF CASTLE, BALLATER

**Low cost solution maintains public access and educational use of Scheduled Ancient Monument and compensates for poor access, restricted firefighting resources and lack of firefighting water.**

Corgarff Castle, West Aberdeenshire is a category A listed structure and also a Scheduled Ancient Monument in the care of Historic Scotland. The castle which came into the ownership of the State in 1961, is maintained as a visitor attraction and is open to the public. The property presented a number of problems relating both to fire safety, fire and rescue service access and property protection.

Concerns about the safety of the castle arose in 2005 as a result of an inspection by the Crown Premises unit of Her Majesty's Fire Service Inspectorate for Scotland (now Scottish Fire and Rescue Advisory Unit). A report suggested that the principal risk from fire in the premises related to the means of escape from the upper and lower floors. It was the Inspectorate's conclusion that the single timber staircase, which is effectively, by reason of the

lack of compartmentation, open for its full height, was inadequate as a means of escape from the upper floors.

The Inspectorate also drew attention to several other issues which exacerbated the fire safety issues – there is no year round supply of firefighting water within easy reach of the castle, the access is extremely poor, the site isolated and in winter, roads in the area can be snowbound for weeks at a time. The Crown inspector suggested that an automatic fire suppression system might 'therefore have benefits both in respect of statutory compliance and heritage asset protection'.

A consultant was appointed in 2006 and using as sources of advice Historic Scotland Technical Advices Notes (now superseded by this Guide), the consultant's report concluded that; 'given the hazards implicit in the age and structure of the building, the poor levels of fire separation and the difficult access for fire and rescue service appliances responding to a fire at this location, Corgarff Castle itself in its present condition and use would be best categorised as 'high normal risk.'

When considering the persons likely to be at risk, apart from staff, the report considered that, taking into account



*Illus 74 Corgarff Castle is remotely located in the hills of Strathdon*

the school parties which regularly use the Garret (fifth floor) room for teaching purposes, the level of fire risk in the premises when it is occupied must be classified as 'high'.

In considering how this level of risk could be reduced the report suggested that there were only a limited number of ways in which the levels of hazard (and hence risk) to the occupants can be reduced. The following were discussed:

(a) The primary hazard is the uncontrolled spread of smoke, heat and fire throughout the structure rendering the stairs impassable and trapping visitors or staff on the upper floors.

(b) The conventional approach to risk improvement in this type of building would be to provide a fire-compartmented staircase. This is clearly impractical given the efforts to provide an authentic mid-18th century interior for the structure. Equally, the heritage impact of a ventilation system would be aesthetically unacceptable, and given the thickness of walls, a problem to install.

(c) Other measures (such as the use of intumescent paint or varnish) were not considered to be realistic or indeed to provide any measurable improvement in the levels of fire safety in the building.

(d) The existing fire safety measures such as fire detection; emergency lighting; signs and portable fire extinguishers were satisfactory and reasonable.

(e) The management of fire safety and related aspects such as staff training also appeared satisfactory.

(f) The report concluded that the only viable option to permit the building to remain accessible to the public would be to install an automatic fire suppression system.

The report reviewed all the options available, but concluded that a water-based system should be considered. After discussions with Historic Scotland it was agreed that bids would be invited for either conventional automatic sprinkler protection or water mist systems. (see Table 2)

The site location poses a number of limitations on the systems which might be installed including:

- Very low temperatures in winter (-15°C being not unusual)
- No water supply on site
- Very limited space available for tank and pumps
- Aesthetics of completed system of great importance
- Single phase power supply
- Limited initial intervention by fire and rescue service.

Following a tender it appeared that sprinklers provided a more cost-effective, whole-life solution than water mist.

Water mist	Sprinklers
Uses less water to extinguish fire	Needs more water
Stores 10-30min	Requires 60-90min storage
Higher purity water	Mains or well water is adequate
12mm stainless steel pipe	30mm steel, CPVC plastic or copper pipe
High pressure pumps or gas cylinders	Simple pump
Quartzoid bulb operated	Quartzoid bulb operated
Heads must be visible	Heads can be concealed
Requires specialist servicing 2-3 times yearly	Annual service only
Electronic controls	Simple, mechanical controls
Service life probably < 15 years	Service life probably > 30 years

Table 2 Comparison of suppression systems that was undertaken prior to the decision to use sprinklers

It was accepted from the outset that it might not be possible to install a system which fully complied with *BS EN 12845: Fixed Firefighting Systems. Automatic Sprinkler Systems. Design, Installation and Maintenance (BS EN 12845)* and *Loss Prevention Standard 1048 - Issue 3: Requirements for Certificated Sprinkler Installers, Supervising Bodies and Supervised Installers*, but as there are no specific building standards issues and no insurer involvement there was no need for formal waivers and it was agreed that the system to be installed would be as fully compliant as possible.

The system now in place is provided with 2.9m<sup>3</sup> of water storage. The locally manufactured tank is of some interest, as it had to be installed in a very restricted space. The glass-reinforced plastic sections of the LPCB/WRAS approved tank had to be small enough to pass through a very narrow doorway prior to assembly. The pipework is principally copper with 'pressfit' connections and will be filled with an approved glycol based antifreeze solution after commissioning and testing. External pipework is in medium weight mild steel. The pump room which also contains the tank is provided with background heating as part of the castle's conservation measures.

The pumps and tank are located in the former brew house (a 'lean-to' structure against the main castle) on the ground floor in an area accessible only to staff. The system is fitted with a 50mm main stop valve with full



*Illus 75 The water tanks and pumps were housed in a lean-to out-building, a former brew house*



*Illus 76 Water tank and pumps – the tank was assembled in situ*

test facilities (all test water is re-circulated to minimise the risk of water damage and to conserve water).

While great care has been taken to minimise the visible intrusion of sprinkler heads into visitor spaces, in some places (like the staircase) the yokes and deflectors have, with the consent of the manufacturers, been painted with a water-based paint to further disguise them. The appearance of the finished items is considered to be visually acceptable.

The system is supplied with two 150 l/min duty pumps rated at 3.5 bars.<sup>28</sup> The pump controller was designed to give the option at a future date of being connected to a diesel-powered generator.

It was Historic Scotland's intention that this project should be used to determine the sorts of problems which are likely to be encountered in the installation of sprinklers in this type of historic building. It is now fifteen years since the first significant fire suppression system was installed in Duff House and many lessons were learnt from that project. The most significant factor is almost certainly the level of coordination which has to be imposed on such a project – especially in respect of issues such as pipe runs, penetrations and head locations. At Corgarff there was exceptionally good collaboration between Historic Scotland and the sprinkler installer and

<sup>28</sup> The single phase electrical supply made it impossible to source a single duty pump.



*Illus 77 Concealed sprinklers do not distract from the original Jacobite graffiti on the ceiling of the former barracks room*

this included, for example, penetrations and preparing pipe runs being undertaken by Historic Scotland's own craft workers. Careful review of pipe runs and routes has minimised both fabric disturbance and visual intrusion.

This project is a good example of how a sprinkler system can be installed in an important historic building of some age without significant damage to heritage fabric or visual intrusion. The system, even though constrained by very limited space, poor power supplies and a lack of mains water will provide a key life safety system which will enable all of the building to remain open to the public and to continue to be used for education purposes. At the same time, part of Scotland's built heritage, located in a sparsely populated area with restricted fire and rescue service cover will be provided with round the clock automatic fire suppression which will minimise the impact of any fire which might occur.



*Illus 78 Sprinkler and detection heads and exposed pipework have been painted to blend in with the timber ceiling*

## CASE STUDY 4: BUCHANAN HOUSE, FRASERBURGH

### **Installation of an automatic fire suppression system enabled the premises to overcome life safety compliance difficulties and remain in use.**

Buchanan House is a category B listed property that was built in 1891, originally as St Peter's rectory. In recent years it has been converted to a residential home for the elderly.

Following a visit from Grampian Fire and Rescue Service in March 2005, a concern was raised regarding the fire risk assessment for the premises and the fact that the evacuation procedures did not acknowledge that emergency evacuation is a management responsibility which cannot be delegated to the fire and rescue service. In their response to the owners, Grampian Fire and Rescue Service provided the following observation:

*'One possible solution, which would be acceptable to the Fire Authority, would be the installation of a sprinkler system. The early and automatic intervention of a sprinkler system prevents fire spread and reduces heat and smoke damage likely to result from a fire situation.'*

*In addition to providing protection to property, a sprinkler system will dramatically reduce the life threatening aspect of a fire and will therefore enhance the safety of the occupants within your premises.'*

The owner decided that the additional life safety and property protection offered by a sprinkler system provided the best solution and commissioned a fire engineering company to install a sprinkler system throughout the premises.

### **The Sprinkler Installation**

One of the requirements of the owners during the installation of the system was that the building should continue to operate as a care home throughout the process. Whilst this added to the time taken to complete the project, with individual rooms having to be emptied and reinstated on a daily basis, this was achieved with only minimal disruption to residents and staff.

The system was designed and installed by an experienced



*Illus 79 This category B listed care home is deemed a high risk property due to the nature of the usage © Mike Coull*





*Illus 80 Pendant sprinkler heads, partially obscured by the ceiling beams © Mike Coull*

sprinkler contractor. The wet-pipe sprinkler system was installed to the requirements of residential sprinkler systems as detailed in BS 9251. CPVC pipe work, ranging in size from 40mm to 25mm, feeds a total of 72 sprinkler heads which are located in all rooms, including linen store and all escape routes.

Wherever possible rooms are protected by concealed sprinkler heads with an operating temperature of 74°C and a response time index of < 50. Due to the presence of beams in the lounge and hall, pendant sprinkler heads are used, these are designed to operate at 68°C.

### **Water Supply and Storage**

The sprinkler flow rates are 49 l/min for each sprinkler operating simultaneously up to a maximum of four sprinklers in a single room.

In order to ensure a suitable water supply was available two options were considered, the mains water supply and a pressure tank. Both presented some difficulty with the mains supply requiring some upgrading work to be undertaken whilst installing a 7000L water tank presented storage difficulties in the premises. It was therefore decided to install a new mains connection in order to supply the sprinkler system.

## CASE STUDY 5: BLACKBURN HOUSE, WEST LOTHIAN

**Derelict category A listed property returned to community use by satisfying both Scottish Building Standards and fire and rescue service requirements without serious impact on historic fabric and visual appeal.**

Blackburn House is a category A listed country house located in West Lothian, built by entrepreneur George Moncrieff, a renowned agricultural improver who made his money in the West Indies. The house is of local importance as he was also responsible for founding the neighbouring village of Blackburn. Built circa 1772, this neo-classical Georgian house is two storeys in height (with attic and basement to rear elevation) and is constructed in sandstone, with sash and case windows and a slate roof. The symmetrical frontage has a pedimented centrepiece with a columned porch, whilst the rear elevation has two projecting polygonal bays. The main house is connected by curving walls to two, 2-storey pavilions. With the exceptions of some 19th century alterations, the house is largely unaltered, hence the need to conserve this significant property, whilst finding a permanent use for it.

Following a colourful range of owners, the house had lain derelict for decades, open to the elements, until a local Building Preservation Trust was created to rescue the house; the Blackburn House Trust (which ran until 1994). In 1993 the Trust undertook repairs and by 1994 the property was made wind and watertight and any dry rot was eradicated. In 2003, the Cockburn Conservation Trust (CCT) commissioned a feasibility survey to determine a new use. A centre for creative arts was deemed the best option. With the CCT taking ownership of the house in 2005, a £3.65 million restoration programme got underway that included partnership-funding from the Heritage Lottery Fund, Historic Scotland, West Lothian Council, Scottish Enterprise Edinburgh and Lothians and the European Regional Development Fund.

A range of conservation professionals and historic building specialists oversaw the project. Original plasterwork and panelled doors in the principal ground floor rooms were retained and the exterior was lime rendered. In addressing fire safety, the project undoubtedly benefitted



*Illus 81 This A listed property lay derelict for many years, vulnerable to fire amongst other things*



*Illus 82 Post restoration*



*Illus 83 The highlighted areas show that concealed sprinkler heads do not detract from the delicate ceiling plasterwork*

from the fact that the building was undergoing a complete refurbishment; rewired, replumbed and redecorated and equipped with a lift, detection and suppression systems and conveniences.

In terms of fire safety within the property, the cantilevered timber stair in the centre of the main house was the only means of escape, and consequently to meet the regulations, the installation of new double smoke stop doors was suggested as a solution. Due to the historic significance of the property and the desire to ensure the survival of the original timber panelled doors, this was deemed inappropriate. Following expert evaluation, sprinklers in the ground floor only were accepted by the authorities having jurisdiction as an alternative compromise solution. The sprinklers were to provide life safety protection, rather than property protection, to facilitate safe evacuation. However, as with all life safety fire suppression systems, they provide major benefit for the protection of the property and its contents.

A wet-pipe sprinkler system designed and installed in accordance with *BS EN 12845: 2004 Fixed Fire Fighting Systems: Automatic Sprinkler Systems. Design, Installation and Maintenance* was specified, to be installed by a third party certified installer. Approved CPVC piping was used and laid between floor and ceiling joists, with risers utilising vertical voids, hence minimising disruption to the fabric. The system was fully hydraulically calculated to determine the smallest pipe sizes required, again minimising impact to the structure. Installing a pressurisation unit to increase water pressure also facilitated a reduction in pipe size diameters. Pipe



*Illus 84 As highlighted, an aspirating vent is visually unobtrusive*

diameter ranged from 22mm to 35mm, depending on the number of heads being fed.

In the selection of heads, to take account of the delicate ceiling plasterwork, concealed sprinkler heads were used. In determining the location of the heads, the manufacturer's data sheets were followed even though this conflicted with BS EN 12845 and the authority having jurisdiction consented to this non-compliance.

In terms of detection, an air aspirating system was installed on the principal floor. The air sampling holes in the ornate plaster ceilings are extremely discreet and the control unit hidden from view in a hall cupboard.

This once-threatened building has now been guaranteed a future. Its new lease of life places it in the stewardship of a creative media company who also provide long-term and short-term office space, digital media suites, recording studios, conference and events space, educational and training facilities and as a film location. Blackburn House offers the benefits of up-to-date services such as heating and a fresh interior within a unique, prestigious heritage setting. Overall, the project has ensured that this derelict historic gem will become a focal point of the local community.



*Illus 85 Sampling unit for the aspirating smoke detection system is hidden away in a hall cupboard*

# USEFUL CONTACTS

(AS AT MARCH 2010)

Association of British Insurers, 51 Gresham Street,  
London EC2V 7HQ; Tel 020 7600 3333;  
Fax 020 7696 8999; Email [info@abi.org.uk](mailto:info@abi.org.uk);  
Web <http://www.abi.org.uk>

Association of Fire Safety Consultants, 20 Park Street,  
Princes Risborough, Bucks HP27 9AH;  
Tel 08700 114514; Fax 01844 274002;  
Email [executive@afc.eu.com](mailto:executive@afc.eu.com)

BAFE (British Approvals for Fire Equipment),  
Bridges 2, The Fire Service College, London Road,  
Moreton-in-Marsh, Gloucestershire GL56 0RH;  
Tel 0844 335 0897; Fax 01608 653 359;  
Email [info@bafe.org.uk](mailto:info@bafe.org.uk)

British Automatic Sprinkler Association,  
Richmond House, Broad Street, Ely CB7 4AH;  
Tel 01353 659 187; Fax 01353 666 619;  
Email [info@basa.org.uk](mailto:info@basa.org.uk);  
Web <http://www.basa.org.uk>

British Red Cross, UK Office, 44 Moorfields, London  
EC2Y 9AL; Tel 0844 871 11 11; Fax 020 7562 2000;  
Web <http://www.redcross.org.uk>

British Standards Institution, 389 Chiswick High Road,  
London W4 4AL; Tel 020 8996 9000;  
Fax 020 8996 7400; Web <http://www.bsigroup.co.uk>

Building Research Establishment Ltd, Bucknall's Lane,  
Garston, Watford, Herts WD25 9XX;  
Tel 01923 664 000; Fax 01923 664 910;  
Email [enquiries@bre.co.uk](mailto:enquiries@bre.co.uk); Web <http://www.bre.co.uk>

Chartered Institute of Building Services Engineers,  
Headquarters, 222 Balham High Road, London SW12 9BS;  
Tel 020 8675 5211; Scottish office Tel 0141 419 3000;  
Web [www.cibse.org](http://www.cibse.org)

Communities and Local Government, Eland House,  
Bressenden Place, London SW1E 5DU; Tel 0303 444 0000;  
Email [contactus@communities.gov.uk](mailto:contactus@communities.gov.uk);  
Web <http://www.communities.gov.uk>

English Heritage, 1 Waterhouse Square, 138-142  
Holborn, London EC1N 2ST; Tel 0207 973 3000;  
Fax 0207 973 3001; Web <http://www.english-heritage.org.uk>

Fire Industry Association, Thames House, 29 Thames  
Street, Kingston Upon Thames, Surrey KT1 1PH;  
Tel 020 8549 5855; Fax 020 8547 1564;  
Email [mgregg@fia.uk.com](mailto:mgregg@fia.uk.com); Web <http://www.fia.uk.com>

Fire Protection Association, London Road,  
Moreton-in-Marsh, Gloucestershire GL56 0HR;  
Tel 01608 812 500; Fax 01608 812 501;  
Email [fpa@thefpa.co.uk](mailto:fpa@thefpa.co.uk); Web <http://www.thefpa.co.uk>

The Fire Service College, Moreton-in-Marsh,  
Gloucestershire GL56 0RH; Tel 01608 650 831;  
Fax 01608 651 788; Web <http://fireservicecollege.ac.uk>

Glass and Glazing Federation/Fire Resistant Glass and  
Glazed Systems Association, 44-48 Borough High  
Street, London SE1 1XB; Tel 0870 042 4255;  
Fax 0870 042 4266; Web <http://www.ggf.org.uk>

Guild of Architectural Ironmongers, 8 Stepney Green,  
London E1 3JU; Tel 020 7790 3431;  
Fax 020 7790 8517; Email [info@gai.org.uk](mailto:info@gai.org.uk);  
Web <http://www.gai.org.uk>

Health and Safety Executive, Belford House,  
59 Belford Road, Edinburgh EH4 3UE;  
Tel 0845 345 0055; Fax 0131 247 2121;  
Web <http://www.hse.gov.uk>

Historic Houses Association, 2 Chester Street, London  
SW1X 7BB; Tel 020 7259 5688; Fax 020 7259 5590;  
Email [info@hha.org.uk](mailto:info@hha.org.uk); Web <http://www.hha.org.uk>

Home Office, Direct Communications Unit 2,  
Marsham Street, London SWP 4DF;  
Tel 020 7035 4848; Fax 0207 7035 4745;  
Email [public.enquiries@homeoffice.gsi.gov.uk](mailto:public.enquiries@homeoffice.gsi.gov.uk);  
Web <http://www.homeoffice.gov.uk>

Industry Committee for Emergency Lighting  
(ICEL), Ground Floor, Westminster Tower, 2 Albert  
Embankment, London SE1 7SL; Tel: 020 8677 0718;  
Fax 020 8529 6909; Email: [info@icel.co.uk](mailto:info@icel.co.uk);  
Web <http://www.icel.co.uk>

Institute of Conservation (ICON), Scotland Group,  
22-26 George Street, Edinburgh EH2 2PQ;  
Tel 0131 240 5038; Email [scotland@icon.org.uk](mailto:scotland@icon.org.uk);  
Web <http://www.icon.org.uk>

Institute of Fire Safety Managers,  
270 Bradshaw Meadow, Bradshaw, Bolton, BL2 4NF;  
Email [info@ifsm.org.uk](mailto:info@ifsm.org.uk);  
Web site: <http://www.ifsm.org.uk>

Institution of Fire Engineers, London Road,  
Moreton-in-Marsh, Gloucestershire GL56 0RH;  
Tel 01608 812 580; Fax 01608 812 581;  
Email [info@ife.org.uk](mailto:info@ife.org.uk); Web <http://www.ife.org.uk>

International Council on Monuments & Sites UK,  
70 Cowcross Street, London EC1M 6EJ;  
Tel 020 7566 0031; Fax 020 7566 0045;  
Email [admin@icomos-uk.org](mailto:admin@icomos-uk.org);  
Web <http://www.icomos-uk.org>

Intumescent Fire Seals Association, 20 Park Street,  
Princes Risborough, Bucks HP27 9AH;  
Tel 01844 276 928; Fax 01844 274 002;  
Email [contactus@ifsa.org.uk](mailto:contactus@ifsa.org.uk);  
Web <http://www.ifsa.org.uk>

LPCB/BRE Certification Ltd (part of BRE Global  
Ltd.), Bucknalls Lane, Garston, Herts WD25 9XX;  
Tel 01923 664 100; Web <http://www.redbooklive.com>

Museums, Libraries and Archive Council, Grosvenor  
House – Head Office, 14 Bennetts Hill, Birmingham  
B2 5RS; Tel 0121 345 7300; Fax 0121 345 7303;  
E-mail: [info@mla.gov.uk](mailto:info@mla.gov.uk); Web: <http://www.mla.gov.uk>

National Fire Protection Association, Batterymarch  
Park, Quincy, MA 02169-7471; Tel +1 617 770 3000;  
Fax +1 617 770 0700; Web <http://www.nfpa.org>

National Galleries of Scotland, The Mound, Edinburgh  
EH2 2EL; Tel 0131 624 6200;  
Email [enquiries@nationalgalleries.org](mailto:enquiries@nationalgalleries.org);  
Web <http://www.nationalgalleries.org>

National Library of Scotland, George IV Bridge,  
Edinburgh EH1 1EW; Tel 0131 623 3700;  
Fax 0131 623 3701; Email [enquiries@nls.uk](mailto:enquiries@nls.uk);  
Web <http://www.nls.uk>

National Museums Scotland, Chambers Street,  
Edinburgh EH1 1JF; Tel 0131 225 7534;  
Email [info@nms.ac.uk](mailto:info@nms.ac.uk); Web <http://www.nms.ac.uk>

National Security Inspectorate, Sentinel House,  
5 Reform Road, Maidenhead, Berkshire SL6 8BY;  
Tel 01628 637 512; Fax 01628 773 367;  
Email [nsi@nsi.org.uk](mailto:nsi@nsi.org.uk); Web <http://www.nsi.org.uk>

