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Department for Communities and Local Government
Final Research Report:

BD 2890
Investigation of real fires

283168 (D19V1)

CPD/04/102/027

Prepared for:

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FIRE

BD 2890

Investigation of real fires

Final Research Report

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Executive Summary

This is the Final Research Report for the Department for Communities and Local Government (DCLG) Building Regulations and Standards Division project titled "Investigation of Real Fires", DCLG Contract reference CPD/04/102/027, BD 2890, which started in November 2012 and was completed at the end of March 2015.

The overall aim of this project was to provide DCLG with rapid and accurate feedback on the performance of real buildings in real fires. The specific objectives of this project were:

- To monitor and provide timely feedback to DCLG from fire incidents on the following issues:
    - The effectiveness of Part B of the Building Regulations and the guidance in AD B in achieving its fire safety objectives, with particular consideration of the impact of the 2006 revisions.
    - Compliance with Part B of the Building Regulations and its associated guidance and standards and how this affects fire safety in practice where fires have occurred.
    - The impact of British and European Standards on building products and systems and the impact of new designs and new methods of construction, and the use of innovative or unusual materials.
    - The role and use of fire safety engineering approaches and other means of meeting the Building Regulations requirements
    - The impact of the Regulatory Reform (Fire Safety) Order 2005 on fire safety in buildings and particularly the interface with Part B.
- To identify and indicate any need for research or for changes to Part B/AD B arising out of specific problems highlighted in fire investigations.
- To maintain close contacts with other investigators in the fire and rescue services and elsewhere to encourage the exchange of information on unusual fires that will be of benefit to DCLG.
- To disseminate findings from fire investigations to the Fire and Rescue Service, building designers and owners and others, as relevant.
- To improve understanding of how unusual fires develop and grow, particularly in domestic properties, through site investigations where appropriate and through consideration of events in other countries.

Data have been gathered from on-site visits, from a network of other fire investigators in the fire and rescue service, police and from the media (primarily the web). The information gathered has primarily been used to inform Approved Document B (Fire safety) for England (AD B). This information offers effective solutions to real fire problems, which are best carried out by examining information from real fires. Positive feedback has been provided where guidance has helped to minimise fire spread and threat to life.

It has been the aim of this project to draw the attention of DCLG to potential or developing life safety issues rather than to explain them after the event.

The findings from this project have reaffirmed the overall effectiveness of the Building Regulations and AD B in providing for the safety of life in the event of fire and most of the significant issues that have been identified during this project fall outside the scope of these regulations.

Contents

1 Introduction and objectives

This is the Final Research Report for the Department for Communities and Local Government (DCLG) Building Regulations and Standards Division project titled "Investigation of Real Fires", DCLG Contract reference CPD/04/102/027, BD 2890, which started in November 2012 and was completed at the end of March 2015.

Data have been gathered for this project from on-site visits, from a network of other fire investigators in the Fire and Rescue Service, police and from the media (primarily the web). The information gathered has been primarily used to inform Approved Document B (Fire safety) for England (AD B). This information offers effective solutions to real fire problems, which are best carried out by examining information from real fires. Positive feedback has been provided where guidance has helped to minimise fire spread and threat to life. It has been the aim of this project to draw the attention of DCLG to potential or developing life safety issues rather than explain them after the event.

Fire safety systems differ from nearly every other engineering system in a building; any faults or failures in design, implementation or maintenance will only become apparent during the very emergency for which they are required. The interaction between these systems, the building fabric, the building users, the management procedures and fire and rescue service intervention cannot be fully tested in simulations or tests. So it is essential that DCLG constantly review the regulations, guidance documents, codes and standards to ensure that these are being effective, and remaining so.

Whilst fire deaths are at a 50 year low the wide range of social and technological factors that affect fire risk are constantly changing. It is necessary, therefore, for DCLG to remain vigilant to identify new problems and to ensure that DCLG are able to adequately and proportionately react to them.

In the past, the results from previous projects have been demonstrated to assist DCLG in keeping Ministers informed of high profile incidents and, from site investigations of fires of interest, ensure that AD B and other guidance published by DCLG properly and accurately reflect what is happening in real buildings in England. The project also serves as a filter and repository for information reported by Fire and Rescue Services to the BRE that would otherwise be addressed directly to DCLG.

The impact of British and European Standards on building materials and systems needs to be continually monitored in the context of real fires as new designs and methods of construction are adopted. Similarly, the impact of new designs and new methods of construction, and the use of (or increasing use of) innovative or unusual materials needs to be kept under review. DCLG must be kept aware of any consequent increase in risk to building occupants and this was to be achieved through the reporting system in this project.

These systematic, scientific and specific fire investigations that are carried out for DCLG underpin all of the DCLG fire safety research programme and give essential credibility to the guidance produced from the DCLG research. With the introduction of the Regulatory Reform (Fire Safety) Order 2005 (FSO), and the increasing use of fire safety engineering methodologies, both of which can significantly affect fire safety, fire investigations continue to be needed to provide a basis for the DCLG fire safety strategy.

Currently acceptable fire safety provisions in new buildings in England can be achieved by compliance with the guidance in Building Regulations AD B, but there is no obligation to adopt any particular solution contained in the Approved Document; the user (designer or fire engineer) may prefer to meet the relevant requirement in some other way by fire safety engineering (or the application of BS 9999:2008 (Code of

practice for fire safety in the design, management and use of buildings)). This project has sought to monitor the effectiveness and safety of alternative methods, and provide feedback to DCLG.