The National Trust for Scotland, 28 Charlotte Square,  
Edinburgh EH2 4ET; Tel 0844 493 2100;  
Fax 0844 493 2102; Email [information@nts.org.uk](mailto:information@nts.org.uk);  
Web <http://www.nts.org.uk>

RADAR Royal Association for Disability Rights,  
12 City Forum, 250 City Road, London EC1V 8AF

Royal Commission on the Ancient and Historical  
Monuments of Scotland, John Sinclair House,  
16 Bernard Terrace, Edinburgh EH8 9NX;  
Tel 0131 662 1456; Fax 0131 662 1477/1499;  
Email [info@rcahms.gov.uk](mailto:info@rcahms.gov.uk);  
Web <http://www.rcahms.gov.uk>

Royal Incorporation of Architects in Scotland,  
15 Rutland Square, Edinburgh EH1 2BE;  
Tel 0131 229 7545; Fax 0131 228 2188;  
Email [info@rias.org.uk](mailto:info@rias.org.uk); Web <http://www.rias.org.uk>

Royal Institution of Chartered Surveyors Scotland,  
9 Manor Place, Edinburgh EH3 7DN;  
Tel 0131 225 7078; Fax 0131 240 0831;  
Email [scotland@rics.org](mailto:scotland@rics.org);  
Web <http://www.rics.org/scotland>

St Andrews Ambulance Service, National Headquarters,  
St. Andrew's House, 48 Milton Street, Glasgow G4 0HR;  
Tel 0141 332 4031; Fax 0141 332 6582;  
Web <http://www.firstaid.org.uk>

Scottish Building Standards, Scottish Government,  
Denholm House, Almondvale Business Park,  
Livingston EH54 6GA; Tel 01506 600 400;  
Fax 01506 600 401;  
Email [buildingstandards@scotland.gsi.gov.uk](mailto:buildingstandards@scotland.gsi.gov.uk);  
Web <http://www.sbsa.gov.uk>

Scottish Fire and Rescue Advisory Unit, Area 1R,  
St Andrew's House, Regent Road, Edinburgh EH1 3DG;  
Tel 0131 244 3275; Fax 0131 244 2564;  
Email [SFRAU@scotland.gsi.gov.uk](mailto:SFRAU@scotland.gsi.gov.uk);  
Web <http://www.scotland.gov.uk>

Scottish Fire Services College, Main Street, Gullane  
EH31 2HG; Tel 01620 842236;  
Fax 01620 843 045; Email [sfscmail@scotland.gsi.gov.uk](mailto:sfscmail@scotland.gsi.gov.uk);  
Web <http://www.scotland-fireservicecollege.org>

Scottish Government/Riaghaltas na h-Alba,  
Victoria Quay, Edinburgh EH6 6QQ;  
Tel 08457 741 741; Fax 01397 795 001;  
Email [ceu@scotland.gsi.gov.uk](mailto:ceu@scotland.gsi.gov.uk);  
Web <http://www.scotland.gov.uk>

Scottish Sustainable Communities Initiative 2008  
The Scottish Government, SSCI Team Area 2H  
(South), Victoria Quay, Edinburgh EH6 6QQ;  
Tel 0131 244 7466;  
Email [sandy.robinson@scotland.gsi.gov.uk](mailto:sandy.robinson@scotland.gsi.gov.uk);  
Web [www.scotland.gov.uk/Topics/Built-Environment/AandP/Projects/SSCI](http://www.scotland.gov.uk/Topics/Built-Environment/AandP/Projects/SSCI)

Security Institute, 1 The Courtyard, Caldecote,  
Warks CV10 0AS; Tel 08453 707 717;  
Email [info@security-institute.org](mailto:info@security-institute.org);  
Web <http://www.security-institute.org>

Skills for Security, Security House, Barbourne Road,  
Worcester WR1 1RS; Tel 08450 750 111;  
Fax 01905 724 949; Email: [info@skillsforsecurity.org.uk](mailto:info@skillsforsecurity.org.uk);  
Web <http://skillsforsecurity.org.uk>

Sustainable Development Commission, Room 101,  
55 Whitehall, c/o 3-8 Whitehall Place, London SW1A  
2HH; Tel 0300 068 6305; Fax 0300 068 6306;  
Email [enquiries@sd-commission.org.uk](mailto:enquiries@sd-commission.org.uk);  
Web [www.sd-commission.org.uk](http://www.sd-commission.org.uk)

Technical Conservation Group, Historic Scotland,  
Longmore House, Salisbury Place, Edinburgh EH9 1SH;  
Tel 0131 668 8668; Fax 0131 668 8669;  
E-mail: [hs.technicalconservationgroup@scotland.gsi.gov.uk](mailto:hs.technicalconservationgroup@scotland.gsi.gov.uk);  
Web: <http://www.historic-scotland.gov.uk>

Thatching Advisory Services, New Lodge, Conholt  
Park, Andover Harts SP11 9HF; Tel 01264 730433;  
Fax 01264 730832;  
Email [info@thatchingadvisoryservices.co.uk](mailto:info@thatchingadvisoryservices.co.uk);  
Web <http://www.thatchingadvisoryservices.co.uk>

Timber Research and Development Association  
(TRADA), Stocking Lane, Hughenden Valley,  
High Wycombe, Bucks HP14 4ND; Tel 01494 569600;  
Fax 01494 565487; Email [information@trada.co.uk](mailto:information@trada.co.uk);  
Web <http://www.trada.co.uk>

***Scottish Fire and Rescue Services***

Central Scotland Fire and Rescue Service, Main Street,  
Maddiston, Falkirk, FK2 0DG; Tel 01324 716 996;  
Fax 01324 715 353;  
Web <http://www.centralscotlandfire.gov.uk>

Dumfries and Galloway Fire and Rescue Service,  
120-124 Brooms Road, Dumfries, DG1 2DZ;  
Tel 01387 252 222; Email [fireadmin2@dumgal.gov.uk](mailto:fireadmin2@dumgal.gov.uk);  
Web <http://dumgal.gov.uk>

Fife Fire and Rescue Service, Strathore Road,  
Thornton, KY1 4DF; Tel 01592 774 451;  
Email [fife.fire@fife.gov.uk](mailto:fife.fire@fife.gov.uk);  
Web <http://www.fifefire.gov.uk>

Grampian Fire and Rescue Service,  
19 North Anderson Drive, Aberdeen, AB15 6TP;  
Tel: 01224 696 666; Fax 01224 692 224;  
Email [info@grampianfrs.org.uk](mailto:info@grampianfrs.org.uk);  
Web <http://www.grampianfrs.org.uk>

Highlands and Islands Fire and Rescue Service,  
16 Harbour Road, Inverness, IV1 1TB;  
Tel 01463 227 000; Fax 01463 236 979;  
Email [enquiries@hifrs.org](mailto:enquiries@hifrs.org); Web <http://www.hifrs.org/>

Lothian and Borders Fire and Rescue Service,  
76-78 Lauriston Place, Edinburgh, EH3 9DE;  
Tel 0131 228 2401; Fax 0131 228 6662;  
Email [enquiries@lbfire.org.uk](mailto:enquiries@lbfire.org.uk);  
Web <http://www.lothian.fire-uk.org>

Strathclyde Fire and Rescue, Bothwell Road,  
Hamilton, ML3 0EA; Tel 01698 300 999;  
Fax 01698 338 444; Email [opinions@strathclydefire.org](mailto:opinions@strathclydefire.org);  
Web <http://www.strathclydefire.org>

Tayside Fire and Rescue Service, Blackness Road,  
Dundee, DD1 5PA; Tel: 01382 322 222;  
Fax: 01382 200 791; Email [enquiries@taysidefire.gov.uk](mailto:enquiries@taysidefire.gov.uk);  
Web <http://www.taysidefire.gov.uk>

## REFERENCES/BIBLIOGRAPHY

- Adams, Prof. H 1906 *Building construction*, Cassell and Co., London
- Alwinkle et al 1997 Technical Advice Note No.11 *Fire protection measures in Scottish historic buildings*, Historic Scotland, Edinburgh
- Arson Prevention Bureau 1995 *Arson: the major threat to places of worship – and how to prevent it*, Arson Prevention Bureau, London. Available at: [http://www.arsonpreventionbureau.org.uk/viewDocument.aspx?Document\\_ID=499](http://www.arsonpreventionbureau.org.uk/viewDocument.aspx?Document_ID=499)
- Arup Fire, 2006 *Sprinklers for safety; uses and benefits of incorporating sprinklers in buildings and structures*, British Automatic Fire Sprinkler Association
- Bailey, Sir Alan et al 1993 *Fire protection measures for the Royal Palaces*, Department of National Heritage/HMSO, London
- British Automatic Fire Sprinkler Association 2002 *Sprinklers and Heritage (on-line)*, BAFSA, London. Available at <http://www.bafsa.org.uk/pdfs/publications/00000060.pdf>
- Council of Europe *Recommendation 93/9 on the protection of the architectural heritage against natural disasters* (Adopted by the Committee of Ministers to Member States on 23 Nov 1993)
- Croner [no date] *Fire record keeping book*, Croner Publishing, London (loose leaf record keeping system with CD Rom templates)
- Department for Children, Schools and Families 2008 *Standard specification 8: Sprinklers in schools*, DCSE, Nottingham
- Department of Environment (superseded by Department for Environment, Food and Rural Affairs) 1995 *Standard fire precautions for contractors engaged on crown works*, HMSO, London
- Ecclesiastical Insurance Group 1995 *Insurance valuation for church buildings*, EIG, Gloucester
- English Heritage/Royal Institution of Chartered Surveyors 1994 *Insuring your historic building: Houses and commercial buildings*, English Heritage/RICS, London
- English Heritage/Royal Institution of Chartered Surveyors 1994 *Insuring your historic building: Churches and chapels*, English Heritage/RICS, London
- English Heritage, 1997 *The use of intumescent products in historic buildings* English Heritage, London
- English Heritage 1997 *Fire safety management in cathedrals, Fire safety in cathedrals*; leaflet 1, English Heritage, London
- English Heritage 1997 *Prevention of loss or damage by fire in cathedrals, Fire safety in cathedrals*; leaflet 2, English Heritage, London
- English Heritage 1997 *Smoke detections systems for cathedrals, Fire safety in cathedrals*; leaflet 3, English Heritage, London
- English Heritage 1997 *Evacuation of visitors from cathedrals in the event of fire, Fire safety in cathedrals*; leaflet 4, English Heritage, London
- English Heritage 1997 *Timber panelled doors and fire. Upgrading the fire resistance performance of timber panelled doors and frames*, English Heritage, London
- English Heritage, Fire Research Database, on-line facility. <http://www.english-heritage.org.uk/server/show/nav.1108>
- Exova Warringtonfire 1994 *FIRAS – Certification scheme for Contractors installing residential and domestic sprinklers*
- Fire Protection Association 1998 Technical Advice Note No. 14 *The installation of sprinkler systems in historic buildings*, Historic Scotland, Edinburgh
- Fire Protection Association [no date] *Code of Practice for the protection of unoccupied buildings*, Fire Protection Association, London
- Fire Protection Association [no date] *Code of Practice for occupational fire brigades*, Fire Protection Association, London
- Fire Protection Association [no date] *Safety at scenes of fire and related incidents*, Fire Protection Association, London
- Fire Protection Association 2007 *Guide to fire safety signs*, fourth edition, Fire Protection Association, London
- Fire Protection Association 1992 *Fire protection in old buildings and historic town centres*, Fire Protection Association, London
- Fire Protection Association [no date] *Fire workplace fire safety log book*, Fire Protection Association, London



- Fire Protection Association 2009 Technical Bulletin 203 *Loss Prevention Council rules for automatic sprinkler installations – incorporating BS 5306-2*, Fire Protection Association, London
- Fire Protection Association, 2009 *Fire prevention on construction sites - the Joint Code of Practice on the protection from fire of construction sites and buildings undergoing renovation*, seventh edition, FPA/Construction Confederation, London
- Geburtig, Gerd (ed) 2009 *Instanzungspraxis an der herzogin-Anna-Amalie-Bibliothek in Weimar*, Fraunhofer IRB Verlag, Stuttgart (Comprehensive report in German of the November 2007 fire at the Anna Amalie library, Weimar. Includes data on the fire, firefighting, salvage, damage limitation, the impact of the fire on the structure and rebuilding)
- Gomez-Heras, M, McCabe, S, Smith, B.J. and Fort R 2009, *Impacts of fire on stone-built heritage*, Journal of Architectural Conservation, Vol. 15, No. 2, July 2009, pp. 47-58, Donhead publishing
- Historic Scotland 1997 Technical Advice Note 8 *Guide to International Conservation Charters*, Historic Scotland, Edinburgh
- Historic Scotland 1999 *Proceedings of the Conference on Fire protection and the Built heritage*, Historic Scotland, Edinburgh
- Historic Scotland 2001 Technical Advice Note 23: *Non-destructive investigation of standing structures*, Historic Scotland, Edinburgh
- Historic Scotland 2003, Guide for Practitioners 4: *Measured survey and building recording*, Historic Scotland, Edinburgh
- Historic Scotland 2007 Research Report *COST Action C17: Built heritage loss to historic buildings – Final report*, Historic Scotland, Edinburgh
- Historic Scotland 2008 *COST Action C17: Built heritage loss to historic buildings - Conference proceedings parts 1-4*, Historic Scotland, Edinburgh
- Historic Scotland 2009 *Scotland's Historic Environment Policy*, Historic Scotland, Edinburgh
- Holden, P 2004 *Heaven helps those who help themselves: the realities of disaster planning*, Journal of the Society of Archivists, vol. 25, No. 1, 2004, pp. 27-32
- Home Office, Fire Policy Unit, Fire Service Circular 6/1994: *False alarms generated by fire detection systems: Remedial measures*, HMSO, London
- Hudson, N 1995 *Film and photography for historic houses and gardens*, Historic Houses Association, London
- Hughes, P [no date] Information Sheet 10, *Patching old floorboards*, The Society for the Protection of Ancient Buildings, London
- Industry Committee for Emergency Lighting, revised 2008 ICEL 1008: *Emergency lighting – risk assessment guide*, third edition, ICEL, London
- The Institute of Structural Engineers 2009, 3rd edition *Appraisal of Existing Structures*, ISE, London
- Jensen, G 2006 *Hypoxic air venting for protection of heritage – Research report*, Riksantikvaren/Historic Scotland, Oslo
- Jensen, G 2006 *Manual fire extinguishing equipment for protection of heritage – Research report*, Riksantikvaren/Historic Scotland, Oslo
- Jensen, G 2006 *Minimum invasive fire detection for protection of heritage – Research report*, Riksantikvaren/Historic Scotland, Oslo
- Kidd, S 1995 *Heritage under fire. A guide to the protection of historic buildings*, second edition, Fire Protection Association, London
- Kidd, S 2001 Technical Advice Note No. 22 *Fire risk management in historic buildings*, Historic Scotland, Edinburgh
- Kidd, S 2005 Technical Advice Note No.28 *Fire safety management in heritage buildings*, Historic Scotland, Edinburgh
- Lewis, A 1999 *The prevention and control of arson*, FPA/ Loss Prevention Council, London
- Lewis, A & Dailey, W 1999 *Fire risk management in the workplace*, third edition, FPA/Loss Prevention Council, London
- Loss Prevention Certification Board 1996 Loss Prevention Standard 1048 – Issue 3: *Requirements for certificated sprinkler installers, supervising bodies and supervised installers*, Loss Prevention Certification Board
- Munday, J 1994 *Safety at scenes of fire and other incidents*, Fire Protection Association, London

National Fire Protection Association 2010 edition  
NFPA 750: *Standard on water mist fire protection systems*,  
NFPA, Massachusetts

National Fire Protection Association 2010 edition  
NFPA 909: *Code for the protection of cultural resources  
properties – Museums, libraries and places of worship*, NFPA,  
Massachusetts

National Fire Protection Association 2010 edition  
NFPA 914: *Code for fire protection of historic structures*,  
NFPA, Massachusetts

National Fire Protection Association December 2003  
*Special date information package: Structures fires in religious  
and funeral properties*, NFPA, Quincy

Office of the Deputy Prime Minister (now  
Communities and Local Government) 2004 *A guide to  
reducing the number of false alarms from fire detection and  
fire alarm systems*, ODPM, London. Available at [http://  
www.communities.gov.uk/archived/publications/fire/  
guide](http://www.communities.gov.uk/archived/publications/fire/guide)

Property Advisers to the Civil Estate (now superseded  
by the Office of Government Commerce) 1999 *Fire  
Safety Guide*, PACE, London. Available at: [http://  
www.ogc.gov.uk/documents/PACE\\_-\\_FSG.pdf](http://www.ogc.gov.uk/documents/PACE_-_FSG.pdf)

United Nations World Commission on Environmental  
Development 1987 *Brundtland Report – Our common  
future*, Oxford University Press, Oxford

Urquhart D 2007, *Guide for Practitioners 6: Conversion  
of traditional buildings. Application of the Scottish Building  
Standards*, Historic Scotland, Edinburgh

### British Standards

British Standards Institution: [www.bsi-global.com](http://www.bsi-global.com)

BS 476 series: *Fire Tests on building materials and structures*,  
BSI, London

BS 476-3: 2004 *Fire tests on building materials and  
structures, Classification and method of test for external fire  
exposure to roofs*, BSI, London

BS 476-10: 2009 *Fire tests on building materials and  
structures. Guide to the principles*, BSI, London

BS476-22: 1987 *Fire tests on building materials and  
structures. Methods for determination of the fire resistance of  
non-loadbearing elements of construction*, BSI, London

BS 750: 2006 *Specifications for underground fire hydrants*,  
BSI, London

BS 3621: 2007 +A1 2009 *Thief resistant lock assembly*.  
*Key egress*, BSI, London

BS 5266-1: 2005 *Emergency lighting. Code of Practice for  
the emergency lighting of premises*, BSI, London

BS 5266-10: 2008 *Emergency lighting. Guide to the design  
and provision of emergency lighting to reduce the risks from  
hazards in the event of failure of the normal lighting supply*,  
BSI, London

BS 5287: 1998 *Specifications for assessment and labelling of  
floor coverings tested to BS 4790*, BSI, London

BS 5306-0: 1986 – *Guide for the selection of installed  
systems and other fire equipment*, BSI, London.

BS 5306-1: 2006 *Code of Practice for fire extinguishing  
installations and equipment on premises. Hose reels and foam  
inlets*, BSI, London

BS 5306-3: 2009 *Fire extinguishing installations and  
equipment on premises. Commissioning and maintenance of  
portable fire extinguishers. Code of Practice*, BSI, London

BS 5306-4: 2001 *Fire extinguishing installations and  
equipment on premises. Specification for carbon dioxide  
systems*, BSI, London

BS 5306-6: 1989 *Fire extinguishing installations and  
equipment on premises: Foam systems*, BSI, London

BS 5306-8: 2000 *Fire extinguishing installations and  
equipment on premises. Selection and installation of portable  
fire extinguishers. Code of Practice*, BSI, London

BS 5378-2 1980 *Safety signs and colours*, BSI, London

BS 5423: 1987 *Specification for portable fire extinguishers*,  
BSI, London (withdrawn and superseded by BS EN 3)

BS 5499-10: 2006 *Safety signs, including fire safety signs,  
Code of Practice for the use of safety signs, including fire safety  
signs*, BSI, London

BS 5839-1: 2002 + A2: 2008 *Fire detection and fire alarm  
systems for buildings. Code of Practice for system design,  
installation, commissioning and maintenance*, BSI, London

BS 5839-6: 2004 *Fire detection and fire alarm systems  
for buildings. Code of Practice for the design, installation  
and maintenance of fire detection and fire alarm systems in  
dwellings*, BSI, London

BS 5839-8: 2008 *Fire detection and fire alarm systems  
for buildings. Code of Practice for the design, installation,  
commissioning and maintenance of voice alarm systems*, BSI,  
London

BS 5867-2: 2008 *Specification for curtains, drapes and  
window blinds. Flammability requirements. Specification*,  
BSI, London

BS 7176: 2007 *Specification for resistance to ignition of  
upholstered furniture for non- domestic seating by testing  
composites*, BSI, London

BS 7273-1: 2006 *Code of Practice for the operation of fire  
protection measures. Electrical actuation of gaseous total  
flooding extinguishing systems*, BSI, London

- BS 7671: 2008 *Requirements for electrical installations. IEE wiring regulations*, seventeenth edition, BSI/Institution of Electrical Engineers, London
- BS 7827: 1996 *Code of Practice for designing, specifying and operating emergency sound systems at sports venues*, BSI, London
- BS 7974: 2001 *Application of fire safety engineering principles to the design of buildings*, BSI, London
- PD 7974-1:2003 -1 *Application of fire safety engineering principles to the design of buildings*. (There are further parts to this PD (Published Document) series)
- BS PD 7974-6: 2004 *The Application of fire engineering to fire safety design of buildings: Human factors. Life safety strategies: occupants, evacuation, behaviour and condition*, BSI, London
- BS 8214:2008 *Code of Practice for fire door assemblies*, BSI, London
- BS DD 8488 *Fired fire protection systems – Residential and domestic premises*. New standard to be published as a Draft for Development in 2010)
- BS DD 8489 *Fixed fire protection systems –Industrial and commercial watermist systems* (New standard to be published as a Draft for Development in 2010 in five or six parts)
- BS9251: 2005 *Sprinkler systems for residential and domestic occupancies. Code of Practice*. BSI, London (to be reviewed in 2010)
- BS 9990: 2006 *Code of Practice for non-automatic firefighting systems in buildings*, BSI, London
- BS9999: 2008 *Code of Practice for Fire safety in the design, management and use of buildings* (replaces all but part 1 of BS 5588 series *Fire precautions in the design, construction and use of buildings*), BSI, London
- BS EN 3 Parts 1-6: 1996 *Specification for portable fire extinguishers*, BSI, London
- BS EN 3-7: 2004 *Standard for the construction, resistance to pressure and mechanical tests for extinguishers with a maximum allowable pressure equal to or lower than 30 bar selection*, BSI, London
- BS EN 3-9: 2006 *Portable fire extinguishers. Additional requirements to EN 3-7 for pressure resistance of CO<sub>2</sub> extinguishers*, BSI, London
- BS EN 54 series *Fire detection and fire alarm systems*, BSI, London
- BS EN 54-20:2006 *Fire detection and fire alarm systems. Aspirating smoke detectors*, BSI, London
- BS EN 671 series *Fixed firefighting systems. Hose systems*, BSI, London
- BS EN 1363-1:1999 *Fire resistance tests. General requirements*, BSI, London
- BE EN 1568 2008 *Fire extinguishing media: foam*, BSI, London
- BS EN 1634-1: 2008 *Fire resistance and smoke control tests for door, shutter and, openable window assemblies and elements of building hardware. Fire resistance tests for doors, shutters and openable windows*, BSI, London
- BS EN 1838: 1999, BS 5266-7: 1999 *Lighting applications. Emergency lighting* (gives the luminosity requirements for emergency lighting), BSI, London
- BS EN 1869: 1997 *Specification for fire blankets*, BSI, London
- BS EN 1991-1-2: 2002 *Eurocode 1. Actions on structures. General Actions. Actions on Structures exposed to fire*, BSI, London
- BS EN 5839-8: 2008 *Fire detection and fire alarm systems for buildings. Code of Practice for the design, installation, commissioning and maintenance of voice alarm systems*, BSI, London
- BS EN 12094 series *Firefighting systems: Components for gas extinguishing systems*, BSI, London
- BS EN 12845: 2009 + A2: 2009 *Fixed firefighting systems. Automatic sprinkler systems. Design, installation and maintenance*, BSI, London (former standard BS 5306-2 withdrawn)
- BS EN 13501 series + A1: 2009 *Fire classification of construction products and building elements*, BSI, London
- BS EN 13823: 2002 *Reaction to fire tests for building products. Building products excluding floorings exposed to the thermal attack by a single burning item*, BSI, London
- BS EN 14520 *Fixed fire-fighting systems. Components for gas extinguishing systems*, BSI, London
- BS EN 50172: 2004, BS 5266-8: 2004 *Emergency escape lighting systems*, BSI, London
- BS EN 60849: 1998 IEC 60849: 1998 *Sound systems for emergency systems*, BSI, London
- BS ISO 14520 2006 *Gas fire-extinguishing systems – physical properties and system design*, BSI, London
- Draft EN 14972: 2004 *Fixed firefighting systems. Watermist systems. Design and installation*, BSI, London
- DD (Draft for Development) 8458 *Code of Practice. Watermist systems for domestic and residential use*, BSI, London
- DD 8459 *Code of Practice. Watermist systems for commercial and industrial use*, BSI, London
- DD 252: 2002 *Components for residential sprinkler systems. Specification and test methods for residential sprinklers* (Under review, to be re-published as BS 9252: 2010)

**Legislation and supporting documents**

- Building (Scotland) Act 2003
- Building (Scotland) Regulations 2004 and associated Procedural Handbook (2007, updated 2009)
- Civic Government (Scotland) Act 1982
- Civic Government (Scotland) Act 1982 (Licensing of houses in multiple occupation) Amendment Order 2002
- Control of Asbestos at Work Regulations 2002
- Control of Substances Hazardous to Health Regulations 2002
- Construction (Design and Management) Regulations 2007
- Dangerous Substances and Explosive Atmospheres Regulations 2002 ([www.hse.gov.uk/fireandexplosion/dsear.htm](http://www.hse.gov.uk/fireandexplosion/dsear.htm))
- Disability Discrimination Act 1995
- Directive 1999/92/EC of the European Parliament and of the Council of 16 December 1999 on minimum requirements for improving the safety and health protection of workers potentially at risk from explosive atmospheres (15th individual Directive within the meaning of Article 16(1) of Directive 89/391/EEC)
- Electricity at Work Regulations 1989
- Electrical Safety, Quality and Continuity Regulations 2002
- European Community June 1989 Council Directive 89/391/EEC on the introduction of measures to encourage improvements in the safety and health of workers at work (known as the Framework Directive)
- Fire (Scotland) Act 2005
- Fire Safety (Scotland) Regulations 2006
- Gas Safety (Installation and Use) Regulations 1998
- Health and Safety at Work Act 1974
- Health and Safety (Safety Signs and Signals) Regulations 1996 SI No. 341
- Licensing (Scotland) Act 2005
- Management of Health and Safety at Work Regulations 1999 S.I. 1999/3242
- Management of Health and Safety at Work (Amendment) Regulations 2006 S.I. 2006/438
- Planning (Listed Buildings and Conservation Areas) (Scotland) Act 1997
- Scottish Building Standards Technical Handbook for Non-Domestic Buildings, 2009
- Scottish Building Standards Technical Handbook for Domestic Buildings, 2009
- Town and Country Planning (Listed Buildings and Buildings in Conservation Areas) (Amendment) (Scotland) Regulations 2006
- Town and Country Planning (General Permitted Development) (Scotland) Amendment (No.2) Order 2001
- Scottish Government Practical Fire Safety Guidance to the Fire (Scotland) Act 2005 for:
- Care homes (revised 2008)
  - Offices, shops and similar premises (revised 2008)
  - Factories and storage premises (revised 2008)
  - Educational and day care for children premises (revised 2008)
  - Small premises providing sleeping accommodation (revised 2008)
  - Medium and large premises providing accommodation (revised 2008)
  - Transport premises (revised 2008)
  - Places of entertainment and assembly
  - Health care premises
- Nature Conservation (Scotland) Act 2004
- Wildlife and Countryside Act 1981
- Workplace (Health, Safety and Welfare) Regulations 1992

# DEFINITIONS

This section is intended to explain terms used but not fully defined in the text; it does not explain terms used in building and construction. Readers who require help in this area are directed towards Glen Pride's *Dictionary of Scottish Building* (qv).

*aerial appliance*: see high reach appliance.

*AFD*: automatic fire detection system.

*AFSS*: automatic fire suppression system.

*analogue addressable detection system*: a fire detection system where each sensor has a unique identity permitting the exact location of a fire to be indicated and signalled.

*air sampling system*: see smoke aspiration system.

*ARC: alarm receiving centre*: a commercially-operated facility which receives calls from fire detection and security systems and passes these on to the appropriate emergency service.

*arson*: see *wilful fire raising*

*authenticity*: defined as being true in substance. The western concept of authenticity has derived from its historical beginnings to be centred on whether or not the material truly proceeds from its reputed source or author, ie material authenticity. However, in vernacular and eastern traditions, it can be seen that authenticity resides in the tradition of workmanship passed from generation to generation rather than the actual material present at the time, ie authenticity in workmanship. While the debate is ongoing as to the precise meaning of authenticity in each culture, it is recognised as the one quality probably most essential to the value of sites of cultural significance.

*average*: the process by which an insurer may reduce a claim if he feels that the value of the property insured has been wrongly stated.

*BAFSA*: British Automatic Fire Sprinkler Association - trade body for manufacturers and installers of wet fire suppression systems including sprinklers.

*BRE*: Building Research Establishment

*central (alarm receiving) station*: See *ARC*.

*CFOA*: Chief Fire Officers' Association (formerly CACFOA).

*collection*: the books, artefacts, works of art or other items displayed, exhibited, archived or used for study in a museum, library, gallery or similar institution.

*conservation*: action to secure the survival or preservation of buildings, cultural artefacts, or other thing of acknowledged value for the future.

*conservation area*: area of special architectural or historic interest, formally designated and afforded statutory protection under Planning Legislation.

*CPVC*: chlorinated polyvinylchloride: a plastic used for sprinkler pipework.

*cultural significance*: aesthetic, historic, scientific or social value for past, present or future generations.

*damage control vehicle*: a fire service appliance specially equipped with equipment for undertaking damage limitation activities.

*damage limitation*: preparing for and planning to deal with the consequences of fire.

*deductible*: the amount by which a claim is discounted by insurers.

*defensive firefighting*: fighting a fire solely from outside the building so that it does not spread to neighbouring properties.

*developing situation*: the state of a fire when it is not clear if it is surrounded, under control or still growing.

*dook*: a wooden plug inserted into masonry or brick walls as a hold for a nail or screw.

*dry riser*: system of pipework in a building which delivers firefighting water to each floor. Dry risers are pressurised via pumping-in points by the fire and rescue service.

*dry riser inlet*: an external box housing dry riser system couplings into which water can be pumped from a fire brigade appliance.

*EWS*: emergency water supply (usually) open water from which the fire and rescue service can draw water for firefighting.

- fabric*: physical material of which a building or artefact is made.
- flashover*: stage in the development of a fire (especially one contained in a room or compartment) where fire spreads rapidly involving all of the combustible material.
- FLA*: Fire Industry Association trade association formed in 2007 with the merger of the two principal organisations representing the manufacturers and installers of fire detection systems and portable fire extinguishers.
- fire action notice*: see *fire instructions*.
- fire action plan*: an organized set of instructions setting out how the occupants of a building are required to respond if a fire occurs in the premises.
- fire appliance*: general term for a fire service vehicle. Appliances consist of 'water tenders' or 'pumps' which transport 5-7 firefighters together with a high capacity pump and hose as well as a small supply of water. Specialist appliances include turntable ladders, hydraulic platforms and salvage vehicles.
- fire and rescue authority*: a legal entity set up under the Fire (Scotland) Act 2005 responsible for providing fire service cover to a geographical location.
- fire compartment*: a room or other part of a building separated from it by fire-rated construction.
- fire damper*: device for blocking an air duct in the event of fire. Usually operated by activation of a fusible link or electrically by smoke detection.
- fire detection system*: equipment intended to detect and report the presence of a fire through sensors which respond to smoke, flame and other products of combustion and alert the occupants.
- firefighting plan*: that portion of the operational plan which deals with firefighting.
- fire instructions*: a printed list of actions, usually in the form of a red, blue and white notice, to be taken in the event of fire. The notice will specify what staff members are required to do when discovering a fire or on hearing the fire alarm. The method to call the fire and rescue services will also be covered as will any procedures relating to the safety of guests, visitors and others in the premises. Also known as *fire action notice* or *fire procedures*.
- fire procedures*: see *fire instructions*.
- fire protection*: theory and practice of applying technology and management to reducing the probability of loss of life and property in fire.
- fire rated*: description of a product or element of construction designed to withstand the effects of fire for a predetermined period.
- fire retardant*: substance or treatment applied to a material to increase its resistance to fire.
- fire (ring) main*: an arrangement of underground pipework, valves and fire hydrants designed to provide a supply of firefighting water for a property or site. Such systems are usually arranged in the form of a ring or loop around the property to provide continuity of supply even when part of the pipework may be out service.
- fire warden*: employee designated and trained to undertake specified tasks (particularly evacuation of people) should a fire take place (also sometimes known as a fire marshal).
- fire safety log*: record keeping book into which should be entered details of all fire safety activity which takes place in a building. Items recorded should include: training undertaken, fire drills, maintenance of extinguishers, fire detection systems and firefighting equipment, inspections undertaken and visits by the fire service, insurers and others.
- fire safety manual*: permanent record of the fire safety policy, procedures and fire protection equipment for a building or premises. Analogous to the owner's manual for a car.
- FDR1 Form and FDR3 Form*: Fire Data Report forms used by UK fire and rescue services to record fires attended by them.
- FPA*: Fire Protection Association.
- FSC*: Fire Service College, Moreton-in-Marsh, Gloucestershire. See also *SFSC*.
- fuel load*: literally, the potential quantity of combustible material in a defined space.
- fusible link*: a metal component of systems (such as the mechanism of a roller shutter or fire damper (qv)) which will melt at a predetermined temperature to allow a safety component to operate.
- hard standing*: a piece of solid ground, sometimes prepared on which a fire appliance can sit while pumping or carrying out other operations. Essential for high reach appliances.
- heritage building*: any building or structure which has either aesthetic or historical interest or which contains or is used for the storage or display of cultural artefacts.
- high reach appliance*: a fire and rescue services vehicle, such as a turntable ladder or hydraulic platform, used to gain access to upper floors of buildings or to project water on to their roofs.

*hot work*: any activity employing the use of heat or a naked flame or producing heat or sparks undertaken during construction or maintenance work. The term also covers tar boiling, lead work and paint stripping as well as welding, brazing and soldering.

*hot work permit*: a document issued by a responsible person to a tradesman or contractor judged to be competent to permit the performance of a task deemed to be hazardous indicating the conditions under which the work is to be undertaken.

*hypoxic air venting*: an active fire protection measure, using inert air that has reduced oxygen concentration. Also known as air inerting systems.

*Incident Commander*: fire and rescue service officer in charge of the attendance at an incident.

*intumescent paint/paper*: specially treated materials which have the property of expanding or swelling when heated. These materials usually also form a crisp, charred outer coating which helps to prevent fire spread and provides additional resistance to fire.

*LPC*: Loss Prevention Council (no longer in existence, its role having been divided between the FPA (qv) and the BRE (qv)).

*LPCB*: Loss Prevention Certification Board (now part of BRE as LPCB/BRE Certification Ltd.).

*new dimension*: relates to provisions made by equipping the fire and rescue services nationally to deal with the effects of major disasters such as flooding and incidents involving terrorism.

*non-combustible*: not capable of sustaining combustion.

*operational plan*: organisational approach adopted by the fire and rescue service at the scene of a fire. The Operation Plan will cover all aspects of firefighting and rescue activities.

*offensive firefighting*: fighting fire by entering the building involved and fighting the fire at its seat.

*passive fire protection*: any fire protection measure depending on the resistance of materials to fire or products of combustion.

*products of combustion*: flames, heat, gases and solid matter (including residues) emitted by a fire or combustion process.

*protective systems*: any equipment or systems intended to protect a building or its contents from threats such as fire, intrusion, theft and flood.

*pumping-in point*: fitting used to permit the fire and rescue service to deliver water to an internal pipework system such as a dry riser or sprinkler system.

*restoration*: alteration of a building, part of a building or artefact which has decayed, been lost or damaged or is thought to have been inappropriately repaired or altered in the past, the objective of which is to make it conform again to its design or appearance at a previous date.

*retained firefighter*: member of a local authority fire and rescue services who (normally) follows another full-time occupation and responds to fires only when called by radio or pager.

*reversibility*: concept of work to a building, part of a building or artefact being carried out in such a way that it can be reversed at some future time, without any significant damage having been done.

*salvage tender*: see damage control vehicle.

*SBS*: Scottish Building Standards.

*service main*: previously known as the 'towns main' – part of the public water supply system which supplies water to underground fire hydrants for fire and rescue service use.

*SFRU*: Scottish Fire and Rescue Advisory Unit – set up in 2008 and replaces the former Scottish Fire Service Inspectorate. Provides independent advice to Scottish Ministers and Government officials on fire and rescue related activities and works with Chief Fire Officers and their staff.

*SFSC*: Scottish Fire Services College, Gullane, East Lothian.

*smoke aspiration system*: fire detection technique which utilises narrow bore pipes to draw air continuously from protected areas for analysis. The air sample is monitored to detect any particulate matter which would indicate a fire or incipient fire.

*sprinkler head*: mechanical, temperature-sensitive device, fitted to a water supply network which opens at a pre-determined temperature and showers water in a predetermined pattern into a protected area.

*suppression system*: any equipment or mechanism designed to (usually) automatically discharge a firefighting agent (such as water or an inert gas) with the intention of controlling or extinguishing a fire.

*traditional building*: a building constructed of traditional materials using traditional techniques before circa 1919.

*vehicle mounted data system*: electronic equipment in the cab of a fire appliance which provides the crew with information on the properties in their operational area.

*volunteer firefighter*: a firefighter usually attached to a small, geographically-remote fire station such as those found in north west Scotland. Called to fires in the same sort of way as retained firefighters, volunteers generally undergo less comprehensive training than retained firefighters.

*wet riser*: an internal system of pipework that is kept full of water, for use by attending fire crews during an incident.

*wilful fire raising*: the deliberate setting of any fire with intent to damage property or endanger life.

*WRAS*: Water Regulations Approvals Service.



# ANNEXES

## Annex I

### **A summary of some of the key principles from Historic Scotland's Scottish Historic Environment Policy**

1.14 The policy of Scottish Ministers is that:

1.14a Actions taken in respect of Scotland's built heritage should secure its conservation for the benefit and enjoyment of present and future generations;

1.14b There should be a presumption in favour of preservation of individual historic assets and also the pattern of the wider historic environment; no historic asset should be lost or radically changed without adequate consideration of its significance and of all the means available to conserve it;

1.14c Scotland's historic environment should be managed in a sustainable way, recognising that it is a social, economic and environmental resource of great value;

1.14d All of the people of Scotland should be able to enjoy, appreciate, learn from and understand Scotland's historic environment; and be assisted in that through access, research, knowledge, information and education and proactive conservation investment, without compromise to cultural significance.

1.15 The conservation of any part of Scotland's historic environment should:

1.15a be based upon sound knowledge and understanding of the particular site, building, monument or landscape, and of its wider context;

1.15b Be founded on full awareness of and consideration of its cultural significance and all phases of its development;

1.15c Be carried out in accordance with a conservation plan, which brings together all of the information and research necessary to guide the proposed action;

1.15d Ensure that what is to be conserved is properly recorded before and, if necessary, during and after the work;

1.15e Make provision for recording where continued preservation is no longer possible or where loss is taking place through change or ongoing decay, and ensure that all records are retained in readily accessible archives;

1.15f Incur only the minimum degree of intervention considered appropriate by the relevant authority for the type of site, building, monument or landscape;

1.15g Use appropriate technical knowledge, materials, skills and methods of working;

1.15h Have regard to retaining, or where appropriate enhancing, the setting of the site, monument, building or landscape;

1.15i Ensure that where change is proposed, it is appropriate, carefully considered, authoritatively based, properly planned and executed, and (if possible) reversible;

1.15j Include effective arrangements for maintaining the condition and safety of the historic asset and for the delivery of routine maintenance and good housekeeping;

1.15k take account of the rich biodiversity of many historic sites, buildings and landscapes.

1.16 The relevant bodies with responsibilities for any aspect of the historic environment should ensure, as appropriate, that:

1.16a the regimes affording protection to the built environment are fit for purpose;

1.16b Effective use is made of the statutory provision available to protect the historic environment.

1.16c The historic is afforded due respect in all their activities

1.16d The highest standards are set for, and applied to, the broad range of conservation principles;

1.16e Appropriate and effective systems are established for monitoring and recording the condition of the historic environment;

1.16f Suitable knowledge, skills, materials and technologies are available to enable conservation

and management to be carried out in ways that safeguard the intrinsic archaeological, architectural, historical, physical and cultural significance of the heritage;

1.16g Support, advice, encouragement and clear and comprehensive guidance, are readily available to all whose activities have an impact upon the repair, maintenance, management, protection and conservation of the historic environment;

1.16h Training and education to enhance the quality of conservation practice and actions are widely available;

1.16i They work in partnership where there are shared interests.

## Annex II

### Damage Limitation Planning and Training at Lanhydrock House, Cornwall

As curators there is little we fear more than the destructive force of fire or flood. It is crucial therefore that an effective disaster strategy is adapted, not as a belated reaction to past tragic losses, but, as an essential part of the property's fire risk assessment and management plan. Such a strategy need not be complex or costly; rather it needs to be, in essence, user friendly and, in practice, attainable.

This case study draws on the experiences of one of the National Trust's flagship properties, Lanhydrock House in Cornwall. Curiously, despite being a 17th century house, its popularity is based around the high-Victorian heritage, namely sound moral planning, arts and crafts decorative features and country house technology – all features that were installed after a fire severely damaged the mansion in 1881.

Lord Robartes' specification to his architect Richard Coad was to sympathetically restore the house to its former glory giving some emphasis onto new technologies. Coad, a man well versed in fire protection in buildings – a skill he had developed while chief assistant for Sir George Gilbert Scott, eliminated, as much as possible, the use of combustibles within the fabric and installed steel framing for the walls and roof and introduced 12 inch thick re-enforced concrete ceilings with patent fireproof plaster. Lord Robartes added that neither gas nor electricity were to be installed into his new home, instead a lamp room was incorporated into the structure where paraffin lamps were filled and primed! Perhaps mindful of this risk an estate fire engine was purchased and a complex fire hydrant system was installed; gravity fed to interior and exterior hydrants from a 200,000 gallon reservoir positioned in the high garden.

Unfortunately, the Victorians were not so advanced on notions of vertical and horizontal fire compartmentalisation or protected staircases – although considering its use as a family home such design features would have been considered superfluous to needs. Consequently, over the past twenty years, the National Trust has invested heavily to create a safe working environment and visitor attraction being sensitive to the restrictions of our Grade 1 listed status.

Lanhydrock, like many heritage attractions, developed a fire strategy in the wake of fires at Hampton Court and Uppark in Hampshire. Taking its responsibility very seriously the National Trust published two guidance documents: *Fire Precautions at Historic Buildings* and *Emergency Procedures in Historic Buildings*. From these documents pioneering work, led by Mr Ken Golding,

ensured that Lanhydrock House was at the forefront of developing a disaster plan. Working alongside the Cornwall Fire Service the automatic fire detection system was upgraded, changes to the vertical and horizontal fire compartments were implemented and a fire salvage plan developed.

To test these systems emergency exercises were held in 1990 and 1998 which gave all interested parties the opportunity to reflect and review the processes and logistics involved. Subject to debriefing by both the fire service and senior National Trust officials some changes were recommended which led to a revision of the plan and to a further exercise in February 2003. This new plan was based around two major initiatives – active and reactive measures.

### ***Active Measures***

Active measures constitute fire prevention and early warning – elements that are essential to support the progression of any disaster plan. Sound risk assessment is the first stage in identifying failures or inadequacies in building design or potential systematic failure. Although good housekeeping will ensure that servicing regimes are met for the more specialist areas such as ensuring the reliability of fire compartments, assessing the safety of high risk areas such as boiler rooms, lift motor rooms etc or guaranteeing the operation of water supply and emergency lighting, require more specialist assessment and can be easily monitored through bi-yearly fire checks. Establishing annual contracts and forging good relations with electrical and electronic maintenance contracts, alarm companies, fire extinguisher and chimney sweeping contractors will ensure that vital components of the fire risk assessment are smoothly met. Furthermore, we operate strict policies on limiting all hot works to beyond 6m of the building and administer management systems for the control of all fire doors and shutters.

Early warning fire detection systems backed up with remote monitoring, emergency lighting and key-holder contacts are vital in raising an early alarm. Remote pager interfaces can help with safe evacuation and provide information for the property contact to relay onto the fire service on arrival. Access to the building through effective key management and a sound knowledge of your site can only help the operation.