Life safety is the prime concern of the Building Regulations and the highest risk is in dwellings. So, amongst other things, this project has sought to identify those aspects of design and construction methods in new build that may lead to unusual or unexpected spread of fire, whilst also monitoring the performance of older property to identify areas that may indicate a need for amendments to the guidance in AD B for future build.

This programme, and the findings from this programme, enables DCLG to respond to national events, and assess the impact of changes in fire safety legislation and guidance documents, to identify issues (and identify priorities) for its research programmes, and the value or cost-effectiveness of current, new, or proposed measures.

The overall aim of this project was to provide DCLG with rapid and accurate feedback on the performance of real buildings in real fires.

The specific objectives of this project were:

- To monitor and provide timely feedback to DCLG from fire incidents on the following issues:
    - The effectiveness of Part B of the Building Regulations and the guidance in Approved Document B (AD B) in achieving fire safety in real buildings in England and in providing protection for fire-fighters.
    - Compliance with Part B of the Building Regulations and its associated guidance and standards and how this affects fire safety in practice where fires have occurred.
    - The impact of British, European and International Standards on building products and systems which have a real consequence on real incidents in England.
    - The impact of new designs and new methods of construction, and the use of innovative or unusual materials.
    - The role and use of fire safety engineering approaches and other means of meeting the Building Regulation requirements which have a consequence on real incidents.
    - The impact of the Regulatory Reform (Fire Safety) Order 2005 on fire safety in buildings and particularly the interface with Part B.
- To provide an on-going watching brief of developments in fire incidents and detailed investigations, reporting back to DCLG.
- To include appropriate site visits, investigative research and small scale experimental fire testing where required and/or dictated by the findings from investigations.
- To provide DCLG with unbiased robust and independent evidence/information to enable the DCLG to take a proactive approach in ensuring that policies and guidance remain proportionate to the risk and continue to be fit-for-purpose, but also to support the continued review of general policies in order to identify and/or remove/simplify existing regulations that have the potential to unnecessarily impede growth.

- In circumstances where substandard workmanship is identified as a contributory factor to an incident, the appropriate dissemination of findings should be adopted to provide a mechanism to raise awareness to industry and improve levels of compliance and competence.
- To improve understanding of how unusual fires develop and grow, particularly in domestic properties, through site investigations where appropriate and through consideration of events in other countries.
- To identify and indicate areas for research or for potential changes to Part B/AD B arising from specific problems highlighted in fire investigations.
- To maintain close contacts with other investigators in the Fire and Rescue Services and elsewhere to encourage the exchange of information on unusual fires that will be of benefit to DCLG.
- To disseminate findings from fire investigations to the fire service, builders, building designers and owners and others as relevant and through consideration of events nationally and internationally (as agreed with DCLG).
- To produce at least two journal articles per year which provide the appropriate dissemination of findings from significant incidents.

The work has involved an on-going, watching brief of developments in fire incidents and detailed investigation, including site visits of selected incidents each year.

The results of the investigations have enabled DCLG to be informed of, and to inform Ministers of, high profile incidents, and to ensure that AD B and other guidance published by DCLG properly and accurately reflect what is happening in real buildings in England.

2 Programme of work

The work programme comprised the following tasks:

Task 1 Continuous monitoring of national and international news and other sources of information on fires in buildings.

Task 2 Continuous appraisal of relevant fire safety issues and research through the acquisition and collation of information regarding fire incidents, being at least 200 (Category 3) fires per year.

Task 3 Investigation and collation of detailed information on at least 30 important (Category 2) fires per year.

Task 4 Site investigation of specific fires, up to 8 (Category 1) fires per year.

Task 5 Analysis of fires, in relation to Building Regulations and AD B and other legislation and in relation to fire safety engineering and scientific content.

Task 6 Reporting to DCLG on all fires, as required, including identification of any potential need for further research or for changes to Part B of the Building Regulations or AD B.

Task 7 Dissemination to a broader audience of interested parties where relevant and agreed with the Department.

Task 8 Where possible cross references with the Department's Incident Reporting system should be incorporated.

Task 9 Experimental small scale fire testing and reporting.

These Tasks are detailed as follows.

Task 1 - Continuous monitoring of national and international news and other sources of information on fires in buildings

Fires of interest were monitored by a number of BRE staff on a continuous basis which ensured maximum coverage. All available media, including television, radio, and web pages were continuously monitored for fires of relevance. Those in the fire community (especially other fire investigators) who were aware of our research also provided information to BRE directly. Public domain material and broadcast material on fires was collected from newspapers and the internet.

Detailed information was gathered through BRE's wide network of contacts with Fire and Rescue Services and police.

Task 2 - Continuous appraisal of relevant fire safety issues and research through the acquisition and collation of information regarding fire incidents, being at least 200 (Category 3) fires per year

Experienced fire scientists have continuously reviewed information on fires that occur (as derived above; Task 1) to identify those events with implications for Building Regulations and/or factors of particular interest and/or where further research is needed. The criteria have included (inter alia):

- the state and age of the building
- any unusual spread of fire and/or smoke
- any unusual performance of materials in the fire. Where there was an effect as a result of British and/or European Standards
- where the fire occurred in a building using fire safety engineering or very new techniques of design and build. Where there were lessons for fire safety engineering and fire safety management
- where there was occupant behaviour of note; either in accordance with expectations, or unusual, or with an unusual outcome
- where the incident was managed well, or poorly
- where the investigators had problems identifying how the fire developed, and why
- where the fire provided a good example of compartmentation. Where the regulatory requirements (or guidance recommendations) were demonstrated to have been successful
- where active or passive fire protection systems were effective
- where there were problems for the fire and rescue service
- where there were other research issues or matters of interest.