### ***Reactive Measures***

For this case study some operational factors need to be taken into consideration. Lanhydrock House has 52 rooms accessible to visitors with a further 50 rooms used for operational needs eg offices, restaurants, shop and storage. The visitor route extends marginally beyond a quarter of a mile where a collection of 16,000 items can be viewed. Amongst the collections are

7000 books – 3000 of which constitute an important library in the National Trust – plus irreplaceable family archives, ceramics, furniture, paintings and photographs. The building is E-shaped which benefits the salvage operations with three well-defined wings.

The aim of our disaster plan is to create a logical system of accountability, limit damage caused to the fabric and collections and plan for effective salvage. To achieve this we have worked very closely with the fire service, National Trust advisors and specialist service providers. In all aspects of our strategy rapid and practiced response remains a vital component to its success. Once the automatic fire system is activated a duty manager is called to the property. If fire is confirmed a back-up 999 call is made to the emergency services and a telephone tree, held by a third-party security company, is triggered. This will activate staff, volunteers, utility companies and specialists to the site who, on arrival, will park and sign-in at a central predetermined outbuilding (in our case a centrally positioned Gatehouse). From here task cards and equipment can be issued in order to set up three main site functions; first, a command and control function to control and be accountable for site entry; second, three salvage teams ready to enter the building with fire service approval and third, a series of peripheral functions such as site and perimeter security, first-aid and quartermaster. It is an important part of this plan to avoid the allocation of pre-determined roles as there can be no guarantee that particular members of staff or specialists will arrive. Once the salvage teams have been formed they will be issued with essential tools, safety equipment and salvage cards that indicate what items need to be removed from the property. These cards have tiered levels of the collections broken down into primary, secondary and desired salvage. Once kitted out the teams will remain self-contained within an outbuilding to await fire service instruction.

### ***2003 Exercise***

Our exercise was held in real-time at night. Therefore no staff were on site when the alarm was activated and we had set times when fire spread to new compartments resulting in evacuation to within two fire doors. The exercise was designed to fully test the fire service (both retained and part-time) and to see how National Trust staff could support the salvage operation. We also built-in lessons learnt from previous exercises such as reducing the amount of radio traffic by deploying runners to relay messages; permanently removing the senior National Trust representative to brief the fire service at incident control and removing all unwanted personnel from the site thereby making systems of transfer easier. To this end the plan worked well and salvage teams entered the property and were successful in decanting or salvaging important collections to safe areas.

### **Training**

Prior to the 2003 exercise a full brief was written and training for house staff and fire service was undertaken. For the exercise itself the issue of task cards, introducing simple tasks in a written format, alleviated the need for excessive one-to-one training. Once early communication was established between the fire service and National Trust staff the exercise ran smoothly with 27 National Trust operatives called to the site from the telephone tree within one hour. Command and control was easily set up within fifteen minutes, the issuing of equipment, task cards and keys worked well and the salvage operation itself saw three teams entering the house and removing the main priority items within 90 minutes.

Staff turnover and operational changes make training crucial in order to maintain the integrity of the plan. Our reciprocal relationship with the Cornwall fire service has remained strong. They introduce new watch members to our property, walk the routes, check the key-holdings, familiarise themselves with the salvage plans and update their Tactical Fire Plan while we, in turn, help with their training needs by offering the property for rope exercises, setting-up and operating specialist appliances and tunnel rescues. For National Trust duty managers we run quarterly training on all aspects of the property that interact with fire safety: alarms, evacuation, gas, heating systems, key-holdings, roof access and tunnel access. As requested on our fire risk assessment all training is recorded in the fire log. For staff a yearly refresher on the plan is delivered at team briefs and conservation staff will receive in-house training on caring for and packing of historic items. We hold on - and off-site materials and containers for packing as well as full collection inventories.

Another major influence on our plan is a regular review. Full debriefs were given after the 2003 exercise which has helped us make adjustments where necessary. One consequence was to supplement our hydrant water supply by developing methods of pumping water from the River Fowey, one mile away, through to an eight-headed manifold. Changes in operations or physical building change also need to be reviewed. Actions resulting from our most recent fire risk assessment will see us strengthening the vertical and horizontal lines of compartments throughout the property and extending the automatic fire detections systems to areas affected by a recent electrical rewiring project. The adjoining church is also in the process of being interfaced into our systems and plans.

### **Conclusion**

Lanhydrock regularly attracts in excess of 200,000 visitors each year making us one of the most popular heritage attractions in the country. The Agar-Robartes family bequeathed the property to The National Trust in 1953 and it is our mission to protect the property and its significant collection in perpetuity for the nation. Those with a duty of care for historic properties and collections must realise that the effectiveness of any disaster plan will rely on the amount of effort put into its preparation. It is a perilous task to forage into the unknown world of endless logistics and permutations, particularly in our hope that such a strategy will never be deployed; nevertheless it is an absolutely crucial professional duty.

*This text is based on an article by Paul Holden: 'Heaven helps those who help themselves: the realities of disaster planning' published in Journal of the Society of Archivists, vol.25, No.1, 2004, pp.27-32.*

*Paul Holden, MA, is House and Collections Manager for the National Trust at Lanhydrock House in Cornwall.*

**Annex III**

**Example of a Fire Safety Log Book (based on material produced by the National Trust and the National Trust for Scotland)**

---

# Fire Safety Log Book

---

**Premises Name:** .....

**Date (From):** .....

**Date (To):** .....

**Address of Premises:** .....

.....

.....

**Location of Log Book:** .....

1

## **CONTENTS OF LOG BOOK**

Useful Contacts	(3)
Fire Safety Advice	(4)
Visit by Fire Service Officer	(7)
Record of Contractors Attendance	(8)
Details of Fire Wardens & Fire Marshalls	(9)
Fire Alarm System	(10)
Fire Fighting Equipment	(12)
Emergency Lighting System	(14)
Fire Training/Instructions	(16)
Fire Drills	(18)

## **USEFUL CONTACTS**

**FOR FIRE SAFETY ADVICE CONTACT:**

**IN EMERGENCY DIAL 999**

Name of Property:  
Address  
Post Code  
OS Grid  
Reference:

## **FIRE SAFETY ADVICE**

The advice given below is intended to assist you and your staff in preventing an outbreak of fire, or if a fire does occur, assist you in preventing injury and unnecessary damage to your premises.

### **What To Do In Case Of Fire.**

On the sounding of the fire alarm, the building must be evacuated following the prepared evacuation plan.

When leaving the building do everything possible to reduce draughts which may fan the fire. If possible close all windows and doors.

Ensure that the fire service is called immediately and that a responsible person is designated to meet the fire appliance when it arrives.

**DO NOT** re-enter the building for any reason.

### **Means of Escape**

- ∞ Fire doors are provided to prevent the spread of smoke and heat. Keep them shut when not in use and never prop them open or remove self-closing devices.
- ∞ Keep corridors and stairways clear of storage and waste material.
- ∞ Ensure that final exit doors can be readily opened from the inside without the use of a key.
- ∞ Keep areas outside of final exit doors clear of obstruction at all times.
- ∞ Always ensure that exits and access thereto, which are not in normal use, are clearly indicated, with the exit signs visible from the furthest part of a room.

### **Fire Alarm**

Always ensure that the fire alarm system is in working order, that the staff know how to use it and what action to take on hearing the alarm.

### **Fire Extinguishers / Hosereels**

These are intended for fires in the early stages. Ensure that all staff know where the extinguishers are sited and how to operate them safely.

Always ensure that they are inspected and maintained regularly.

### **Emergency and General lighting.**

Ensure that all lighting systems are checked and maintained regularly. Replace any defective bulbs/tubes/components immediately.



### **Instructions to Staff and Guests**

Ensure that all staff are aware of their responsibilities in the event of an emergency. Ensure that they: -

- ∞ Know how to raise the alarm
- ∞ Know how to call the fire service
- ∞ Know when not to tackle a fire
- ∞ Know how to use a fire extinguisher correctly and safely
- ∞ Know the correct evacuation procedures for the premises
- ∞ Are aware of the contents of the Fire Risk Assessment.

### **Electrical installations**

The misuse of electricity is a major cause of fire. Old wiring should be regularly checked and renewed if necessary. You may need another ring circuit to cope with the increasing number of electrical appliances you want to use.

Ensure that you always use the correct fuse. Before you go to bed or leave the building pull out the plugs of all appliances not in use.

Space around electrical intakes should not be used as extra storerooms.

### **Heating**

Keep boiler houses clear – do not use them as an extra storeroom.

Keep portable heating appliances away from furniture, curtains and any other combustible materials. It is the organisation's policy to only use oil-filled thermostatic radiators as portable heating appliances. Convection heaters are only permitted when wall-mounted and used as part of a 'white meter' heating system. Fan heaters should not be used in any circumstances.

### **Open Fires**

Do not use flammable liquids to start fires. Always keep them securely guarded.

Sweep chimneys twice per year, more if wood is burnt. Ensure that hearthstones and chimney linings are checked by a competent person on a similar frequency.

### **Smoking Materials**

- ∞ Wherever possible, prohibit smoking in all buildings. Be vigilant in areas where people smoke and provide adequate ashtrays.
- ∞ Before leaving rooms which will be unoccupied for long periods, or in which persons will be sleeping, make a final check for any lighted cigarette ends. These may have fallen into the recess of an armchair, on the carpet or on the bedclothes when some one fell asleep.
- ∞ Empty all ashtrays into a metal bin and take outside.
- ∞ Never permit smoking in store rooms.

## Visitors

Ensure that all visitors to the premises are aware of the actions to take in the event of an emergency.

Premises which accommodate foreign visitors should have their fire instruction notices printed in the appropriate language.

## Be Aware Of Common Fire Causes

- ∞ **Electricity:** It is a source of heat and ignition. All installations and appliances must be inspected and maintained regularly to identify potential faults, overloading etc. Faults should be repaired immediately by a competent electrician. Switch off appliances after use.
- ∞ **Rubbish:** Get rubbish out of the premises and into bins with lids as quickly and as often as possible.
- ∞ **Smoking:** A very frequent fire starter. NTS operate a no smoking policy throughout all its buildings, and this must be adhered to at all times.
- ∞ **Heaters:** Portable heaters start fires if not placed carefully and used wisely. It is the organisation's policy to allow only oil-filled thermostatic portable heaters. Convection heaters can only be used when wall-mounted and properly guarded, and portable fan heaters are prohibited.
- ∞ **Dangerous Goods:** For example, paints, varnishes, heating fuel are either flammable or explosive. Keep them all well away from any source of heat. The careful use and storage of any flammable liquid is essential to maintain a safe working environment.
- ∞ **Arson:** Help to protect your premises from the arsonist by locking away any flammable liquids or gases. Effectively secure your premises at the end of the day including any out of the way doors or windows that are easily missed.

## Fire and Rescue Service

Keep a record of all inspections/visits from the Fire & Rescue Service and ensure any recommendations/comments are acted upon as soon as possible.

## Contractors

Keep a record of all contractors attendance on site including a brief description of the works carried out and its location.

## Fire Wardens & Fire Marshalls

Fire Wardens – designate members of staff to check & record the condition of fire extinguishers, availability of escape routes, etc.

Fire Marshalls - designate members of staff who in an emergency will have responsibility to ensure their designated area is clear of all persons.

**VISIT BY FIRE & RESCUE SERVICE OFFICER,  
INSURER OR FIRE CONSULTANT**

Date	Inspecting Officer	Comments

**RECORD OF CONTRACTORS ATTENDANCE**

Date	Name & Company	Reason for Visit	Location	Time In	Time Out

### APPOINTMENT AND TRAINING OF FIRE WARDENS

Date	Name	Role	Location	Date of Training

### OTHER FIRE TRAINING

	Name	Role	Location	Date of Training

## **FIRE ALARM SYSTEM**

### **Fire Alarm**

It is important that the operation of testing the alarm does not result in an unwanted fire signal being received by the Fire Service.

- ∞ Inspect the panel daily for normal operation of the system. Where provided, check that the connection to the remote staffed centre is functioning correctly.
- ∞ Test and inspect the alarm weekly to ensure that the system is capable of operating under alarm conditions, namely: -
  - a. Operate the trigger device (manual call point or detector) or end of line switch on a zone circuit. Zones should be tested in strict rotation, each zone being tested at least quarterly for a monitored system and weekly for an unmonitored system. Each time a zone is tested a different trigger device should be used.
  - b. Examine batteries and connections, including electrolyte level.
- ∞ Quarterly and annual inspection and test. To be done by the installer/maintenance contractor.

### **Fire Detectors**

- ∞ Regularly inspect detectors for damage, unusual accumulations of dirt, heavy coats of paint and other conditions likely to interfere with the correct operation of the detector.
- ∞ All detectors should be checked for correct operation and sensitivity in accordance with manufacturer's instructions.

### **Automatic Door Releases activated by the Fire Alarm System.**

- ∞ These tests should be carried out weekly in conjunction with the fire alarm test; [check that all doors are being released and closing fully onto the door rebates.]

**FIRE ALARM TEST RECORD**

<b>Date</b>	<b>Fire Alarm Call Point or Detector Location or Number</b>	<b>Details of Fault</b>	<b>Remedial Action Taken</b>	<b>Date Fault Cleared</b>	<b>Signature &amp; Company</b>

## FIRE FIGHTING EQUIPMENT

### Portable Fire Extinguishers

#### Weekly inspection: -

Weekly inspection of all extinguishers, spare gas cartridges and replacement charges to be carried out.

This is to make sure that the appliances are in their proper position and have not been discharged, or lost pressure (in the case of extinguishers fitted with a pressure indicator), or suffered obvious damage.

Any extinguisher not available for use to be replaced.

#### Annual inspection, service and maintenance: -

Extinguishers, gas cartridges and replacement charges are inspected, serviced and maintained as recommended in current British Standards.

Currently Messrs Fife Fire carry out an annual service.

#### Intervals of Discharge: -

The recommended times, in each case since the date of manufacture or the last actual discharge (test or otherwise) of the particular extinguisher body (see note below) are as follows: -

Extinguisher Type	Intervals of Discharge
Water	Every 5 Years
Foam (All Types)	Every 5 Years
Powder (gas Cartridge)	Every 5 Years
Powder (Stored Pressure – Valve operated)	Every 5 Years
Powder (Stored pressure – Primary sealed) Carbon Dioxide (all Types)	Every 10 Years and subsequently after a further 10 years and thereafter at intervals not exceeding 5 years.

### Hose Reels

Weekly inspected for leaks and correct operation.

Annually - the hose is to be completely run out and subjected to operational water pressure to ensure that it is in good condition and that all couplings are water tight. A flow test should be carried out to ensure that a discharge of at least 30 L/min is achieved.

### FIRE FIGHTING EQUIPMENT – RECORD OF TESTS

Date	Result of inspection or test Satisfactory / Faulty	Equipment Location or ID no/ref	Remedial Action Taken	Date Fault Rectified	Signature & Company



## **EMERGENCY LIGHTING SYSTEM**

Due to the possibility of a failure of the normal lighting supply occurring shortly after a period of testing of the emergency lighting system or during the subsequent recharge period, all tests should whenever possible be undertaken at time of minimum risk

### **System Powered from a Central Source**

Twice a year the system should be tested by simulation of a failure of the normal lighting supply for a continuous period of at least one hour.

During this period all luminaries and/or signs should be checked for correct operation.

At the end of the test period the system should be restored to normal operation and the charging arrangements checked to ensure correct operation.

For systems with specified duration categories in excess of one hour, it is recommended that a test for the full duration should be carried out every three years, or at the discretion of the enforcing authority.

### **Self-Contained System (ie battery pack within individual units)**

Monthly - each self-contained unit and internally illuminated exit sign should be energised from its battery by simulation of a failure of the supply to the normal lighting for a period sufficient only to ensure each lamp is illuminated.

Six-Monthly - each 3 hour self-contained unit or exit sign should be energised from its battery for a continuous period of one hour by simulation of a failure of the supply to the normal lighting. If the unit is rated as 1hour then the period of simulated failure should be 15min.

Three Yearly - each self-contained unit or exit sign should be tested for its full duration.

Subsequent Annual Test - after the first three-yearly test each unit or exit sign should receive this test annually, or at the discretion of the enforcing authority.

### **General**

All systems – daily check that all maintained (ie those that are constantly illuminated) are illuminated & the control panel indicates normal.

**EMERGENCY LIGHTING SYSTEM – RECORD OF TESTS**

<b>Date</b>	<b>Duration of test</b>	<b>Result of Test</b>	<b>Fault (Specify)</b>	<b>Date Fault Cleared</b>	<b>Signature &amp; Company</b>

## **FIRE TRAINING/INSTRUCTIONS**

### **Fire Instructions**

At the intervals (not exceeding those indicated below) instructions/training should be given to employees in respect of the following matters: -

1. Action on discovering a fire (including operating the fire alarm)
2. Action on hearing the fire alarm.
3. Confirmation of assembly points.
4. Calling the Fire Service & details to be given to them.
5. Making power supplies safe.
6. Use of extinguishers.
7. Means of escape routes.
8. Evacuation of staff / visitors and role call.
9. Snatch list.
10. Other persons/organisations to be contacted.
11. Duties of person in charge.

**First Month Of Employment:** two periods of instruction

**Staff on Night Duties:** three monthly.

**Staff on Day Duties:** six monthly.

**RECORD OF FIRE TRAINING/INSTRUCTIONS**

<b>Date</b>	<b>Instruction Duration</b>	<b>Person Receiving Instruction</b>	<b>Nature of Instruction</b>	<b>Signature of Instructor &amp; Company Details</b>

## Fire Drills

Everyone needs to know how to get out quickly & safely, what to do if their normal route is blocked and where to assemble after evacuation.

Consideration will need to be given to the potential needs of visitors e.g. ambulant disabled, non English speaking, etc.

The appointment of Fire Wardens and/or Fire Marshalls with specific duties such as having a specific area of the building to sweep to ensure all persons have vacated that area.

**At least twice/annum** conduct a fire & evacuation drill to simulate fire conditions eg one escape route obstructed, no advance warning given other than to specify staff for the purposes of safety, with the fire alarm being operated on instructions of the person in charge.

**Do NOT** call the Fire Service for the purposes of a drill.

## FIRE DRILLS

Date	Nature & Location of Drill	Names of persons taking part.	Evacuation Time	Comment	Signature of Person in Charge



## Annex IV

### Worked Examples of Fire Risk Assessments

A) Reproduced from the Scottish Government's guidance - can be viewed at <http://www.infoscotland.com/firelaw/v2jsp?pContentID=240>

**Record of fire safety risk assessment**

Adviceline: 0800 019 2211  
[www.healthyworkinglives.com](http://www.healthyworkinglives.com)  
[www.infoscotland.com/firelaw](http://www.infoscotland.com/firelaw)

Example

<b>Building use and address</b>	Island View Hotel 56 Wilson Road Largs		
<b>Postcode</b>	KA1 4 RQ		
<b>Name of person(s) with fire safety duties</b>	Joan McDougal		
<b>Name and contact details of Assessor</b>	Joan McDougal (Owner) as above		
<b>Assessor signature</b>		<b>Date of assessment</b>	15 June 2007

**STEP 1 Identify people at risk**

List all persons potentially at risk from fire, including employees, residents, visitors and contractors

*In addition to adults of all ages, including a specific group of disabled elderly adults who visit the premises annually, the premises also frequently accommodate children of all ages including infants accompanied by adults.*

**STEP 2 Identify fire hazards**

Note: Action Points should be recorded at STEP 4

Fire hazards	Comments
Sources of ignition	unguarded log burning fire in lounge.
Sources of fuel	Large bottle of white spirit and one LPG cylinder stored in cupboard under fire escape staircase.
Source of oxygen	

	<b>YES</b>	<b>NO</b>
Action required (Please tick) If you answered yes, record action at STEP 4	✓	

<b>STEP 3 Evaluate risk and adequacy of existing fire safety measures</b>			
Note: Action Points should be recorded at STEP 4			
<b>a) Likelihood and consequences of a fire starting</b>	<b>Comments</b>		
Accidentally By act or omission Deliberately	Sparks from wood fire could cause a fire in surrounding area. White spirit in unlocked cupboard could be used to deliberately start a fire. LPG cylinder could increase severity of fire.		
	Action required (Please tick) If you answered yes, record action at STEP 4	<b>YES</b>	<b>NO</b>
		<input checked="" type="checkbox"/>	<input type="checkbox"/>
<b>b) Adequacy of existing fire safety measures</b>	<b>Comments</b>		
Provision and protection of escape route Lighting and signage Fire detection and fire warning Fire fighting equipment Staff training and fire drills Management and fire safety policy Co-operation and co-ordination with other building owners/occupiers.	Self-closing device on door to first floor bedroom (front) removed. Cardboard boxes stored within staircase (ground floor) partially block exit route. Fire extinguishers not positioned adjacent to storey exits e.g. at the access into the staircase at first floor level. Fire alarm not being routinely checked. Fire exit sign needed at first floor corridor level to lead guests to escape route. Several fire resisting doors not fitted with 'Fire Door - Keep Shut' signs. No 'Fire Action' notices provided in guest bedrooms. Emergency procedures do not cover disabled guests.		
	Action required (Please tick) If you answered yes, record action at STEP 4	<b>YES</b>	<b>NO</b>
		<input checked="" type="checkbox"/>	<input type="checkbox"/>

The assessor completing the following section should prioritise remedial measures, based on the level of risk.

**Priority ratings and suggested timescales:**

Low (L) 3 – 6 months	Medium (M) Up to 3 months	High (H) As soon as possible
----------------------	---------------------------	------------------------------

The above timescales are recommendations, however, risks should be removed as soon as possible.

STEP 4 Action points			
	Priority	Person responsible	Completion date
1. Provide fireguard.	H	Joan McDougal	
2. Remove white spirit and LPG cylinder from below stair. Store externally in locked hut.	H	Joan McDougal	
3. Fit self-closing device to bedroom door.	H	Joan McDougal	
4. Remove cardboard boxes from escape route and keep clear.	H	Joan McDougal	
5. Fire extinguishers to be wall mounted on hooks and sited adjacent to storey exits.	M	Joan McDougal	
6. Fire alarm to be checked weekly. Record of test to be kept.	H	Joan McDougal	
7. Provide Fire Exit sign at first floor level.	M	Joan McDougal	
8. Provide 'Fire Door – Keep Shut' signs on self closing doors.	M	Joan McDougal	
9. Provide 'Fire Action' notices in all guest bedrooms.	M	Joan McDougal	
10. Review emergency procedures to include measures to cover periods when disabled guests stay in the premises.	M	Joan McDougal	

Continue on separate sheet if necessary.