The locations of fires reviewed were primarily confined to England but information was examined on relevant fires in other countries such as Scotland and Wales and overseas.

Information about fires of interest has been reviewed in relation to the effectiveness or otherwise of AD B and related guidance, and DCLG has been kept informed of findings on a regular basis. This network enabled rapid confirmation of details so that the implications for Building Regulations could be reported in a clear and unambiguous manner.

Over the period of the project, 1676 fires have been reported upon.

Task 3 - Investigation and collation of detailed information on at least 30 important (Category 2) fires per year

A fire of particular interest was selected on the basis of the following "priority" list agreed with DCLG. Once a fire of particular interest was identified and appraised, more detailed and direct information was gathered from a variety of primary sources including the police, Fire and Rescue Service, forensic scientists and fire consultants in the private sector. These are Category 2 fires.

Fire Incident Survey: High priority List

1. Fatal fires:
    - all non-domestic premises
    - multi-fatal fires in domestic premises
    - other domestic premises with specific issue of interest
2. Non-fatal fires with injury or rescue:
    - all non-domestic premises
    - domestic premises with specific issue of interest
3. Fires involving difficulties for fire and rescue service intervention: all non-domestic premises
4. Fires of relevance to Building Regulations and/or AD B, for whatever reason
5. Fires of National Importance for whatever reason
6. Fires in fire engineered buildings, or with implications for fire engineered buildings
7. Fires where there are significant implications regarding the FSO, and/or the interactions between Building Regulations and the FSO.
8. Fires of specific scientific interest – e.g.:
    - Major evacuations or other human behaviour issues
    - Smoke toxicity issues
    - Cladding
    - Failure (or success) of compartmentation or other passive fire protection product or system
    - Extensive or unusual fire spread or smoke movement

- Problems with detection
- Successful or unsuccessful action of sprinklers
- Spread beyond building of origin
- Involvement of Innovative Construction Products and Techniques (ICPT) or Modern Methods of Construction
- Involvement of insulation in buildings (polymeric)
- Fires in tall buildings or deep buildings
- Post 9/11 issues (including success/failure of passive fire protection to steelwork – boards, cementitious, intumescent thin film coatings)
- Fires involving disabled or otherwise non-ambulant people, or involving people with reduced or limited decision-making capability.

Fire Incident Survey: Low priority List

9. Buildings which fall under the remit of another government department (e.g. prisons, schools, hospitals). However, these buildings usually conform to AD B (e.g. via BB 100 for schools) and may offer useful information for DCLG.
10. Arson fires with no other issues of interest
11. Derelict buildings
12. Buildings under construction (although noting that some buildings under construction can be partially occupied, or may otherwise be relevant to DCLG)
13. Overseas fires
14. Fire and rescue service operational issues only
15. Caravans, temporary buildings
16. Transport.

In addition to the "traditional" sources of information, other sources were exploited where appropriate. These included legal judgements from major or significant incidents which had been through Court. These latter sources provided the opportunity to delve quite deeply into the circumstances of individual fires, in particular with regard to the design, construction and management processes. However, legal judgements may often only appear years after an incident.

A “Dear Chief Officer” letter was sent to all local authority fire and rescue services in England during February 2010. This resulted in a number of responses and contact names. Partly as a result, and partly as a continuation of existing liaison, BRE continued to receive a high level of co-operation from all local authority fire and rescue services.

Once an important fire was identified and appraised (but where a site visit was not appropriate, necessary, or, indeed, possible) more detailed and direct information has been gathered on fires through BRE's existing wide network of contacts with the Fire and Rescue Service and police.

Detailed information has been sought at the earliest reasonable opportunity although the duty rosters of relevant fire and rescue service officers often resulted in a number of days delay in making contact with the Officer-in-Charge of an incident.

Detailed information has been obtained from Fire and Rescue Services or other fire investigators on the following Category 2 fires:

1. Secondary school, Hampshire, 7th November 2012
2. House of Multiple Occupation, East Sussex, 9th November 2012
3. Manor house, Devon, 14th November 2012
4. Nursery, Surrey, 2nd December 2012
5. Hotel, Lancashire, 20th January 2013
6. Block of flats, Hertfordshire, 25th January 2013
7. Block of flats, Halifax, 16th February 2013
8. Flat, Cumbria, 3rd March 2013
9. Car wash with flat(s) above, London, 20th March 2013
10. Block of flats, Leeds, 24th March 2013
11. End of terrace house, Nottingham, 25th March 2013
12. Terraced house, London, 29th March 2013
13. Block of flats, Manchester, 3rd April 2013
14. Semi-detached house, Cornwall, 5th April 2013
15. Block of flats, Surrey, 20th April 2013
16. Multi-purpose building, Avon, 24th April 2013
17. Sheltered housing, East Sussex, 24th April 2013
18. Bonfire spreading to Semi-detached house, Northumberland, 3rd May 2013
19. Block of flats, London, 6th May 2013
20. Offices, Wisconsin, USA, 14th May 2013
21. Industrial building, London, 6th June 2013
22. Block of flats, Greater Manchester, 19th June 2013
23. Bar and entertainment venue, Lancashire, 19th June 2013

24. Block of flats, Kent, 24th June 2013
25. Block of flats, London, 30th June 2013
26. Car park, Berkshire, 6th July 2013
27. Hotel, Oxfordshire, 5th September 2013
28. Mid-terraced house, Buckinghamshire, 11th December 2013
29. Detached house, East Sussex, 14th December 2013
30. Block of flats, Kent, 19th December 2013
31. Mid-terraced house, Derbyshire, 20th November 2013
32. Factory, Hampshire, 26th February 2014
33. Detached house, West Midlands, 28th February 2014
34. Mid-terraced house, Cheshire, 3rd March 2014
35. Mid-terraced house, South Yorkshire, 28th April 2014
36. Detached house, Greater London, 3rd May 2014
37. Terraced houses, East Sussex, 25th May 2014
38. Block of flats, Cornwall, 31st May 2014
39. Block of flats, Hampshire, 7th June 2014
40. Terraced houses, Manchester, 12th June 2014
41. Block of flats, Essex, 14th June 2014
42. Block of flats, Hampshire, 4th July 2014
43. Block of flats, Bristol, 6th September 2014
44. Laboratory (under construction), Nottinghamshire, 12th September 2014
45. Power station, Oxfordshire, 19th October 2014
46. Block of flats, London, 26th October 2014
47. Hotel, Hampshire, 15th November 2014
48. Mid-terraced houses, Greater Manchester, 11th December 2014
49. Terraced houses, West Sussex, 30th December 2014
50. Block of flats, Devon, 1st January 2015

Task 4 - Site investigation of specific fires, up to 8 (Category 1) fires per year

From the continuous review, BRE has identified fires of specific particular interest. These are Category 1 fires. When attending fire scenes, the BRE Fire Investigation Team has been led by an experienced BRE investigator assisted by the appropriate colleagues for the particular site investigation. When a visit has been thought to be required, the prior approval of DCLG has been obtained.

For any particular site investigation (Incident), the Investigation Team has been flexible in its composition and was tailored to the needs of the investigation. As well as calling upon our own team of experienced fire investigation scientists, the BRE Fire Investigation Team has access to all the research staff at BRE, and these staff have provided specialist input to an investigation about almost any aspect of the fire, or the building including, for example, the performance of building types, ventilation systems, materials and fire spread.

Attendance at the fire scene was always at the discretion of those in charge of the scene; this was usually the Fire and Rescue Service, but may be the police, or the Health and Safety Executive, or the owner. Fire investigations only proceeded when the forensic and other formal investigations were completed unless BRE is specifically invited. The fire investigation team were not normally on site while the fire is being fought or during the hours of darkness, or while police or other forensic investigations were taking place, and only rarely at weekends. Often access has been limited due to structural damage. Subject to these limitations, the team has normally been on site within one week of the incident occurring, but usually within a couple of days.

The BRE experts carrying out the investigation provided information such as cause and development of the fire under investigation, identified any implications for the Department and the guidance given in AD B, identified any implications for life safety, identified new areas of research and reported in a clear, unambiguous and concise manner.

An important benefit of this work was that fire damaged buildings offered the opportunity to examine construction quality and other construction issues that were revealed by the fire and not accessible to "normal" inspection.

Information of fires of interest has been reviewed in relation to the effectiveness or otherwise of AD B and related guidance, and findings reported to DCLG on a regular basis.

The BRE Fire Investigation team attended those fires identified as being of particular interest. During this project, these were:

1. Nursing home, East Sussex, 23rd October 2012
2. Convenience store, London, 25th February 2013
3. Block of flats, Newcastle, 4th April 2013
4. Office block, Watford, Hertfordshire, 15th April 2013
5. Shop, Manchester, 13th July 2013

6. Block of flats, Essex, 29th July 2013
7. Terraced house, Oxfordshire, 14th September 2013
8. Block of flats (converted from a hotel), Warwickshire, 19th February 2014
9. Car park, Derby, 14th March 2014
10. Market, London, 19th May 2014
11. Block of flats, London, 22nd September 2014
12. Shopping complex, Northamptonshire, 30th December 2014

During this project, other fires of significance were:

- Lakanal House Inquest

  It is noted that the inquest into the six fatalities at Lakanal House, Camberwell on 3rd July 2009 concluded on 28th March 2013. The full transcripts, narrative verdicts and the Coroner's findings from this inquest are publicly available at http://www.lambeth.gov.uk/elections-and-council/lakanal-house-coroner-inquest . Last accessed 20th February 2015.

- Shirley Towers Inquest

  Findings from the Coroner of the inquest into the Shirley Towers incident of 6th April 2010 were made public in February 2013 and several recommendations were made; including a recommendation that fire crews should be provided with wire cutters to prevent them getting trapped by falling cables. More information is available at http://www.highrisefirefighting.co.uk/docs/shirleytowers.pdf . Last accessed on 26th February 2015.

- Wealdstone Fatality Inquest

  The inquest into a house fire in Wealdstone, North London which occurred in November 2010 and killed one adult male was heard and concluded on 26th September 2014. The man died as he tried to save his children from the fire. He and his wife were passing their three babies to a neighbour. The inquest concluded he died as a result of smoke inhalation. His wife was left in a coma for two weeks as a result of the fire. The cause of the fire was determined to have been a faulty defrost timer mechanism within a fridge freezer.

Task 5 - Analysis of fires, in relation to Building Regulations and AD B and other legislation and in relation to fire safety engineering and scientific content

The analysis of fires examined issues in relation to Building Regulations, AD B, and other relevant legislation, in particular, the Regulatory Reform (Fire Safety) Order 2005 (FSO) and The Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR).