**Review the fire risk assessment if there is a reason to suspect it is no longer valid or if there has been a significant change in the matters to which it relates.**

STEP 5		Assessment review	
Review date		Reviewed by	
Reason for review			
Outcomes of review			

The Scottish Centre for Healthy Working Lives is part of NHS Health Scotland. We provide information, advice and support on health and safety legislation, occupational health and health promotion. To arrange a workplace visit, call our adviceline free on **0800 019 2211**. Alternatively, contact your local Healthy Working Lives team based in your NHS board area. The contact details for each team are available from the adviceline and are given on our website at [www.healthyworkinglives.com](http://www.healthyworkinglives.com)

**The Scottish Centre for Healthy Working Lives is endorsed by:** the Confederation of British Industry (CBI Scotland), the Federation of Small Businesses (FSB), the Scottish Trades Union Congress (STUC), the Scottish Government, the Health and Safety Executive (HSE), NHS Scotland, the Convention of Local Authorities (COSLA), Jobcentre Plus, Scottish Enterprise and Highlands and Islands Enterprise (HIE).



2.692/2/2008

**Worked Examples of Fire Risk Assessments**

B) Reproduced from TAN 22 and originally from a CFOA(S) guide (now out of print)

Notes	Record finding	
<p>Worksheet 1: Life Risk Residential flat on top floor (attic). Staff numbers maximum of 100 but visitors/diners could add up to 100. Escape routes complex but well signed.</p>	Sleeping	
	Mobility	
	Familiarity	
	Numbers	
<p>Worksheet 2: Ignition Sources Basement boiler plant area well protected. Workshops at rear of premises not directly connected. Kitchen in basement</p>	Benchmark	
	Below benchmark	
	Compensation	
	Sub-standard	
<p>Worksheet 3: Combustible Materials Storage of material for shop. Timber etc in workshop.</p>	Benchmark	
	Below benchmark	
	Compensation	
	Sub-standard	
<p>Worksheet 4: Prevention and Management New premises so not able to fully assess but indications are that good management regime will be imported (Excellent rating to be considered after occupation).</p>	Excellent	
	Benchmark	
	Below benchmark	
	Sub-standard	
<p>Worksheet 5: Communications Excellent automatic fire detection system with direct connection: Good exit signs and action notices</p>	Excellent	
	Benchmark	
	Below benchmark	
	Sub-standard	
<p>Worksheet 6: Structural Precautions Heritage (listed) building complex but good standard of compartmentation and protection. Control of penetration needs to be maintained.</p>	Excellent	
	Benchmark	
	Below benchmark	
	Sub-standard	
<p>Worksheet 7: Means of Escape Escape routes meet standards but some are complex. There needs to be high standard of training and supervision to obtain "Excellent" rating</p>	Excellent	
	Benchmark	
	Below benchmark	
	Sub-standard	
<p>Worksheet 8: Operational Facilities for Brigade Firefighting These meet statutory requirements and good liaison exists. To obtain "Excellent" rating these would need to be assessed and strategy co-ordinated with Brigade</p>	Excellent	
	Benchmark	
	Below benchmark	
	Sub-standard	

## Annex V

### Edinburgh Old Town Fire, December 2002 – Case Study Illustrating the Vulnerability of Traditional Buildings to Fire

The fire in the area of the North Bridge and Cowgate on the 7 December 2002 had significant impact on a number of buildings and offers lessons on the problems which face firefighters in premises which have undergone changes of use and where such changes may not have been compliant with legislation.

The area forms part of a designated World Heritage Site and covers an area approximating half of a large city block. The buildings were of traditional construction, mainly stone with both pitched slate roofs and modern

flat roofs with asphalt coverings. They dated primarily from the 16th century with substantial developments taking place during the 17th and 18th centuries to the present day, including conversions and sub-division of a large department store to commercial, leisure and domestic habitation.

Firefighters experienced great difficulty in tackling the blaze which had spread in several different directions due to the presence of voids and shafts and an absence of effective fire compartmentation. Fire crews were withdrawn on two occasions, after the second time, only external firefighting was deemed safe.

The official Lothian and Borders Fire and Rescue Service incident report summarises the impact of the event succinctly:



*Illus 86 Dampening down the fire damaged area the morning after the fire © Crown Copyright: RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk)*



Illus 87 Firefighting operations were complicated by the fact that the buildings varied from five to seven storeys and the site was accessible from two different street levels © Crown Copyright: RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk)



Illus 88 This image demonstrates the complexity of the site – five interlinked buildings containing thirteen premises © Crown Copyright: RCAHMS. Licensor [www.rcahms.gov.uk](http://www.rcahms.gov.uk)

The fire involved five interlinked buildings containing thirteen premises, which included Licensed Premises, Nightclubs, Shops and Offices. The footprint of the building measured approximately 60m x 60m, with buildings ranging from five to seven floors, serviced from adjoining road levels at Ground (Cowgate) and Fourth Floor (South Bridge). The buildings were of traditional construction and consisted mainly of stone walls, timber floors, part pitched, boarded and slated, part flat roof construction. Over a number of years renovation had taken place within a number of buildings which had resulted in knock through access between buildings for persons and additional services. In addition, there were numerous void/ducted areas that ran vertically and laterally throughout many of the buildings. These renovations inevitably played a major part in the very rapid spread of fire throughout the buildings.

In discussing the role the buildings' structures played in the fire, the report continues:

*The subsequent rapid development and spread of fire may have been restricted to a smaller area, or avoided, had adequate barriers including building separation, fire stopping and fire compartmentation been in place. In addition the lack of suitable stopping led to unrestricted fire spread throughout the adjoining properties, both vertically and laterally. The fire continued via large void areas, some one metre in depth, at floor and ceiling levels and through openings in walls, such as doors and windows which were inadequately fire stopped or enclosed during changes to the properties. These changes included the conversion, of what*

*appeared to have been a courtyard bounded by old tenement properties, into licensed premises. The rapid unseen spread of fire and the dangerous conditions that were developing within the first floor level and surrounding area resulted in the emergency evacuation of all the building and the re-siting of all firefighting appliances to a safer area.*

*During the investigation it was noted that a sprinkler system had been installed.....<sup>29</sup> The system had been de-commissioned during renovations and conversions for the change of use to Places of Entertainment. Had the system remained in place, and been fully operational, the fire damage to the surrounding properties would have been significantly reduced.*

*The fire was eventually detected by automatic smoke detectors in a remote area of the surrounding properties owned by ..... Had smoke detection been installed throughout the premises of the ..... Public House, the additional early warning may also have reduced the damage to the surrounding properties.*

*The actuation of the manual fire warning system installed in the premises resulted in the safe evacuation of all members of staff and members of the public.*

It is perhaps worth recording the number and nature of the businesses whose premises were destroyed or damaged as well as those evacuated because of the presence of unsafe structures to reflect the economic impact of the fire on these businesses. These are listed below:

<sup>29</sup> Note that the property owners' names have been omitted.

**List of Properties Destroyed by Fire**

ADDRESS OF PROPERTY	
1.	77 South Bridge, Edinburgh Camping and Outdoor Centre
2.	80 South Bridge, Edinburgh Department of Artificial Intelligence
3.	82 South Bridge, Edinburgh The Bridge Jazz Bar
4.	84 South Bridge, Edinburgh Leisureland
5.	11 Hasties Close/209 Cowgate, Edinburgh La Belle Angel
6.	233 Cowgate, Edinburgh Ticketing Services/Art In Partnership/The Graphics Company/16K Designers/Paul Ferranx/Rags/Create/Lois
7.	235 & 237 Cowgate, Edinburgh Club Loca The Livingroom
8.	227 & 229 Cowgate, Edinburgh The Guilded Balloon

**List of Properties Damaged by Fire, Smoke or Firefighting Water**

ADDRESS OF PROPERTY	
9.	1, 1A Chambers Street and 74/75 South Bridge, Edinburgh Biblos The Beat Jazz Bar
10.	1B Chambers Street, Edinburgh Richer Sounds
11.	3 Chambers Street (Including Adam House), Edinburgh
12.	76 South Bridge, Edinburgh Gossip Clothing
13.	207 Cowgate, Edinburgh

**List of Properties Evacuated due to Dangerous Neighbouring Buildings**

ADDRESS OF PROPERTY
37 & 39 Guthrie Street, Edinburgh
200 Cowgate, Edinburgh Occupiers:- Capital City Homes address as per owner
Scottish Council for Single Homeless
C/o 54A Fountainbridge (4th Floor), Edinburgh, EH3 9PT
Scottish Refugee Council C/o 5 Cadogan Square, 170 Blythswood Court, Glasgow, G2 7PH
Community Services Volunteers C/o Age Concern Scotland, Leonard Small House, 113 Rose Street, Edinburgh, EH2 3DT
37 South Bridge, Edinburgh
85-87 South Bridge, Edinburgh Occupiers:- Department of Social Work per Director, Shrubhill House, Shrub Place, Leith Walk, Edinburgh, EH7 4PD
Department of Environmental and Consumer Services per Director, Chesser House, 500 Gorgie Road, Edinburgh, EH11 3YJ
38 South Bridge, Edinburgh Occupier:- Piemaker
40/41 South Bridge Occupier:- Forbidden Planet (Scotland) Ltd 168 Buchanan Street, Glasgow, G1 2LW
42 South Bridge, Edinburgh Occupier:- Emport Apparell Ltd C/o Xile, Princes Mall, 3 Waverley Bridge, Edinburgh
45/46 South Bridge, Edinburgh Occupier:- Costcutter Express 125 Lothian Road, Edinburgh
34/35 South Bridge, Edinburgh
43 South Bridge, Edinburgh

## Annex VI

### Arson Prevention

The text in this section is abstracted from Arson Prevention Bureau<sup>30</sup> publications and is included here with their kind permission

#### *24 Ways to Stop your Building Becoming an Arson Statistic*

##### Responsibility

- In any enterprise the owner/manager or a named individual of senior grade must be made responsible for fire safety including protection from arson attack
- Think about the ease with which intruders/ arsonists could break into the premises and take immediate steps to strengthen your defences
- If there have been any small fires on your own or neighbouring premises inform the police immediately as well as calling the fire service. A small fire could be a warning of something worse to come!

##### Security

- One entrance is better than two especially if that one entrance is manned throughout the day
- Outer fences, walls and gates need to be high enough and strong enough to keep out intruders
- Doors and windows must be in good repair and locked when not in use
- Use good quality locks and padlocks
- Gaps under doors should be as small as possible
- Letter boxes should have metal containers fitted on the inside
- Know who holds keys; chase any that are missing
- Stored material of any kind should not be stacked adjacent to fences or walls where it could be set alight from outside.

##### Employees

- Warn all staff of the threat from arson fires
- Ask them to challenge anyone who should not be on the premises and to report any suspicious activities
- Vet new employees
- Keep an eye on outside contractors

##### Visitors

- The movement of visitors within the building should be controlled

##### Fire Protection

- Ensure equipment which you have installed – extinguishers, hose-reels, alarms, detectors, sprinklers – is in good working order and protected against sabotage attempts

##### End of Day Checks

- You or a named individual must be responsible for securing the building at the end of each working day
- Check that doors and windows are secure
- No combustible material is left lying around
- No unauthorized people on premises
- Alarms switched on
- Outside illumination on
- Any flammable liquids locked away in secure store.

30 <http://www.arsonpreventionbureau.org.uk/>

**How to Assess the Risks of Arson in Churches**

<b>POINTS</b>		<b>DEDUCT</b>	
The church <sup>31</sup> is in an isolated location	12	There is a system of management ensuring that when the church is open the arrival and departure of visitors is monitored	12
The church is not in a good state of repair	12	The church has an intruder alarm which is maintained by a qualified engineer	8
The church is situated in an urban area	15	The intruder alarm is connected to a central monitoring station	12
The church is open throughout the day (whether or not there is a responsible person present)	20	The church has fire extinguishers and/or hose reels which are clearly visible	4
The church has a number of entry points most of which are kept open during the day	20	The church has a fire detection system connected to a central station	12
The church has suffered small fires, break-ins or malicious damage during the past two years	15	The church has locks to BS3621 on all external doors and key-operated window locks on all ground floor and other accessible windows	10
There have been fires and/or break-ins in other churches in the locality in recent months	10	The church has external security lighting	8
There are articles of value on display in the church	15	The church has external CCTV cameras	12
The church is used by outside groups and/or is used as a community centre	8		
The church has no special security policy or a nominated official to oversee security	10		
The church has no fire protection equipment or has not sought advice from local fire officers during the last five years	10		
<b>TOTAL</b>		<b>FINAL TOTAL</b>	

**SCORING**

Less than 20	Not too much to worry about
20-50	Potential hazard
50-100	Considerable hazard exists
Over 100	Disaster can be expected!

*Completion of the above form will assist you in completing your Fire Risk Assessment required under the Fire (Scotland) Act 2005 and regulations made thereunder*

<sup>31</sup> Each reference to 'the church' should also be taken to include church halls and community centres.

## ANNEX VII

### Daily, Weekly and Monthly Fire Safety Checklists

#### Daily Inspections

Prior to opening the premises or admitting the public, the following should be undertaken:

- Chains and secondary locking devices should be removed/unlocked from fire escape doors
- Fire control panel should show correct indications ('green lights')
- Any work scheduled must be covered by the appropriate permits and the necessary fire zones isolated and staff notified
- Wastebaskets should be emptied and combustible rubbish removed to a secure place
- Fire extinguishers which may have been moved should be returned to the correct locations
- All fire doors which should be shut or secured are in the correct position
- Fire exit signs should be lit and visible
- Security staff, wardens or others such as telephone operators should be briefed on any special events or activities
- Any open fire should be extinguished or protected by a fixed fire guard
- Ashes from open fires should be removed from the building in a steel container with a lid and disposed of safely.

#### After Closing for the Day:

- All contractor work should cease, permits should be withdrawn and work sites inspected
- Fire doors should be secured
- Fire alarm panel should show correct indications
- Internal doors should be closed
- Fire exit signs should be lit
- Night telephone line should be checked
- Open fires should be checked/extinguished.

#### Weekly Inspections

- All weekly equipment checks should be completed
- Fire exits should be in proper working order and external escape routes walked to check that they are clear
- Seals on fire extinguishers should be checked
- Fire extinguishers with pressure gauges should be checked for correct reading
- Hose reel cupboards should be opened to check for leaks or signs of corrosion
- Fire alarm system should be tested (including direct link to central station)
- Emergency lighting should be tested
- A visual check for fire hazards should be carried out
  - electrical appliances off (as necessary)
  - extension leads
  - overloaded sockets
  - unauthorised equipment
  - signs of illicit smoking
  - storage on obstruction of escape route
  - safe storage of flammables, gases, chemicals, etc.

#### Monthly Inspections

- All monthly equipment checks should be completed
- Fire instructions must be up-to-date
- Fire wardens list must be up-to-date
- Call out list must be up-to-date.



## Annex VIII

### Sample Fire Policy and Fire Instructions

*As has already been made clear, all historic buildings should have a fire safety policy which should, at the very least set out the intentions of the owner or occupier in respect of the importance of managing fire safety effectively.*

*Two model safety policy statements are attached. The first is a comprehensive statement which encompasses much more technical detail and is almost a mini fire safety manual. The second is a short and simple example of the sort which might be appropriate for a smaller historic building.*

#### FIRE POLICY STATEMENT (LONG VERSION)

##### 1. Employer's Duties

We are a responsible employer and take our fire safety obligations seriously. For this reason, we have formulated this policy to help us comply with all our legal obligations to staff, visitors and other relevant persons as required by the Fire (Scotland) Act 2005, and associated regulations, the Management of Health and Safety at Work Regulations 1999 and other relevant legislation.

These obligations and duties include the provision of a safe place of work where risks of and from fire are minimised and where reasonable steps have been taken to eliminate or reduce fire safety hazards. Due to its importance, this fire safety policy also forms part of our overall health and safety policy.

##### 2. Employees' Duties

All employees have a duty to ensure that they do not place themselves or others at risk of harm. They are also required to co-operate fully with us and those nominated by us to manage fire safety matters in complying with any procedures that we may introduce to protect the safety and well-being of our staff and visitors.

All employees have an obligation to ensure that they work safely and use the equipment provided as instructed.

##### 3. Communications

We will keep staff informed of any changes that are made to our fire safety procedures and fire risk assessments.

We will also ensure that all visitors to our premises are briefed in the evacuation procedures and not left alone unless they are aware of, and familiar with, all available escape routes.

Equally, employees must also bring to the attention of their supervisor or other nominated person any equipment, condition or situation which they consider to pose a hazard.

##### 4. Procedures

We have introduced the following procedures in order to maintain high standards of fire safety:

- A full fire risk assessment has been undertaken which will be reviewed annually. However, more frequent reviews will occur if there are changes that will impact on its effectiveness. These may include alterations to the premises or new work processes
- The fire evacuation procedures will be exercised at least annually
- Training will be provided as necessary to any staff given extra fire safety responsibilities, such as those who are appointed as fire marshals
- It is our policy that all staff will be trained in the use of fire extinguishers
- All new members of staff and temporary employees will be provided with induction training which will include instructions on how to raise the alarm and use the available escape routes
- All escape routes will be clearly signed and kept free from obstructions at all times
- All fire-related equipment will be regularly serviced and maintained
- If any employee becomes aware of defective or missing equipment, they must report it to a fire marshal, manager or other designated person
- Alarm systems will be tested regularly. Staff will be told when a test is scheduled
- Any other safety systems will be checked regularly to ensure correct operation
- This policy forms part of all employees' conditions of employment. Failure to comply may be treated as a disciplinary matter.

## 5. Procedures in the Event of a Fire

### *a. On discovering a fire*

- If you discover a fire raise the alarm immediately
- If you have been trained and feel that it is safe to do so, attempt to fight the fire using the equipment provided
- If this fails, evacuate immediately. Ensure that no-one is left in the room and close the door behind you
- Ensure that you or the designated person has called the fire service
- Play your part in the roll call so you are safely accounted for.

### *b. If you hear the fire alarm*

- Operate any essential shutdown devices, e.g. machinery
- Immediately leave using the nearest available fire exit
- Report to the assembly point for a roll call
- If you are with a visitor or there are contractors or temporary staff working nearby, ensure they accompany you.

### *c. Fire marshals*

- Encourage staff around you to evacuate and to proceed to the assembly point
- Report to the person in charge, noting any absentees.

### *d. Person in charge*

- Gather all information regarding the evacuation
- Establish if it is a genuine fire or false alarm
- Ensure that the fire service has been called
- Liaise with the fire service on its arrival.

## FIRE POLICY STATEMENT (SHORT VERSION)

The (Trustees) have resolved that in relation to the protection of (ABC House) the first priority should be the protection of life safety in the event of fire. The second priority is the protection of the buildings and its contents. All efforts to achieve these measures taken are consistent with the overall objectives of the protection of the house's heritage value to ensure the protection of Scotland's national heritage for the enjoyment and instruction of future generations.

The (Trustees) require all staff, contractors, visitors and other persons visiting the premises to comply at all times with relevant legislation, statutory guidance and codes of practice as they relate to the building and its contents and to any and all (ABC House) fire safety rules and procedures which may be promulgated from time to time.

The (House Manager) is nominated as the person responsible for all fire safety matters within the site. In the event of his or her absence from site, this responsibility is delegated to the (Deputy House Manager).

**Annex IX**

**Sample Hot Work Permit**

MONUMENT/DEPOT	CODE No	PERMIT NO
Permission is Granted to.....	Date.....	.....(Valid for Day of Issue Only)
To Use.....	In the.....	.....(Exact Location)
Between..... am	..... pm	And..... pm
<b>TO BE COMPLETED WITH THE CONTRACTOR IN ATTENDANCE:</b>		
a) The above location has been examined	<input type="checkbox"/>	<input type="checkbox"/>
b) There are no combustible liquids, vapours, gases or dusts	<input type="checkbox"/>	<input type="checkbox"/>
c) All combustible materials have either been removed or suitably protected against heat and sparks including levels underneath/below	<input type="checkbox"/>	Yes/No
d) Suitable extinguishers are locally available and someone trained in their use is standing by	<input type="checkbox"/>	Yes/No
Signature of Person Issuing the Permit: .....		
<b>Historic Scotland Manager</b>		
<b>TO BE COMPLETED BY THE CONTRACTOR DURING AND ON COMPLETION OF THE WORK:</b>		
The following inspections of the work area have taken place during the course of the operations and the proper procedures are being followed.		
Time: .....	Signature: .....	Time: .....
Time: .....	Signature: .....	Time: .....
The contractor responsible for the works confirms that the works are complete, that the work area and the adjacent areas to which heat and sparks might have spread have been thoroughly inspected.		
Signature: .....	Time: .....	Name Printed: .....for.....(contractor)
<b>AFTER SIGNING THE CONTRACTOR IS TO IMMEDIATELY RETURN THIS PERMIT TO THE ISSUING HISTORIC SCOTLAND MANAGER</b>		
<b>TO BE COMPLETED BY THE ISSUING HISTORIC SCOTLAND MANAGER:</b>		
The area has been thoroughly inspected by the Historic Scotland Supervisor again 30 minutes after the work being completed to ensure no smouldering has taken place and that there is no risk of a fire starting.		
Signature: .....	Time: .....	Name Printed: .....

**NOTE:** This permit is required for all operations involving flame, hand or arc welding and cutting equipment, brazing and soldering equipment,, blow-lamps, bitumen boilers and other equipment producing heat or having naked flames. Plus all disc cutting and grinding works in which sparks are emitted.

## Annex X

### Post Fire Structural Stability

*The following is based on text prepared by Historic Scotland's in-house structural engineer.*

When a building is considered dangerous The Building (Scotland) Act 2003 defines the local authority's responsibilities. During a fire the authority's opinion on whether walls or gables are unsafe and need to come down could inform the fire services approach. Immediately after a fire the local authority will assess the building and where it appears that a building constitutes a danger to persons in or about it, or to the public generally, or to adjacent buildings or spaces, the local authority must carry out such work (including, if necessary, demolition) as it considers necessary to protect the public and adjacent property and persons. Subsequently a dangerous building notice may be served on the owner requiring works to be carried out within a set period.