One objective of this project has been to assist DCLG in keeping Ministers informed of high profile incidents and fires of national importance by providing information and opinion specific to the needs and interests of DCLG.

The work has identified and examined fires with implications for AD B and other current regulations, codes, standards and government fire safety guidance. The information gathered has been presented to meet particular DCLG requirements but with the primary function of giving an early warning of topics that need to be addressed during updating of documentation. This continuous review underpins the usefulness and effectiveness of current guidance by highlighting its successes and to ensure that the guidance published by DCLG reflects what is happening in real buildings in England.

Each incident has been analysed for its relevance to AD B and other guidance and to the fire safety engineering knowledge pool. Both successes and failures of the guidance were considered. Relevant issues have been passed to DCLG. The overall effectiveness of the Building Regulations and AD B has been monitored so as to identify any aspect of these documents which might be failing to achieve its life safety objective, and to demonstrate the effectiveness of AD B through specific, "successful", incidents. The analysis has also sought to identify the effect of the Building Regulations in providing for, or failing to provide, protection for fire-fighters. Topics which have been kept under review have included;

- Multiple fatality fires.
- Effects of legislative changes (e.g. the FSO) and the 2006 changes to AD B.
- Fires in fire engineered buildings.
- Post 9/11 issues.
- Fires involving buildings constructed using innovative construction methods or modern methods of construction, materials or processes, for example, increased use of (polymeric) insulation in buildings.
- Fires involving substantial fire spread.
- Fires involving substantial smoke spread.
- Fires with a significant involvement of sprinklers, detectors and/or other active or passive fire protection.
- Fires in tall buildings.
- Fire in deep buildings.
- Fires involving major evacuations.
- Fires involving people with mobility disabilities, or otherwise non-ambulant people, or other physical or sensory disabilities.
- Fires involving people with reduced or limited decision-making capability.
- Fire-fighter injuries and near-misses.
- Effectiveness of built-in fire-fighting equipment (viz. AD B).
- Fire relevant to current research (e.g. the effect of fires on the environment).

Task 6 - Reporting to DCLG on all fires, including identification of any potential need for further research or for changes to Part B of the Building Regulations or AD B

Findings and conclusions (in particular with regards to any potential need for further research or for changes to the Building Regulations or AD B) have been made available, exclusively, to DCLG on a regular basis.

Day-to-day communications regarding the project have been directly with DCLG. Urgent news items and briefings have been made directly to DCLG.

Task 7 - Dissemination to a broader audience of interested parties where relevant and agreed with the Department

With the agreement of DCLG, the findings of the project have been disseminated in journal articles, lectures and presentations to other investigators, fire engineers, building designers, owners and others, as relevant.

Where individual fires are reported in this way they are usually treated as generic exemplars of particular problems or successes, and the project has not sought to put detailed or incident-identifiable information in the public domain (except where clearly appropriate). This approach has been intended to maintain the freedom of access to information from a variety of sources, respect the data protection requirements, and seeks to avoid distress to those who have been involved in fires causing injury and life loss.

Information on various aspects of the investigations has been shared with interested parties such as Fire and Rescue Service Officers, Scenes of Crime Officers and Building Control Officers as the opportunity arises. BRE continued to raise awareness of Fire and Rescue Services, forensic scientists and other investigators to the relevance of their findings for regulators. Findings from the project have provided input to a number of other DCLG-funded fire safety projects.

The dissemination process has provided the opportunity for BRE (on behalf of DCLG) to maintain BRE and the DCLG networks and profile within the fire investigation community.

A number of presentations based on the work on the project have been given and attendance at various relevant meetings during this project, as follows:

1. BRE was represented at the Chief Fire Officers Association (CFOA) Fire Investigation Strategic Steering Group meetings by Martin Shipp and Ciara Holland on 7th January 2013, by David Crowder and Ciara Holland on 13th May 2013, by David Crowder on 12th November 2013 and 19th November 2014, and by Ciara Holland on 5th September 2013 29th January 2014 14th May 2014 and 23rd February 2015. All meetings were held at CFOA Headquarters, Tamworth with the exception of the meeting on 5th September 2013 which was held at West Midlands Fire & Rescue Service, Birmingham. The meetings continued to formalise actions to be carried out under the various work streams that have been developed by the Steering Group members. A new chairman, Chris Blacksell of Humberside Fire & Rescue Service was appointed on 5th September 2013. A new Code of Practice for Fire Investigators investigating fires in the Criminal Justice System was discussed at several meetings and is due to be finalised in March 2015.

2. BRE was represented at the Arson Prevention Forum (APF) by David Crowder and Ciara Holland on 6th February 2013, by Ciara Holland on 29th May 2013, 4th September 2013, 26th November 2013, 20th February 2014 and 10th December 2014 and by David Crowder on 11th June 2014. The earlier meetings were held at LFB Headquarters, Union Street, London and the latter meetings at

DAC Beechcroft LLP, Minster Court, London. A report by the APF was published in September 2014 titled "Arson: a call to action. A "State of the Nation" Report". The report can be accessed via the APF website: www.stoparsonuk.org

3. A "Dear Chief Fire Officer's Letter" explaining the project and the role of BRE has been drafted and sent to all Chief Fire Officers in England. The "Dear Chief Fire Officer's Letter" has resulted in a positive response from many Fire and Rescue Services and some of these services are already contacting BRE to inform us of incidents.

4. BRE was represented at the UK Association of Fire Investigators (UK-AFI formerly IAAI) Annual Training Conference by David Crowder, Martin Shipp and Ciara Holland which was held on 28th January 2013 at BRE, Garston.

5. Martin Shipp and David Crowder presented information about the DCLG Investigation of Real Fires project to the Chief Inspector of Fire and Rescue Authorities (Scotland) and two Directors of the new Scottish Fire and Rescue Service on 30th January 2013 at BRE, Garston.

6. David Crowder and Martin Shipp gave presentations to Allianz at their Regional Training days held on 12th March 2013 at Westmorland, Penrith, Cumbria and on 13th March 2013 at BRE, Garston, on `The fire risks of renewable energy generation`.

7. David Crowder gave a presentation to Zurich about the findings from the Lakanal and Atherstone Investigations during their Property Team CPD meeting on 3rd April 2013 at BRE, Garston.

8. David Crowder presented information about the Lakanal Inquest to the Central London Fire Scrutiny of the Draft Fifth London Safety Plan on 22nd April 2013 at Old Marylebone Town Hall, London.

9. David Crowder gave a presentation at the Fire Investigators Association of Ireland (FIAI) AGM and Training Day on 24th April 2013 at Northern Ireland Fire & Rescue Training Centre, Belfast about the Fire Safety and Building Regulations Impact of Non-compliance which included information about the Lakanal Investigation.

10. David Crowder has provided 30 presentations on the fire at Lakanal between April 2013 and July 2014. These presentations were not funded by this project.

11. BRE was represented at the UK Association of Fire Investigators (UK-AFI formerly IAAI) 3-Day Training Conference by David Crowder, Martin Shipp and Ciara Holland which was held from 3rd June 2013 to 5th June 2013 at the Hilton Hotel, Watford and at BRE, Watford.

12. David Crowder gave a presentation on experience from real fires in timber buildings and timber frame construction sites to the Wood2Build conference in Namur, Belgium on 6th June 2013.

13. BRE was represented at Interflam 2013 by David Crowder and Ciara Holland on 26th June 2013 at Royal Holloway University of London, Surrey. David Crowder presented a poster on "Lakanal Fire Investigation – Reconstruction and modelling in support of the Metropolitan Police and London Fire Brigade Investigation" and gave a presentation on "Investigation of the fire in Atherstone-on-Stour UK using reconstruction and fire modelling".

14. Martin Shipp gave a presentation on "Fire Investigation at BRE" at the Tokio Marine Training day on 26th June 2013 at BRE, Garston.

15. BRE was represented at the Institution of Fire Engineers (IFE) AGM and Conference "The Responsibility of Leadership – Principles and Practices for the Fire Professional " by Martin Shipp, David Crowder and Ciara Holland on 10th and 11th July 2013 at Stratford Manor Hotel, Stratford-upon-Avon, Warwickshire. Martin Shipp delivered a presentation on "Leading practices and competency development for fire engineers" and David Crowder delivered a presentation on "Lakanal Fire Investigation – the interrelationship between building performance and fire-fighting operations".

16. David Crowder gave presentations and Martin Shipp chaired a day for the Chartered Institute of Loss Adjustors (CILA) on 18th July 2013 at BRE, Watford. Presentations during the day included a case study of the Atherstone-on-Stour fire and a study on the importance of design and workmanship of cavity barriers in mitigating unseen fire spread.

17. Martin Shipp, David Crowder and Ciara Holland attended a meeting with London Fire Brigade Fire Investigation Team on 22nd July 2013 at LFB Dowgate Station, London to discuss drawing up an agreement between BRE and LFB for the exchange of information from fire incidents for the purpose of this DCLG project.

18. David Crowder gave a series of presentations on the fire risks of renewable energy technologies, fires in buildings with modern methods of construction, and the fires at Atherstone-on-Stour and Lakanal to Hiscox insurance CPD day on 23th July 2013.

19. BRE was represented by David Crowder and Steven Abnett at the Knowledge Infrastructure Workshop at Buckinghamshire Fire and Rescue Headquarters, Aylesbury. The workshop was held to discuss the development of a research infrastructure for Fire and Rescue Services in the UK.

20. Martin Shipp gave a presentation on the Lakanal fire on 16th September 2013 at Pellings LLP CPD Seminar "Fire Safety Management of High Rise Buildings", Building Centre, Store Street, London.

21. David Crowder gave a presentation on "Mitigating Arson in education facilities" at the Education Estates Exhibition and Conference which was held at on 26th November 2013.

22. David Crowder gave a presentation on "Do you understand the structure of your building?" at the All Party Parliamentary meeting on 4th December 2013 which was held in Palace of Westminster, London. The presentation discussed issues of disproportionate loss and damage after fire due to poor workmanship.

23. BRE was represented at the UK Association of Fire Investigators Annual Training Conference by Ciara Holland, David Crowder and Martin Shipp which was held on the 27th January 2014 at BRE, Watford. David Crowder gave a presentation on the Atherstone-on-Stour and Lakanal fires.

24. Martin Shipp gave a presentation on "New Building Construction Technologies" at the London IFE Branch meeting at BRE, Watford on 28th February 2014.

25. Martin Shipp gave a presentation on "The Penhallow Hotel Fire: Fire Development and the Building Research Establishment work" at the Fire Industry Association (FIA) CPD day at Cheshire Fire & Rescue Service HQ, Winsford on 1st April 2014.