However, when considering listed buildings and scheduled monuments a local authority must, if **reasonably practicable**, consult with the Scottish Ministers and the planning authority. It is important in such cases to have a structural engineer or conservation specialist on hand, with experience in the form and structure of historic buildings and the approach to securing and conserving historic fabric, who can inform the approach to stabilising the building. There are now Structural Engineers formally accredited in building conservation.

Where the structural damage is significant, clearly in addition to historic value the location of buildings and external pressures can influence the extent of making safe and the approach. A city centre building adjacent



*Illus 89 Broadstone House, Renfrewshire. Post-fire stabilisation works underway*



*Illus 90 Broadstone House. Although appearing precarious, substantially constructed traditional masonry can often be demonstrated to remain stable despite major loss of secondary structural elements*

to a major thoroughfare is a different situation to an isolated building standing in its own grounds.

Appendix 6 of The Institution of Structural Engineer's publication *Appraisal of Existing Structures* gives useful guidance when carrying out a structural assessment after a fire. However, it is not a publication that considers conservation as a priority. It notes that the 'reparability' after a fire cannot be simply based on the assessment of the technical feasibility, but must be based on much

broader considerations such as the aesthetic appearance, the reliability of repairs and the views of the insurance company and client. However, technical feasibility and a related cost appraisal must be reported as a datum from which other consideration can be judged.

Traditional buildings may have an advantage in surviving a fire in that they are often significant structures built to a high standard and benefiting from thick solid stone walls - often with masonry arches over door and window openings in conjunction with timber safe lintels and occasionally steel or cast iron safe lintels.

Smaller fires can result in damage to parts of the building not directly implicated due to efforts to prevent the fire spreading. Water damage to historic plaster ceilings can be particularly difficult to deal with, the immediate reaction of 'take down before it collapses' needs to be countered by propping and opening up the floor above to allow drying before inspection by a specialist conservator.



*Illus 91 Broadstone House, wall head dormer detail*

A major fire can lead to significant structural risk from collapsing roofs or floors causing progressive collapse. The resulting loss of ties to walls or outward force on a wall could result in failure and collapse of parts of the outer envelope. A safe inspection of a precarious structure can be difficult. For taller buildings a hanging basket from a crane with suitable reach should be utilised to enable close up inspection. Smaller units such as 'cherry pickers' can be used for smaller structures.

Health and Safety issues are of major importance when dealing with a structure subjected to fire. Hazards and risks must be thoroughly considered to inform the approach to inspection and making safe and secure. Method statements defining the approach to work should be produced before carrying out stabilisation, conservation or repair work. Access to carry out archaeological assessment and recording can also prove difficult when making safe and clearing a site as soon as practicable is required.

After a fire where roof collapse has occurred, gables and pediments over wall head dormers can be left standing exposed with no rear support. While the initial instinct may be to carefully dismantle stone by stone utilising hanging baskets or temporary scaffold and storing the stone for subsequent re-construction, the necessity of such intervention should be carefully considered. It should be taken into account that the triangular form is well suited to resisting wind load, with a low centre of gravity providing stability and a reducing area to catch the wind minimising the overturning moment. Each situation should be considered on its merits with consideration being given to the height and location of the building, the size of the stone blocks, the tightness of the joints and the effectiveness of inter-bedding. Where feasible tying gables and pediments back by the erection of temporary support systems to enable their safe retention in-situ is preferable, as it reduces the risk of

stone damage and loss, compared with dismantling and reconstruction. Chimney stacks and corner turrets can also appear precarious when in fact they are perfectly stable. Consideration has to be given to the greater exposed areas to wind load and loss of counterweight of roof structure.

The extent of heat damage to stone and mortar needs to be assessed case by case. Sandstone can resist heat better than some other stones, whilst brick, having been formed by firing, is more resistant. The thickness of the stone wall and form of construction (rubble, regularly coursed etc) subjected to the heat of the fire will be a factor in the degree of damage. Damage may take the form of spalling, de layering or the formation of micro cracks making the stone and mortar more prone to deterioration if exposed to weather.

Roof loss may lead to wall heads and stone faces meant only for internal exposure being exposed to weathering. Protective measures to conserve will need to be considered if early remedial work is not likely. The most severe stone damage is likely to be on the thinner isolated elements such as lintels, mullions and transoms. Propping or framing out to provide support should be carried out as quickly as possible.

Metal elements of a structure provided with sufficient fire protection or built into stonework may survive a fire without severe deflection or loss of strength. However, if exposed to a substantial level of heat, expansion, deflection and loss of strength will occur. In steel for example, the yield strength at room temperature will be reduced to about half at 500°C and to 10% or less at 1000°C. Strength recovery post fire is usually dependent on the temperature reached but a reduction of around 5% is allowed for hot rolled steel cooling from 800°C. Expansion of built in metal beams during a fire – especially elongation – can also cause damage to stonework resulting in bulging and cracking in walls.



*Illus 92 Bulging and cracked external masonry caused by expansion of internal metal beam*



*Illus 93 Fire damaged timber safe lintels with masonry arch over*

For wrought iron a high temperature can be beneficial to strength on re-cooling. As for cast iron a permanent loss of strength would occur if subjected to temperatures greater than 750°C although working stresses are usually lower. Generally cast iron is considered to perform well in fires and is less prone to collapse in the early stages of a fire than steel. However, sudden cooling as a result of direct exposure to fire hose water can cause severe cracking and failure. Cast iron beams are more prone to collapse and sudden failure than columns. Where cast iron elements have survived a fire a detailed study of the components is advisable to check for surface crack development and to ensure their long term reliability.

Concrete has an inherently good resistance to the effects of fire. This is not to say that it is not susceptible to deterioration when exposed to extreme heat, spalling

may occur and steel reinforcement may expand and lose strength. Older concretes require careful consideration as they may contain combustible materials. Filler joist slabs combine concrete and metal, the metal joists being provided with a degree of fire protection by the concrete.

Timber of standard small cross sectional area will normally only survive localised fires or fires where rapid intervention by the fire service has been successful. In such instances, larger sections may suffer only surface charring. Inspection of timber elements will reveal the extent of section reduction due to charring and if not extensive their structural integrity may not be compromised. In some cases sufficient section may survive to enable retention with the addition of strengthening.

## Annex XI

### Additional Technical Information

#### 1. Installing a Sprinkler System in a Traditional Building

This publication contains information on a number of ways in which sprinkler systems can be utilised in the protection of traditional buildings and in particular, to facilitate alternative compliance with building standards.

##### 1.1 Installing the System

Having carried out a fire risk assessment (refer to Part 1, Section 8) it may have been determined that the best way to eliminate or minimise the levels of hazard in a traditional building is by the installation of a fire suppression system. Alternatively, it may be that a suppression system is the most practical way of meeting building standards in respect of fire spread, means of escape or facilities for the fire service.

The risk assessment should contain a record of this conclusion and should be used as part of the process in the procurement of the suppression system. Reference can be usefully be made to the Corgarff Castle case study (Case Study 3) which makes it clear that only the installation of an automatic fire suppression system permitted the castle to remain in use as a visitor attraction. The case studies of the National Library of Scotland's George IV Bridge building and Duff House also provide useful information on implementing the findings of a risk assessment through fire protection system improvements.

Before setting out to procure the fire system, any historically important construction, finishes and detail of the building should be fully documented, if this has not already been done. This is especially the case in a building which has been extended over time, as it is possible that earlier features are hidden behind more recent work, for example, painted joists and ceilings may survive above later plaster ceilings or an early external stone wall with moulded openings may be concealed by strapping. Reference should be made to original building records to aid understanding the history of the development of the building, which may give clues to possible hidden features and structural discontinuities. Sources of this material include the Royal Commission on the Ancient and Historical Monuments of Scotland, the Scottish Record Office, original architect's offices or the client's records. The building survey and documentary search will serve to establish:

- The nature and importance of the fire resistance of walls, floors and ceilings. This will suggest routes for pipework and the nature of the fittings which can be used

- The historic relevance and fire resistance of doors and glazing to ensure that they are consistent with the fire resisting properties of the building elements in which they are located
- Whether all penetrations involving existing pipes, cables and other services are fire stopped to an appropriate standard
- The locations of voids within the construction of walls, behind panelling and above ceilings or below floors. These may be considered as areas through which pipework may be run. Where voids are large, it may be necessary to install sprinklers to protect them
- Compartmentation possibilities and difficulties.

The temperature extremes in areas through which pipes may run must be ascertained so that the types of sprinkler systems and temperature rating of sprinkler heads which might be installed can be determined and other measures taken to prevent freezing.

##### 1.2 Design Guidance for the Installation of a Sprinkler System

No design guidance for work in traditional buildings can be prescriptive, as each building presents a different challenge. The starting point must be to carry out a comprehensive survey of both the physical fabric and documentary sources of information, which will allow an assessment of the importance of the building to be made. Following the survey, which may have been carried out as part of the fire risk assessment, a framework can be set for acceptable levels of intervention, protecting those qualities that have been recognised as central to the building's importance.

The fire risk assessment will have highlighted where the risk of fire is most acute or where the risk to life is unacceptably high or where means of escape cannot be accommodated without significant intervention. A range of solutions should be considered, and all the options judged against the framework of acceptable intervention set for the particular building.

Thus in an 18th century building with fine unaltered interiors, the aesthetics of these interiors will be paramount and it may be decided that any disruption of these, may be unacceptable. Measures to reduce the fire risk, such as improved compartmentation and automatic fire detection may be equally undesirable in respect of fabric damage but may represent the minimal intervention strategy that has to be adopted in this case to comply with building standards management procedures, such as increased vigilance, provide another way of improving the fire protection of an historic building, with no impact on its fabric. Each case must, however, be considered on its own merits.



**Selecting a Fire Protection Consultant**

It is important to employ only consultants who are experienced in the installation of fire protection and suppression systems in traditional buildings. It is suggested that in the case of larger or more complex buildings that an experienced conservation architect is responsible for the coordination of the work of specialist consultants. The selection of an appropriately experienced consultant, who understands the need for minimum intervention and is sympathetic to the aesthetic dimension of designing within historic interiors, is vital to the success of the project. The consultant should be made aware of the distinction between the ‘front’ and ‘back of house areas’ of the building (the fire and service areas) and the locations of these. Detailed plans of the building should be made available and these should show the locations of voids where these are known. The spaces required in building cavities for crossovers of pipework and cables must be accurately assessed at the design stage. Detailed layout drawings showing all proposed pipework should be drawn up by the consultant, and the scheme discussed at all stages with those responsible for electrical, heating and other installations, who should also be required to produce drawings of similar accuracy.

Those responsible for procuring the sprinkler installation should ensure that they see and approve the detailed plans of the installation before work commences. In sensitive areas of a building the suggested route of every pipe and location of each sprinkler head should be checked before the final design is agreed. Note that consultation with both the fire authority and planning authority is essential. In addition, where necessary listed building consent and scheduled monument consent must be obtained prior to the commencement of any work. It is also wise to consult the property owner’s insurers especially if a discount on a fire insurance premium may be possible.

Tender documentation must be prepared which specifies the exact location of the water supply (where appropriate), pumps, alarm valves, the intended location of all pipework runs and the type, layout and position of the sprinkler heads to the sprinkler installation contractor. Technical drawings, such as fig 1-3 should accompany the detailed plan to assist designers and installers. Any deviations from BS EN 12845: 2009 should also be detailed. If the owner of the premises or the relevant insurer has requested that the system complies with the LPC Rules then care should be taken that there are no significant deviations from this document and that all deviations, however minor, are formally recorded and agreed with all relevant parties.

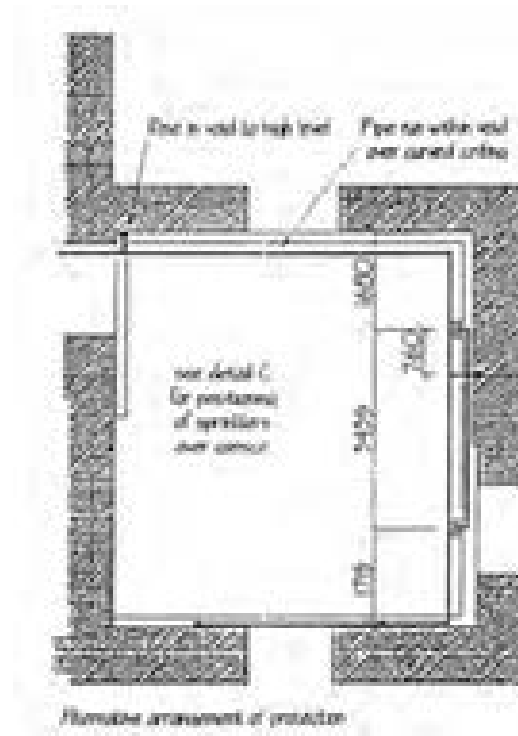


Fig 1 In addition to the main architectural plan, additional drawings/sketches can be useful

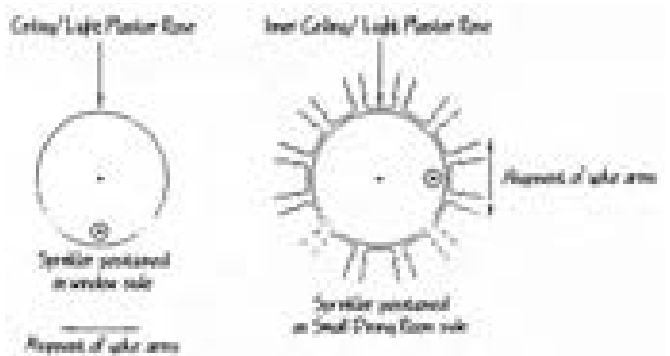


Fig 2 The exact location of sprinkler heads should be marked and if not obvious to the installing engineer, also the alignment of the yoke arms

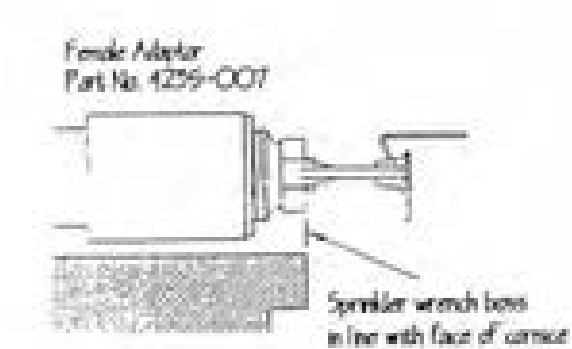


Fig 3 Detailed drawings of the sprinkler heads may be required for installations in sensitive areas

### 1.3 Selecting a Sprinkler Installation Contractor

The selection of the sprinkler installation contractor is of vital importance to the success of the project. The chosen contractor must be able to demonstrate that they have experience of work in traditional buildings, and all operatives too must be selected for their individual experience of working in such buildings and their understanding of conservation issues.

The installing company should be in possession of third party certification for the type of system, to be installed. For systems in residential premises the installer should be listed either by LPCB/BRE Certification (to LPS 1301) or Evoca (formerly Warrington Fire Research) to their FIRAS Residential and Domestic Scheme. In the case of all other systems, installers should meet the requirements of *Loss Prevention Standard 1048: Requirements for certificated sprinkler installers, supervising bodies and supervised installers* or to the FIRAS Commercial and Industrial scheme run by Warrington Fire Research.

Following the issue of a specification and tender documents, a site visit should be arranged and representatives of the selected companies should be invited to visit and be shown the full extent of the premises as well as any related infrastructure. The restrictions that will have to be observed during the installation must be fully explained and described. In particular, the need for the avoidance of hot work, method statements and work site housekeeping and storage must be emphasised.

The contractor must also be made aware that, in historic buildings, service runs need to be carefully coordinated so that minimal disruption is caused to the building fabric. This requires close communication between all the individuals responsible for the various service installations.

On receipt of the completed tender documents, the consultant should, in conjunction with other parties such as the owner's representative and conservation architect, draw up a tender analysis. This should include consideration of the following:

- Proof of experience in undertaking installation of sprinklers in traditional buildings
- Compliance with specification and any special conditions
- Submission of all specified information
- Technical excellence
- Materials and components to be used
- Price.

Note that price should be the last consideration, and that only those tenderers who meet the other prerequisites should be considered for award of the contract.

#### 1.3.1 Work in Progress

Close monitoring of the work in progress is required to ensure that all systems are installed to the highest standards of workmanship, especially that all pipework joints are correctly made. A quality control regime should be incorporated into the contract to ensure this is the case.

A location for temporary accommodation for the installation contractor should be agreed. If this is to take the form of a temporary building, unless it is fire rated (externally and internally) it should be located at least 10m from the historic premises. The contractors should be required to observe other relevant recommendations in the *Code of Practice for Fire Prevention on Construction Sites* published by the Fire Protection Association. Failure to do so could result in the CAR<sup>32</sup> insurer withdrawing cover.

If work is to be undertaken while members of the public are being admitted elsewhere, suitable routes into the premises for the contractors will have to be agreed. Security measures must also be reviewed while contractors are at work.

Plans should also be drawn up for the protection of furniture, carpets, pictures and fittings as necessary. Suitable safe storage must be found for any valuable items temporarily relocated. The fire load of such storage areas should be reassessed and additional fire extinguishers purchased or rented.

Many fires occur while contractors are working in buildings. A large proportion of these result from changes to well-established management procedures necessitated by the work in hand. Thus close liaison should be maintained with contractors and if changes to routines are necessary great care should be exercised. Staff should also be suitably instructed and advised to be vigilant.<sup>33</sup> The guidance contained in the HSE *Fire Safety in Construction Work* should be followed. A large proportion of fires occur when hot work is being carried out. The contractor should therefore be required to assure those responsible for the property that suitable precautions are observed if welding, cutting or similar operations are undertaken. Hot work should only be used if there is no other suitable technique available. A hot work permit system should be implemented and adherence to this scheme should be a written requirement within the work contract. An example of a hot work permit is shown in Annex IX.

Any modification to other fire safety provisions made at this time, such as the temporary covering of automatic fire detectors, should be for as short a period as possible, and only be carried out after consultation with the fire and rescue service and insurers. It may also be necessary to erect temporary fire exit signs.

<sup>32</sup> Construction All Risks.

<sup>33</sup> For a description on how this was achieved during the fire protection improvement works at the National Library of Scotland see Part 3, Case Study 2.

### 1.4 Installing Water Supply Tanks

Water supply tanks will be necessary if mains pressure is insufficient to supply the sprinkler system, yet finding a suitable location for water supply tanks will often be very difficult in traditional buildings. Ingenuity is then required to find a suitable location for these, and some compromise on their capacity may have to be accepted.<sup>34 35</sup>

It may be necessary to consider the provision of underground water storage tanks and associated pumps, as at Duff House, Banff. On sensitive sites, this approach could require an archaeological investigation in advance. Normal design and structural considerations should apply during the inception, construction and finishing stages of the work, employing sheet piling, surface water pumping and tanking as appropriate. Care needs to be exercised when determining the position of the storage facility to ensure that it both functions appropriately and integrates well with the site; there is a need to fully consider the visual effect of the finished scheme. Vent pipes, manhole covers, or breather pipes may be required above ground, and the presence of these elements should be anticipated and steps taken during the design process to minimise their visual impact. The finished level should avoid unnecessary above-ground intrusions on backfilling. In the case of Duff House, where the effect of the above-ground plant room paraphernalia is further compounded by floodlighting fittings, the visual consequences are considerable (illus 94). Often it is the failure to consider small points of detail that can negate the entire effect of an otherwise well executed installation.

### 1.5 Housing Pumps, Generators and Valve Sets

Pumps and generators are unsightly items which need to be housed discreetly but easy access will also be required for maintenance. They may be installed in peripheral areas or outbuildings where they will be less noticeable, though care should be exercised in their design and detailing, and if the building is listed, their installation will require listed building consent.

Fail-safe power supplies must be provided for electrically driven sprinkler pumps. This can either be in the form of diesel driven pumps or by providing a diesel powered generator. At the National Library of Scotland, electrically driven pumps were installed in a small room beside the water storage tanks; there was no space, nor sufficient ventilation to install a diesel pump. The solution was to house a diesel generator, with sufficient capacity to serve the entire building's needs in the event of a power failure, in a separate location. This approach

34 See the case study of Corgarff Castle for an account of how a suitable tank was installed.

35 See also the National Library of Scotland case study for information on how tanks were installed inside the vaults of the George IV Bridge.



*Illus 94 Tank landscaping at Duff House indicates that more careful consideration needs to be given to this aspect*

may be applicable in other cases, where a generator in an outbuilding can be installed with minimal disruption to historic fabric of a property.

Any valve sets which need to be installed in the traditional building should have their location identified by appropriate signs so that they may readily be found by the fire service on their arrival. As well as a sign on the door of the cupboard or room in which they are positioned, a sign should be displayed on the external wall adjacent to the entrance nearest the valves. Listed building consent may be required for the signage, and this will need very careful consideration so that functional needs are adequately balanced by sympathetic design and positioning. Suitable lighting should be provided in pump rooms and if these have to be accessed via a ladder or stairs, the light switches should, for safety, be located at the start of the route.

#### 1.5.1 Electric Pumps

Electric pumps should be correctly installed and wired in accordance with the requirements of BS 7671: *Requirements for electrical installations 2008* (The Institution of Electrical Engineers Wiring Regulations). The wiring practices for electrically driven sprinkler pumps are described in detail in BS EN 12845 and the LPC Sprinkler Rules and it is important to follow the advice given to make sure that electrical power is available to the pumps in the event of a fire. One of the first actions that the fire and rescue service will take when attending a fire is to isolate the power supplies to the property to protect firefighters from electrocution. If the wiring circuits are incorrectly configured the sprinkler pumps may be switched off unintentionally.

When using diesel generators as a power source for electric pumps it is essential that the power output of the generator is correctly estimated. The power requirements

for properties have a tendency to grow with time. Overloading a generator during a fire may result in a total power failure of the sprinkler system. The LPCB publish a list of approved electric- and diesel- powered sprinkler pumps.