26. Martin Shipp attended the Fire Sector Federation meeting at Portcullis House, Houses of Parliament, London on 6th May 2014 where, as chair of the Fire Investigation Work Stream (FIWS) he presented some areas of current interest.

27. Martin Shipp delivered two presentations at the IFE South Western Branch UK AGM on 28th May 2014 at Devon & Somerset Fire & Rescue Service Headquarters, Exeter on "New building construction techniques" and "Fires in space".

28. David Crowder delivered a presentation at the Universities Safety and Health Association (USHA) Fire Seminar "It should be alright on the night" on 4th June 2014 at Portsmouth University Business Centre on "Fire safety in student accommodation – lessons from related real incidents".

29. Ciara Holland attended the Fire Statistics Users Group meeting at Eland House, London on 5th June 2014.

30. David Crowder delivered a presentation to Catalyst Housing on 10th June 2014 at Catalyst Housing Offices, Ealing Gateway, London on "Lessons from real fires in timber construction".

31. David Crowder was required to provide expert witness testimony at HM Coroner's Court for Surrey regarding the death of a woman following a fire attended by BRE Investigators reference FOSI Report 03/11-12.

32. BRE was represented at FIREX International, Expertise and Guidance Theatre by David Crowder and Ciara Holland on 17th and 18th June 2014 at ExCel London. David Crowder delivered a presentation on "Fire safety issues in social housing" and Ciara Holland delivered a presentation on "Understanding additional risks through the introduction of photovoltaics".

33. Ciara Holland delivered a presentation at the CFOA Conference "A view from the top floor" on 18th June 2014 at ExCel London on "Fire Investigation – The intelligence led approach".

34. BRE was represented at the Institution of Fire Engineers (IFE) AGM and Conference "Intelligent engineering – reducing risk" by Martin Shipp, Carl Sherwood and Ciara Holland on 25th and 26th June 2014 at Stratford Manor Hotel, Stratford-upon-Avon, Warwickshire. Martin Shipp delivered a presentation on "Learning from incidents" and Ciara Holland delivered a presentation on "National Operational Guidance – Fires in the Built Environment".

35. David Crowder delivered a presentation to Hiscox on 16th July 2014 at ATC Venues, Birmingham on "Lessons learned from modern methods of construction losses".

36. Martin Shipp, David Crowder and Ciara Holland hosted Hampshire Fire Service Arson Task Force at BRE, Garston to discuss sharing of information in fire investigation on 9th September 2014.

37. Ciara Holland delivered a presentation entitled "Fires in Educational Premises – Is there a problem?" at the Institution of Fire Engineers South East branch meeting at Siemens Headquarters, Frimley on 26th September 2014.

38. Ciara Holland attended the European Network of Forensic Science Institutes (ENFSI) Fire and Explosion Working Group 17th Annual meeting in Barcelona, Spain from 1st to 3rd October 2014.

39. David Crowder and Ciara Holland hosted the British Fire Services Association London District along with members of the German Fire and Rescue Services at BRE, Garston on 10th October 2014 to discuss BRE's fire investigation activities.

40. David Crowder delivered a presentation on fire investigation at the Office Fire 2014 event at BRE, Garston on 16th October 2014. This event included carrying out a demonstration of a fire in a section of an open-plan office.

41. Ciara Holland delivered a presentation on "A series of experiments to assess the effect of fire on a selection of electrical cable supports" at the IFE RE14 Annual Conference on Fire Related Research and Developments on 13th November 2014 at The Fire Service College, Moreton-in-Marsh, Gloucestershire.

42. David Crowder attended a meeting to discuss the next stages in the development of the Fire Investigation Code of Practice (Protocol) on 7th January 2015 at the University of Dundee, Scotland.

43. Martin Shipp attended the Fire Sector Federation meeting on 7th January 2015 at Portcullis House, London.

44. Martin Shipp delivered a presentation on "Fire investigation at BRE" and Nathan Cole attended a workshop entitled "Fire & Explosives Investigation – Challenges and Opportunities Workshop" which was held by the Knowledge Transfer Network on 13th January 2015 at Ambassadors Bloomsbury, London. The workshop discussed the current technical challenges and opportunities for research in the field of fire and explosives investigation. A report of findings from the workshop will be produced and should be available by March 2015.

45. Ciara Holland delivered two presentations at the UK Association of Fire Investigators Annual Training Conference on 26th January 2015 at the University of London. The event focussed on "Fakes"; the presentations were on "Counterfeit fire protection products" and "Fake lithium batteries".

Journal articles have been prepared, as follows:

1. A journal article on "Fire safety and solar electric/photovoltaic systems" was published in International Fire Professional Issue No. 6, October 2013.

2. A journal article on "Lakanal Fire Investigation – Reconstruction and modelling in support of the Metropolitan Police and London Fire Brigade Investigation" was presented as a poster at Interflam 2013, 24th to 26th June 2013.

3. A journal article entitled "A series of experiments to assess the effect of fire on a selection of electrical cable supports" has been drafted for submission to Building Engineer Journal.

4. A journal article on Compartmentation in roof voids titled "Gone to blazes; Tackling fire spread in roof voids" was published in RIBA Journal, on 10 February 2015 and is available at http://www.ribaj.com/intelligence/fire-compartmentation-in-roof-voids Last accessed: 20th February 2015.

5. A journal article on "External fire spread in multi-storey buildings" has been drafted for submission to relevant journals.