### 1.5.2 Diesel Pumps

Diesel pumps are generally considered to be the preferred pumping equipment for sprinkler systems and for certain risks and combinations of water supplies insurers may insist on at least one diesel driven pump. They have their own self-contained power source and have proved to be dependable and are immune from the problems associated with the reliability of electrical power supplies in remote areas or during fires. The disadvantages of using diesel driven pumps are that they are more costly than comparable electrically driven pumps, are noisier and require more maintenance and a store of flammable fuel.

Diesel pumps require a purpose-built pump house with adequate heating and ventilation. Ideally, the pump house should be external to the building and easily accessible to the fire and rescue service during a fire.

## 1.6 Installing Pipework

It should be accepted that all of the fabric of a traditional building is valuable – regardless of whether it is concealed or on show, unadorned or splendid. All such fabric contributes to the authenticity of the building. Any decision to disrupt any part of the fabric should therefore be carefully thought out. While sprinklers may provide a range of compensating features in respect of compliance with the building regulations, steps should be taken, where possible, to minimise the amount of pipework needed. This could be by combining sprinkler risers with other fire protection supply pipework, reducing the diameter of pipework where possible and using innovative systems such as flexible sprinkler connections to allow exact placing of sprinkler heads on a ceiling.

Because the use of the term ‘traditional building’ encompasses such a large variety of types of structures, it is impossible to codify specific guidance for the installation of automatic sprinkler installations in such premises. Every sprinkler installation is unique but a few general rules can be provided.

Every proposed system must be considered from first principles on its own merits. This makes it especially important to build the appropriate team of experienced professionals who understand the unique problems that traditional buildings pose.

### 1.6.1 Exposed Pipework Systems

This approach minimises the degree of disturbance to

the structure of the traditional building, and, in this respect, is the preferred installation approach. Exposed pipework will, however, have a visual impact on the spaces into which it is inserted, and this will not be appropriate in all historic interiors, especially those where the importance of the room rests in its precise geometry or fine detailing.

Care will always need to be exercised in the design of the exposed pipework to ensure its appearance is appropriate to the historic interior to be protected. Two approaches can be taken to the installation of exposed pipework systems in historic buildings:

- The installation is frankly expressed as a new insertion whose aesthetics are appropriate to the building in question
- The installation can be ‘painted out’ to blend with the background decor (for example the dark painted sprinkler pipework in the elaborate hammerbeam roof of Parliament Hall, Edinburgh or the light painted pipework of the Laigh Hall in the High Courts, Edinburgh, and Corgarff Castle, Ballater (see illus 95 to 97).

In some historic interiors, it may be possible to run exposed pipework out of sight above existing cornices.

Reversibility is one of the criteria that should be applied to all proposals for intervention in historic buildings to test their suitability. Even though experience shows a



*Illus 95 Sidewall sprinklers and exposed pipework in the Laigh Hall, High Courts, Edinburgh*



*Illus 96 Detail of sprinkler head, Laigh Hall, High Court, Edinburgh*



*Illus 97 Pipework in Corgarff Castle 'painted out' to blend with the background decor*



*Illus 98 In this out of view attic space, the pipework has been suspended from the ceiling timbers, so minimising impact on the fabric*

sprinkler system will remain serviceable for more than 50 years, consideration should be given to the need for its eventual removal, renewal or replacement as the life of any traditional building is likely to be considerably greater than that of building services installations.

An exposed sprinkler system is more readily removed due to the ease of access to its constituent parts, a characteristic that will also facilitate the maintenance of pipework during the life of the system.

Exposed pipework should be used in all unoccupied areas of the building, such as attic spaces, basements and service or utility areas where ease of access for maintenance will be important and the appearance of the system less significant.



*Illus 99 Exposed pipework can often be incorporated in basement areas where the appearance of this system is less of a concern*

All sprinkler pipes in wet sprinkler systems in unheated areas should be adequately protected from frost. Even in a well-heated house, the ambient temperature in roof spaces in winter can fall below freezing point. Pipework should be fully protected by an adequate thickness of insulation. For added protection the pipework can be trace-heated, with junction boxes positioned on the vertical cheek of rafters for ease of access and maintenance. Other possibilities include the use of a special antifreeze, as at Corgarff where winter temperatures regularly go below  $-15^{\circ}\text{C}$  water, or installation of loop system to permit circulation of warm water.

Suspending, or cheek securing, to the timber roof structure are simple methods of fixing new services in place with minimal damage to the original fabric (illus 98). All sprinkler pipework should be installed away from roof timbers so maintaining a free air flow, and protecting the timbers from rot. If a large number of securing points are required, it may be best to consider installing a separate plate to which the larger number of fixings can be made.

### 1.6.2 Concealed Pipework Systems

In order to keep intrusion to a minimum and maintain the aesthetic and traditional qualities of the building, it is likely that pipes will have to take circuitous routes to reach their destinations. For example, in the installation of sprinklers at Duff House, pipes were installed in the timber floor and these followed the route of earlier heating pipes in order to minimise disruption of the fabric, and supply some sprinkler heads from below. This is entirely acceptable from an engineering point of view provided that hydraulic calculations have been carried out to ensure that adequate flow and water pressure is provided at the sprinkler heads. Designers should be encouraged to rise to this challenge.

In order to conceal pipework from view it may be run:

- Under floors, between joists
- Above ceilings
- In voids, such as those behind panelling, or up redundant chimney flues
- Along the top of wide cornices
- Along the walls of adjacent service areas
- Along previously disturbed, but redundant, service routes.

Ideally, all new pipework should be located within existing voids and service routes through the building. However, for a full installation, some hard structure ragging may need to be accepted, but the actual extent of disturbance should be kept to a minimum. Full testing of installed pipework should be carried out before the recreation of finishes. If compartment walls are breached to allow sprinkler pipes to be installed, they must be fully fire stopped on completion of the works to maintain fire integrity.

### 1.6.3 The Integration of Pipework in Solid Floors

In many installations, the main supply pipework will enter the building at the basement floor. It may be appropriate to chase the pipework into the solid floor at this level and this can be easily achieved with plastic pipe, which can be laid directly into a chase lined with trading material and screeded over. If steel piping is to be used, it will require protection from corrosion by additional tanking wrapped around the pipework itself. If a general refurbishment is taking place, lined recesses can also be created to house conduit, electrical cabling and plug outlets.

Sprinkler water supply pipes can also be accommodated within existing floor screeds if these are of sufficient depth. Care needs to be taken to keep the overall size of the pipe slot to the minimum so that the relaid flooring can span the installed pipe without damage through deflection, or lack of support.

### 1.6.4 The Integration of Pipework in Timber Floors

If major conservation works are required, or the historic building is being refurbished due to a change of use, it is likely that entire floors will be lifted allowing the opportunity for a range of services to be comprehensively detailed and installed (illus 100). This approach creates additional demands on the design team and on-site contractors, especially when the topside of the underlying ceiling is exposed.

Additional protection should be installed to prevent damage to those features exposed by the lifting of floorboards and this should be maintained in a satisfactory

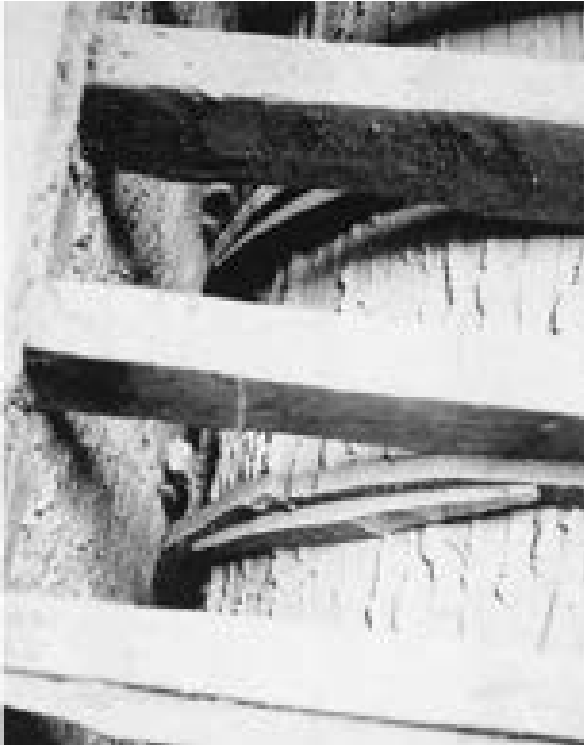


*Illus 100 The timber floor has been lifted to allow the integration of horizontal service ways*

condition throughout. Temporary moveable flooring may be required to provide safe working areas and to prevent operatives, tools and materials falling onto, or through, the exposed plasterwork below. Appropriate fire precautions must also be taken at all stages of the work.

When lifting an historic timber floor, it is imperative that all floorboards are individually identified prior to work starting. Apart from simple numbering, one method of achieving this is to lay masking tape over the floorboards, and mark on each a unique reference number. The tape is cut as the boards are lifted, but on relaying the tape alignment will allow accurate repositioning of the boards. Bundling of adjacent boards before storage will further aid their accurate reinstatement. A detailed plan should be drawn showing the position of each board and they should be carefully stored in appropriate environmental conditions for the duration of the work. Care will be required during lifting and relaying to avoid damage and splitting of the boards, helpful guidance can be found in *SPAB Information Sheet 10, Patching Old Floorboards*.

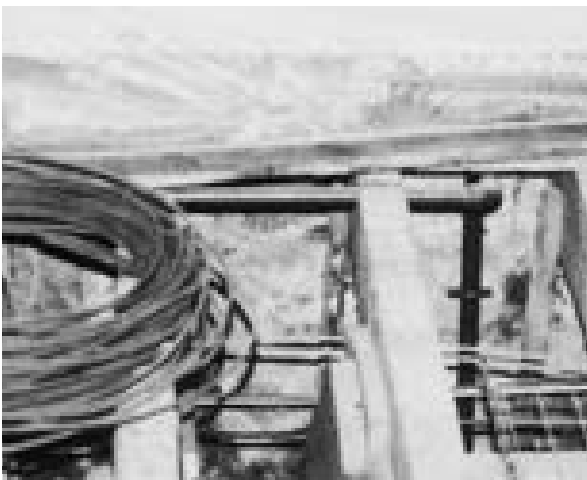
Following the removal of the floorboards, a detailed analysis of possible service-ways should be made. Useful voids can usually be found above the lath and plasterwork of coved or combed ceilings. In the example shown in illus 101 the laths are fixed to formers. These, in turn, are cheek-nailed to the face of the floor joists to create a common profile. The void created provides a horizontal 'duct' space, ringing the room below. The void can accommodate a wide range of services, pipes, cables, apparatus and sensors, installed from the floor



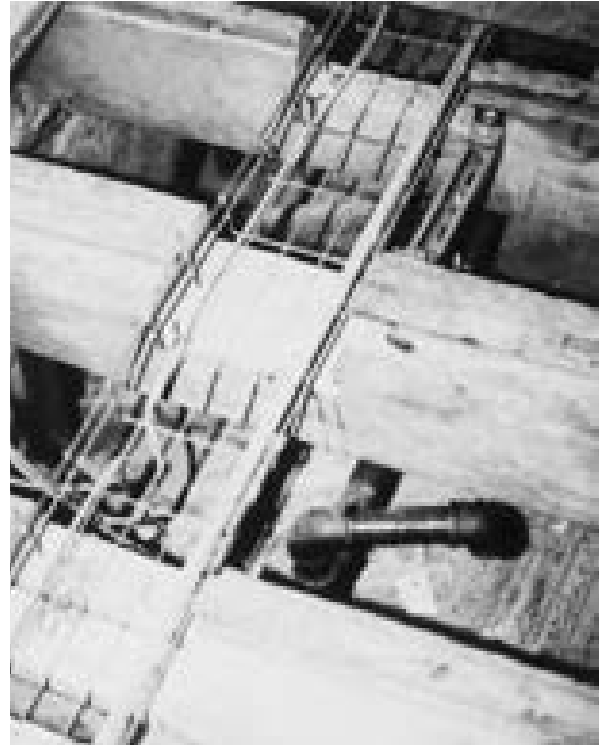
*Illus 101 Hidden voids*

above. However, maintaining a free airflow in this zone will be critical to ensure dry rot does not break out, especially crucial if the floor joists bear on an external masonry wall. In the example shown in illus 102 pipes installed in the void behind the falsework of a combed ceiling are secured directly to the masonry with brackets. Right-angled pipework bends allow direct connections to the horizontal runs. A more sympathetic integration in this situation would have located the horizontal pipe run below the joists, so avoiding notching into them.

The onus lies with the conservation architect working with the consultant to avoid creating situations that will



*Illus 102 Sidewall sprinkler supply pipe*



*Illus 103 The sprinkler supply pipe has been installed beneath the joists. The same care has not been taken to integrate the cable tray for electrical services without damaging the historic fabric*

require the destruction or removal of any part of the structure and fabric of the building. Thus, pipes should be set between the joists, running parallel to them, whenever possible. When laying pipework within an existing timbered floor space, it can either be laid around the timber members resulting in a large number of closely spaced pipework joints or longer lengths of straight pipe can be used resulting in extensive timber notching (illus 103). In the context of a traditional building the services should be adapted to suit the building and not vice-versa, and the pipework laid around the structural timbers wherever possible.

Provided stringent quality control checking is in place and a competent company is installing the pipework, the increased jointing of pipework should not result in any increase in the risk of leaks. Utilisation of CPVC pipes, which are more flexible than steel, longer lengths of pipe may be routed through the structure with minimal notching of timbers. CPVC is also inherently cleaner to install than steel and providing manufacturer's instructions regarding the way in which jointing is carried out, there is equal reliability in respect of leaks.

Top or bottom notching of structural floor timbers greatly reduces their strength. Some traditional structures may have been over-designed, so that it is sometimes possible to reduce the section of a piece timber without impairing its performance, though the advice of a structural engineer should always be sought before this is contemplated. In addition to considering the strength

of the timber to be notched, the impact of the change on the wider structural system of the building should always be considered.

Where it is necessary to notch the uppermost surfaces of floor joists, the pipework should be designed so that jointing pieces do not occur at these timbers, so minimising the depth of the notch required.

Where a sprinkler head position has been determined by the ceiling design, it is possible that this will coincide with a structural floor member above (illus 104). Removal of timber can be minimised through the use of a hole saw, though precautions will need to be taken to avoid the saw wandering off a true vertical alignment. It may be necessary to carry out local strengthening of the structural timber so that the sprinkler head can be accommodated within it if a recessed or concealed type is to be used. Any strengthening steelwork inserted into the structure should be protected to give the required level of fire resistance, this may be most simply achieved with an appropriate intumescent paint.

Once work is completed, any floorboards that have been uplifted should be replaced in their original position (illus 105). Care needs to be taken when refixing the boards not to puncture any underlying cables or pipes with securing nails.

Access covers will need to be provided at appropriate locations, and these should be noted on any drawings submitted for listed building consent. The design process should be geared towards an effective integration of the service installation with the original finishes at the outset (illus 106). This should mean that the shape and size of access ways align with naturally occurring joints in the

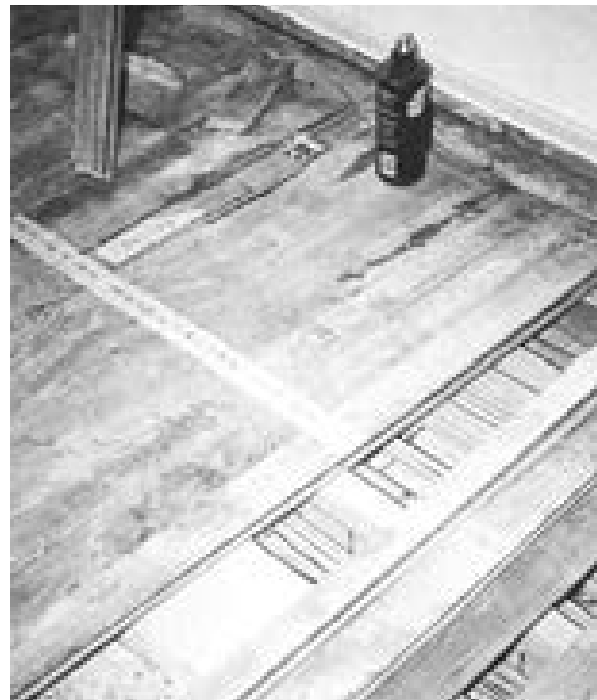


*Illus 104 Sprinkler supply pipe installation*

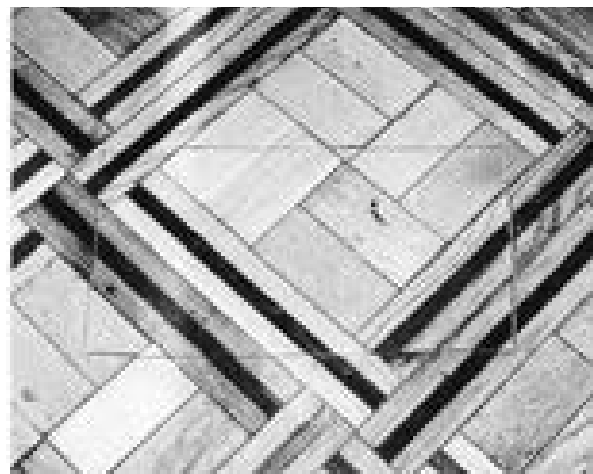
floor patterns. The provision of access panels may involve rebating the flooring to enable a frame to be inserted to give the panel strength. Panels should be screw-fixed to avoid puncturing the underlying installations when refixing after routine inspection or maintenance work. Floor plans showing the location of access and inspection covers should be available to maintenance contractors at all times.

### 1.6.5 The integration of riser pipework

Ingenuity will be required to design any minimum impact system. For example, if no shafts or existing service routes exist to house sprinkler pipework risers, it may be possible to install these within a series of vertically-aligned wall cupboards. In this case, it will only



*Illus 105 Timber floor reinstatement*



*Illus 106 Inappropriately located access hatch*



be necessary to make physical connections at each floor in order to provide a continuous vertical rising duct.

Exposed pipework is preferred as its installation will cause the minimum possible damage to the fabric of the building, and allow the pipework to be easily accessed for any future maintenance. Should it be decided that riser pipework must be concealed within the structure, pipe and cable-ways need to be carefully secured into ragged internal masonry. Pipe holdfasts should be fixed directly into the bodies of the larger stones that are encountered.

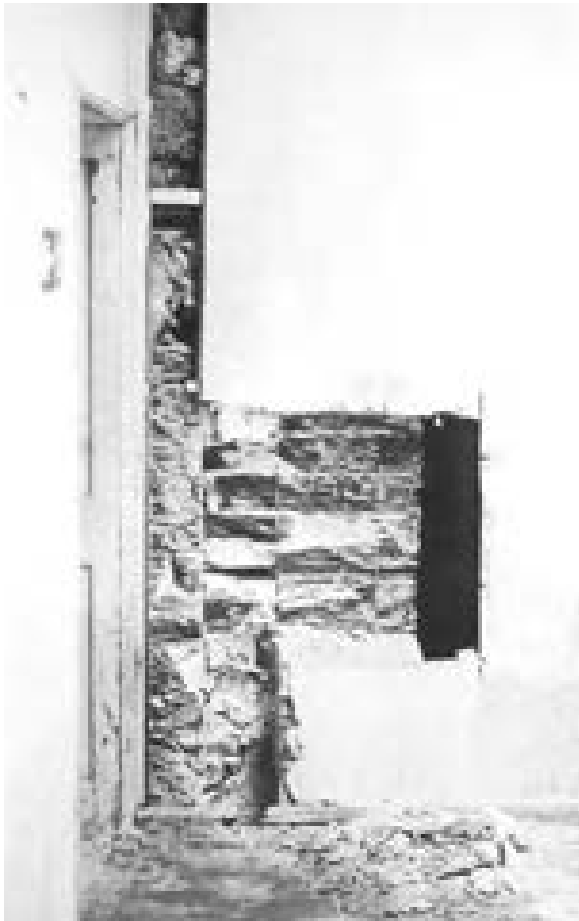
Care should be taken to ensure that walls are thick enough to accept ducts safely. Only ducts of adequate, but restricted, dimensions should be cut into walls or solid floors, of sufficient depth to allow for all pipework and joints and for the sensible recreation of the room's plaster or other finishes. Should inspection panels be needed, these should be carefully detailed so that they integrate with the completed decor of the room.

Disc tool cutting equipment greatly assists in minimising the amount of disruption to historic fabric that can occur whilst inserting services but must be used by skilled operatives only. In the example shown in illus 107, a series of four vertical cuts shape the vertical duct and hose reel recess. A series of five cross cuts further

define the recess and allow the segmented pieces to be extracted with little further distress to the fabric. The wall plaster spanning across a solid stone wall and timber stud partition ably demonstrates how structural discontinuity and hence fire route risks can be hidden within the structure of an historic building.

Before covering up, water supply and sprinkler pipes should be lagged with fibre insulation (illus 108). This helps to protect the assembly from any possible interactions that might occur after the wall has been replastered. Banding of grouped cable runs also helps to minimise interference, as long as the electrical installation has been designed to allow cables to be bunched or covered in this way. The lagging of the pipes provides protection from frost and should prevent mechanical damage occurring after the wall has been plastered. Care needs to be taken to avoid over-lagging the pipework as this could reduce the depth available for replastering.

Wherever vertical routes through the building are created, additional care will be required to ensure that the floors are fully fire-sealed on completion of the work. Failure to do so will create a weakness in the fire compartmentation of the building. Intumescent bags, granules and blocks can be used if it is not possible to create a suitable hard fire stopping at breakthrough positions.



*Illus 107 Vertical pipe casework*



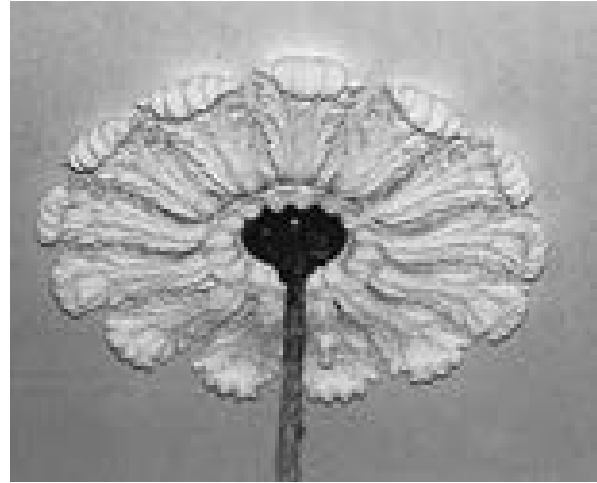
*Illus 108 Vertical pipe installation*

### 1.7 Installing Sprinkler Heads

BS EN 12845 recommends head spacing for sprinklers to achieve the correct water discharge density, however the final decision on water application densities should be taken from the head manufacturer's data sheet – in recent years there has been considerable innovation in the design of sprinkler spray deflectors and the coverage which can be provided by individual sprinkler heads. In traditional buildings the visual impact of the sprinkler heads must also be taken into account, and this may often lead to a non-standard pattern of sprinkler heads being adopted to achieve the necessary coverage. However, the maximum and minimum spacing requirements should be adhered to, otherwise fire protection may be compromised either by inadequate water coverage or by sprinkler heads causing excessive cooling at adjacent sprinkler head locations.

Each room should be considered individually since each will present a different challenge. Heads can be exposed or concealed, depending on the strategy agreed for the building. In either case their finished appearance and visual impact should be considered at the outset.

In the last twenty years, there has been increasing use made of quick-response sprinkler heads. These sprinkler heads are able to react more swiftly to fire, thus minimising fire, smoke and water damage, they also tend to be smaller than other sprinkler head types. When painted (in accordance with the manufacturer's instructions) to suit the room's decoration, they may be combined with an existing decorative feature to become almost invisible to the casual observer (illus 109). In some cases, the heads may be painted by a craftsman with appropriate skills to create an effect approaching that of camouflage or *trompe-l'oeil*.

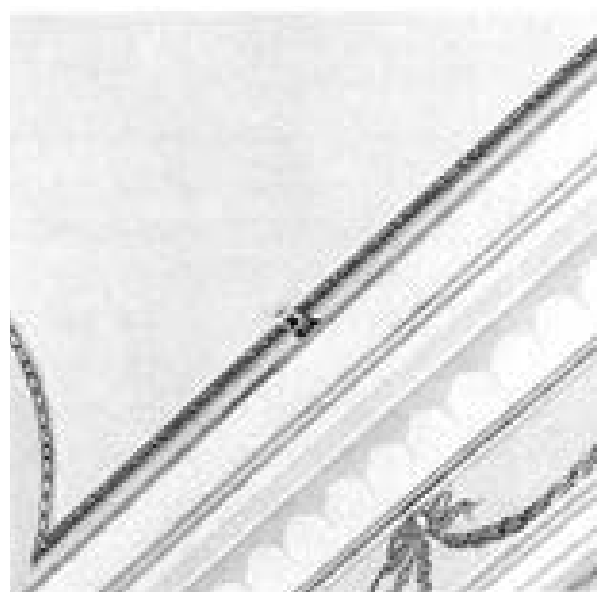


*Illus 109 Quick response sprinkler installed in a ceiling rose*

Quick response, horizontally-mounted extended coverage sprinklers have also been developed and these are capable of distributing water horizontally over a distance of up to 7m. It is therefore possible to protect some rooms, galleries or similar areas without the need for ceiling-mounted sprinklers. One such installation is shown in illus 110.

The effectiveness of the sprinkler will depend upon its ability to detect and suppress a fire. Thus any obstructions to the head and its spray pattern, should be avoided. This may require the cooperation of other service disciplines and the curator of the building who oversees the arrangement of furniture.

The example illustrated in illus 111 shows the sidewall sprinkler, detection head and fluorescent light fitting all installed to a common alignment. Unfortunately, the projecting cowl of the light fitting extends below the



*Illus 110 Two examples of sensitively located sprinkler heads, one painted to blend in and the other a sidewall sprinkler installed above a cornice*



*Illus 111 Sidewall sprinkler pitfalls*

uppermost boundary of the sprinkler head spray range. Should the head be activated, the effective range of the spray will be greatly reduced. A pendant light bulb, rather than a strip light, would have been more appropriate in this location. Any storage on the uppermost shelf will also interfere with the intended spray pattern, greatly reducing the coverage of the sidewall sprinkler. Greater attention to design detail and subsequent housekeeping management is necessary.

### **1.7.1 The Installation of Ceiling-mounted Sprinkler Heads**

Through careful integration with the design of ornate ceiling work it is possible to greatly reduce the visual impact of sprinkler heads. When viewed obliquely, the raised modelling of the ceiling plasterwork will further obscure the heads.

In the example illustrated in *illus 112*, the concealed sprinkler head is located along the centre line of the ceiling design, between the bird's head and the surrounding frame, below the vase base. Using a circular hole-saw it is possible to cut the lath and flat plasterwork of the ceiling with minimal damage (*illus 113*). The hole should be tightly sized to the head assembly dimensions, as the screw-on cap will then completely cover the opening.



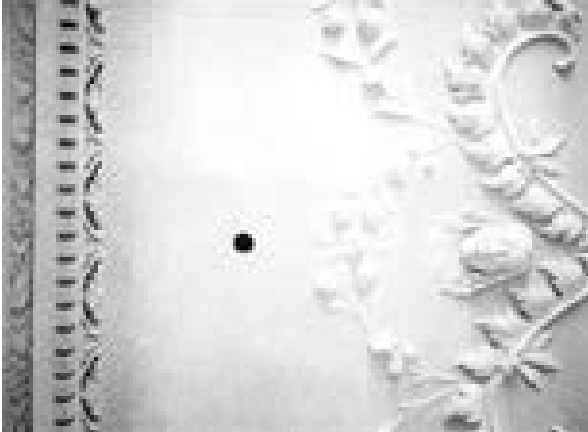
*Illus 112 Installed concealed sprinkler head, the vestibule, Duff House*

The opportunity to use any existing ceiling openings should be seized. In the example shown in *illus 114*, the sprinkler head has been effectively concealed by mounting it within the existing ornate ventilation grille.

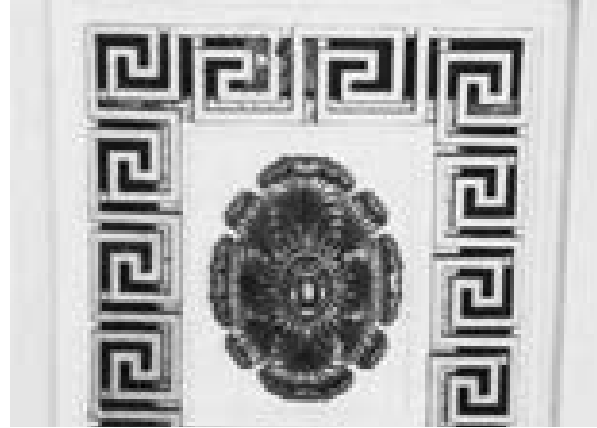
Care must be exercised when carrying out repainting work as the cover of concealed sprinklers must not be over-painted except by or in accordance with the manufacturer's permission. This could affect their performance through creating an 'insulated' layer that might interfere with the response mechanism and timing. More importantly, any paint could effectively glue the concealer plate to the ceiling. Such restrictions dictate that the concealer plate's finished colour be factory applied by the manufacturer. In order to specify the colour when ordering, a detailed historic paint analysis may be required.

Sprinkler heads recently installed in Windsor Castle were factory-finished in gilt<sup>36</sup> to suit the surrounding decoration, and manufacturers should be consulted early in the design process to ensure their cooperation in the production of appropriately finished sprinklers. Increasingly better colour matches are available, although some manufacturers may restrict the actual colour

<sup>36</sup> While this may seem extravagant, the sprinkler heads in the Verandah suites of the *Queen Mary* are silver plated.



*Illus 113 Hole cut in ceiling, ready to receive concealed sprinkler head, the vestibule, Duff House*



*Illus 114 Sprinkler head mounted within a ventilation grille, High Courts, Edinburgh*

supplied to a near match of the historic hue. In some sensitive historic interiors this approach is inappropriate. Suppliers need to be aware of the need to improve the provision of coloured concealer plates if they wish to support a greater use of sprinkler systems in historic properties.

In some cases, sprinkler heads can be hand painted but this must be carried out under the close control of the consultant who should clear the proposal and the type of paint to be used with the sprinkler installer and head manufacturer. Illus 115 shows a lime wash finish on concealer plates at Corgarff.



*Illus 115 A limewash finish on a concealed sprinkler plate, Corgarff Castle*

From a practical point of view, sprinkler heads should be located where they can best detect and suppress a fire. In roof spaces, a location in the apex of each void is likely to provide the optimum situation.

Protective guards (see illus 116) can be installed on most types of non-concealed sprinkler heads to offer some protection from accidental knocks. These may be necessary in areas where ladders and other tall items are moved around. The guards will not interfere with the water flow patterns should the head be activated, but they do considerably increase the visual bulk of the sprinkler head, and should be deployed only where appropriate, ie in storage and service areas and attics.



*Illus 116 Protective grill placed over sprinkler heads in the low-ceiling book storage areas in the National Library of Scotland*



*Illus 117 Sidewall sprinkler head installed within cornice*

### 1.7.2 The Installation of Wall-mounted Sprinkler Heads

The horizontal mounting of sidewall sprinklers brings advantages in that the pipes may be introduced through a wall from an adjacent area or from a void formed by coving. It may also be possible to run exposed pipework out of sight on top of cornices. The visual intrusion of the sprinkler heads can also be reduced by locating them above a projecting cornice, concealing some of their bulk. Alternatively, sprinklers may be mounted within a cornice, incorporated within the decorative pattern (illus 117). The impact of the projecting head can be further reduced if its colour is matched to that of its surroundings.

## 1.8 Care and Maintenance

As part of the specification for the installation, the contractor should be required to design and supply a maintenance manual for the complete system. This should include a comprehensive maintenance and test schedule for the equipment that has been installed. Although the basic maintenance routines should be common for all systems some of the details will vary depending on the equipment employed and the use of the system.

The maintenance schedule should be strictly observed as sprinklers have been installed as a form of compliance with building standards and the planning authority has the power to specify an ongoing maintenance regime. The system is also liable to be inspected on behalf of the fire authority as well as the insurers of the property. The installer should support this on handover by providing an intensive equipment familiarisation and training programme for those members of staff who have been nominated to look after the installation. It is worth noting that in the case of remote buildings which may be unoccupied for parts of the year it is worth involving

the local fire and rescue service personnel who may be likely to be called to the building to such training.

A designated member of staff, who may be called the fire safety manager, should be made responsible for the day-to-day care of the sprinkler system. The individual may be the building owner or manager or some other responsible person. The nominated person should be trained to carry out the daily, weekly and quarterly checks outlined below. (These are explained in detail in Technical Bulletin 203: 2004 of the LPC *Rules for Automatic Sprinkler Installations*.)

The sprinkler installation contractor should hand over drawings of the installation as it was fitted and records should be kept of all modifications to the system. A quality assurance scheme for documentation should be operated for this purpose.

### 1.8.1 Staff Training

Everyone who works in a building protected by a sprinkler system should be aware of the installation, its purpose and how it operates. They should be instructed about the care that they should exercise when undertaking maintenance or cleaning work in the vicinity of sprinkler heads. Staff training should also include instruction on:

- The purpose of the system
- The need to keep sprinkler heads unobstructed at all times
- The need to avoid damage to sprinkler heads and other components of the system
- Pumps and back up testing
- Water supply matters
- The action they should take if the system operates as a result of a fire.

Staff should be made aware that they should not tamper with the control valves and only operate them under close supervision. Pipes should not be used to support ladders and items should not be hung from them.

Specialist staff require more detailed training, depending on their role in the organisation. These personnel include security staff, maintenance staff and the fire safety manager. The member of staff designated as being responsible for the installation should receive in-depth training so that he or she understands the system fully and is competent to carry out or supervise the regular inspections and authorise any follow up requirements. Back up personnel should be instructed in the emergency operation of the system so that a trained member of staff is always available.

The system should ideally be maintained by the installing

company as part of a regularly reviewed contract. It is suggested by some authorities that the installation contract should include a requirement for the system to be maintained for three years after installation – usually free for the first year as part of the reliability and warranty requirements and on a repayment basis for the second and third years.

Painters must be warned not to paint over the sprinkler heads, and cleaners should *carefully* keep them free of accumulations of dust and fluff.

All staff should be instructed to report any incident of unauthorised tampering with the sprinkler system. All such incidents should be fully logged.

### 1.8.2 Action in the Event of Fire

In almost all circumstances staff should react to a fire alarm in the same manner whether a sprinkler system is installed or not. The primary response must be to call the fire service and evacuate the premises. The service should be called even if an automatic service connection is fitted as this will confirm that the call has been received.

Only after calling the fire service and evacuating the building should the cause of the fire be investigated if it is safe to do so. The sprinkler stop valve should not be shut except on instruction from a fire officer. Even if it appears that a fire is out the sprinklers should remain operating until the building has been searched to ensure that there is not more than one fire.

After a fire, the sprinkler system should be reinstated as soon as possible, with sprinkler heads that have operated replaced by spares. If a number of heads have operated it is advisable to call the maintenance contractor to inspect the system, but this should not be regarded as a reason for delaying putting the system back into full working order as soon as possible after the incident.

In the case of a false alarm the cause should be established and the system reinstated. The insurer should be informed of all incidents, whether a claim is made or not.

### 1.8.3 Routine Checks

The following sections are based on advice given in Technical Bulletin 203 of the LPC *Rules for Automatic Sprinkler Installations*, to which reference should be made.

Routine security patrols should be provided with a simple checklist which should enable them to make an easy and effective inspection as part of their normal duties. If the premises are not patrolled the member of staff responsible for fire safety should delegate the duty, which should include reporting:

- Any leaks found

- Obstructed sprinkler heads
- Obvious tampering with control valves, such as the straps being removed or unbuckled
- Incorrect pressures in the system (gauges should be marked with their correct pressures)
- Lack of heating in pump and valve rooms
- Materials stored in pump and valve rooms.

The regular inspections carried out by the fire safety manager should be in accordance with a series of more detailed checklists. The topics to be covered on the weekly list should include:

- Unmonitored fire service alarm connections
- Adequacy of heating
- Recording the readings of pressure gauges
- Checking the positions of valves
- Tests at alarm valves
- Drain and test valve checks
- Checks for leaks
- Testing the automatic pumps and where fitted, checking fuel and oil supplies for any diesel driven pump or generator
- Checking the water levels on storage tanks.

If a serious fault is found, the fire service and insurers should be informed immediately and the maintenance company engaged as soon as possible to effect repairs. The fire service or central monitoring station should be informed before any directly connected alarms are tested.

The quarterly checklist should in addition include reference to:

- Unstrapping and exercising valves
- Reviewing the hazard classification
- Checking the condition of sprinkler heads, pipework and hangers
- Checking batteries and chargers.

A stock of spare sprinkler heads should be kept on the premises so that the system can be reinstated without delay in the event of a fire or of a head being broken. A proper sprinkler head spanner should be kept with the spares to ensure that they are not damaged when being fitted.

Spare fuel filters, oil filters, belts, gaskets, hoses and injector nozzles for diesel engine driven pumps should also be kept available. Any spare parts which are used should be replaced immediately.

### 1.8.4 Maintenance by Sprinkler Contractors

The exact maintenance undertaken by the contractor will depend on the type of system installed but will generally include:

- Changing alternate systems from wet to dry operation (or vice versa) as appropriate
- Greasing and exercising valves
- Inspecting and testing fire service connections
- Servicing and changing the oil in diesel engines
- Testing water flows and pressures
- Checking pressure gauges against a standard for accuracy
- Checking batteries with a hydrometer and topping up if necessary
- Checking the condition of pipework, hangers and sprinkler heads.

The contractor should provide a complete report of all work carried out and should certify that the system has been left in an operable condition.

### 1.8.5 Safety during Sprinkler Shutdown

Before a sprinkler system is wholly or partly shut down, all interested parties should be informed, in particular the fire service, insurers and central monitoring station. Indeed, it would be wise to obtain permission from insurers, where possible, before shutting down the system. If the system becomes inoperative or has to be turned off as a matter of urgency the fire brigade and insurers should be informed as soon as possible. In the case of a life safety sprinkler system, additional measures will also be necessary.

Work should be planned so that there is the least possible interruption to the protection provided by the sprinkler system:

- If possible sprinklers should not be left inoperative overnight
- Alterations and repairs should be carried out during normal working hours as far as practicable
- Sprinkler contractors should make sure that the staff involved are ready to do the work and that they have the materials and tools needed to complete the task before sprinklers are shut off
- In the case of manufacturing premises extensive alterations or maintenance should be deferred until machinery and plant are idle.

When it is impossible to complete the work in one day, as much of the system as practicable should be made

operative before the sprinkler contractors leave and special attention paid to parts of the premises where the system is inoperative. It is particularly important to make sure that fire doors and shutters are closed.

As many sprinkler heads as is practicable should be kept in service while work on the system is in progress:

- Where there are large systems made up of more than one installation or suitably zoned into areas, each with its own stop valve and/or alarm valve, only the installation being worked on need be shut down
- Sections of an installation on which work is being carried out can be blanked off so that the remainder of the installation is kept in operation. This may involve temporary connections to hydrants or to other sprinkler installations
- In some cases shutting down a system can be avoided entirely by the use of pipe tapping machines with which connections can be made to underground mains without shutting off the water. (This technique should only be undertaken by appropriate specialists.)

In order to reduce fire dangers during shut down, a number of precautions should be assiduously taken:

- Before turning off sprinklers check thoroughly that there are no signs of fire in any part of the buildings
- Suspend all operations which could give rise to fire including:
  - processes known from past experience to be hazardous
  - burning of rubbish
  - hot work.
- Prohibit smoking in all affected areas at all times
- Rigorously enforce normal fire safety requirements such as the removal of combustible waste and the closure of fire doors
- Ensure that all extinguishers are in position and ready for use, with trained staff available
- Arrange for continuous patrolling of areas in order to detect any signs of fire and to maintain good standards of housekeeping
- Display bold 'valve closed' notices on closed valves as a reminder to open them when work is complete
- Close the building to members of the public or increase supervision.

On completion of the work, ensure that all valves are reopened fully and restore the system to normal operating

conditions. Secure the valves open by padlocked chain or straps. In sprinkler systems in historic buildings it is appropriate that stop valves be electronically monitored to indicate when they are fully open.

If the mains water supply to a sprinkler system is cut off because of burst pipework or any other reason beyond your control, pay special attention to maintaining any alternative water supplies and observe the precautions indicated above as if the sprinkler system had been shut down.

## 2. Insulation from Fire and Use of Flame Retardant and Intumescent Materials

Materials which are combustible or otherwise vulnerable to fire may be 'passively' protected by providing insulation to delay the rise in temperature. Examples of these in traditional buildings could include:

- Ash, sand or lime pugging in floors
- Thick plasters or renders over timber structures
- Concrete filling of cast iron columns
- Over-sized timber beams which char without loss of effective structural strength.

Modern intumescent products function by expanding to give additional insulation to vulnerable thin components.

### 2.1 Flame Retardants

Depending on their material or finish, the surfaces of walls and ceilings may contribute to the spread of fire within buildings. In many cases proposed alterations to surface treatments are now controlled by legislation to ensure that the spread of flame from an ignited part to adjacent surfaces is restricted.

The main areas of concern in traditional buildings will be from timber panelling, surfaces of all kinds which have many layers of paint, and large fabrics such as wall hangings and curtains, particularly in rooms visited by the public. Many such fabrics may themselves be of historic value. Once other fire precautions have been implemented it may be that some form of retardant to the spread of flame on such surfaces will require to be considered.

Spraying or dipping of modern fabrics can be carried out to retard flame spread. It may be necessary to apply the treatment on a regular basis to ensure proper protection. It is unlikely that this would be appropriate for historic fabric and such treatment should not be undertaken without specialist advice and consultation with Historic Scotland.

For timber and painted surfaces thin film intumescent

paints might be applied provided the original finish had no particular historic merit. When subjected to heat these paints will expand to produce a layer of rigid closed-cell foam which inhibits the spread of flame. The material will also provide some insulation to the base material from the high fire temperatures. Each surface to be treated should be investigated to determine the nature of previous coatings, and these may have to be removed before effective protection can be obtained. The proper preparation of the surfaces is fundamental to the success of the application.

Because of the potential loss of historic fabric through removal of previous coatings, and as the new treatment is not easily reversed, the application of flame spread retardants should be considered the last resort in all but exceptional circumstances.

### 2.2 Intumescent

A range of products is available on the market which have been chemically formulated to react to the presence of heat from flames or hot smoke. The active ingredients of these products are commonly sodium silicate, ammonium phosphate or intercalated graphite. The reaction of the active ingredient with heat, causes it to expand, thus providing a protective insulating shield to the material or construction to which it has been applied. A further benefit of such expansion when heat is applied is to cause gaps in construction (which are necessary in a normal condition or may have occurred as an ageing process) to be sealed under fire conditions, thus preventing the spread of fire and smoke through the gaps.

The products which are available include paint and other applied coatings, sheet material, encapsulated strips, reinforced rolls, pre-formed collars and emulsion based mastics. Each has been designed to suit a specific application and can be formulated to give a range of expansions of varying volumes and exerted pressures.

**Intumescent paint** may be used to increase fire resistance of timber and structural metalwork, whilst providing a decorative finish.

**Intumescent coatings** are by definition thicker than paints, and therefore, have less satisfactory visual appearance, but can offer substantially greater fire protection. Elements of structure which will be subsequently encased with another finishing material could receive intumescent coatings.

**Intumescent sheets** can vary in thickness from the equivalent of a thin card, up to several millimetres and they can be secured to the surface of a material using glue, nails or screws. Depending on the method of fixing, there may be advantages over painted treatments as they can be later removed



without adversely affecting the material to which they were applied.

**Intumescent rolls and collars** – larger masses or rolls of intumescent material can be reinforced and contained in ‘pillows’ or rigid PVC or steel collars to provide a good seal around service ducts, pipes or wires when they pass through otherwise fire resistant walls or floors. High pressure and volume expansion would be specified to completely close off a pipe passing through a floor to prevent fire or smoke penetrating between compartments.

**Intumescent pastes and mastics** are used in combinations with any of the other intumescent products to ensure edge conditions are not vulnerable to fire. They are also used for repair of physical damage to intumescent coatings and can combine as a bedding material for fire resistant glass to achieve periods of fire resistance for glazing into window frames.

ISBN: 978-1-84917-035-2



9 781849 170352