Task 8 - Where possible cross references with the Department's Incident Reporting system should be incorporated

It was agreed with both relevant sections within DCLG that cross-referencing would only be carried out where essentially required. It was not deemed necessary to cross-reference incidents during this project; however, where possible, the FRS Incident Number was obtained which could be used for cross-reference at a later date as required.

Task 9 – Experimental small scale fire testing and reporting.

Four experimental programmes have been carried out and reported to DCLG as follows:

- A series of experiments to assess the effect of fire on electrical cable supports.
- Experiments to assess the performance of domestic electrical consumer units from an ignition originating within the unit.
- Experiments to assess the performance of a range of commercially available fixings for cable supports in concrete substrates when exposed to elevated temperatures.
- Experiments to assess the performance of different external facades including non-fire rated double glazing when exposed to a fire from below.

Where appropriate, the findings from these experimental programmes have been published; see above.

3 Conclusions

The findings from this project have reaffirmed the overall effectiveness of the Building Regulations and AD B in providing for the safety of life in the event of fire and most of the significant issues that have been identified during this study fall outside the scope of these regulations.

The key findings from the project include:

- The vast majority of fatalities and injuries are in residential buildings.
- Fires caused by arson are resulting in fatalities.
- The importance of smoke alarms is again demonstrated and the risks of allowing them to be out of order. Where smoke alarms are not provided (or are out of order, or not heard) then safety may depend upon neighbours alerting people. However, even where smoke detectors have operated properly, there are cases of injuries; indeed, there have been fatal fires in domestic premises with working smoke alarms.
    - There have been a number of fires where a fitted smoke alarm was reported as not functioning.
    - There have been a number of fires where functioning smoke alarms have alerted neighbours and a number of successful or attempted rescues by members of the public, or neighbours hearing alarms.
    - But there have also been cases of occupants and neighbours ignoring the fire alarm due to the high frequency of false alarms.
    - One fatality occurred when a dust cover had not been removed from the smoke alarm following decorating works. The alarm did not activate and as a result the elderly occupant did not have sufficient warning to escape the fire.
    - Two fatal fires have highlighted the issue that sleeping children will not necessarily wake to the activation of smoke alarms.
- In residential premises, there have been a number of rescues from fires in blocks of flats with some associated with fires in common areas.
    - There have been a number of fires in blocks of flats where all the residents were evacuated. Some of these evacuations are evidently a response to a direct risk from fire spread, others due to risk from extensive smoke spread. In other cases it appears that the block is evacuated, due to a lack of understanding of the fire strategy for the building i.e. the building was designed for a “stay-put” policy. There were several incidents where blocks of flats were evacuated by police; however, discussions with the fire service revealed the evacuations were unnecessary. Other evacuations have been after the incident is effectively over, due to smoke contamination, sooting and smell. Such “emptying” of the block may not, strictly, be considered an “evacuation”.

- Since the previous DCLG project where it was noted that large scale evacuations appeared to be becoming more frequent in blocks of flats; these now appear to be decreasing. This may in part be due to London Fire Brigade's "Know the Plan" campaign.
- In blocks of flats there have been reports of occupants leaving front doors of flats open when evacuating. It is not known whether this is increasing the smoke spread in communal areas.
- There have been some fires in flats where fire and/or smoke have spread to the common areas of the block. This has led to difficulty during evacuation and occupants requiring hospital treatment for smoke inhalation.

- There have been a number of incidents in residential premises where occupants have become trapped by the fire, both blocks of flats and dwelling houses, and have jumped from the windows of the upper floors of the property.
- There have been a number of incidents where fire spread has been an issue:
  - Fire spread through poorly stopped penetrations (which were modifications to the building; the original fire stopping was properly done).
  - There have been a number of incidents where fire has spread between dwellings in terraced houses. Most appear to be as a result of fire spread at roof level due to a lack of or inadequate compartmentation.
  - There have been notable fires where the fire started in a (ground floor) commercial unit (shop/restaurant) and spread to flats above. Such mixed-use building need particularly careful assessment under the Fire Safety Order, since the residence (other than common areas) is not subject to the Order.
  - There have been several incidents (some overseas) which have involved fire spread up external claddings. These demonstrate the value of the additional recommendations in AD B.
  - There have been a number of incidents of external fires spreading into buildings, such as from vehicles, bonfires, household waste fires or wheelie bin fires.
  - There have been a few cases again of fires, and fire-fighting, being affected by weather conditions, especially wind affecting fire spread in tall buildings. The potential effects of wind should be considered in any fire safety engineered design, but this is not an issue discussed in AD B.
- There has been a continuing trend of a number of fires in industrial premises which often result in large fire-fighting operations, local road or rail closures and residential evacuations.
  - Gas cylinders continue to appear as an issue, either because they explode, or because they limit fire-fighting. These incidents require the setting-up of a hazard zone and there have been a number of incidents involving gas cylinders (a range of types) which have cause serious local disruption to residents and transport networks.

- There have been a number of fires involving recycling plants and/or scrap yards or involving storage areas of recycling plants. As the demand for recycled material fluctuates so does the possibility of such fires – when demand is low so the stocks are likely to increase, and, hence, the size of potential fires. These are being reported as having high environmental impact.
- There are increasing concerns for fire and rescue services with regards to modern methods of construction. The main concern relates to the on-scene identification of such buildings which affects the standard operating procedures of the fire crews.
    - A number of timber frame properties have suffered disproportionate damage as a result of fire spread to that expected from traditional construction.
    - There are related concerns that fire-fighters may not recognise the nature of some types of (innovative) construction and may use inappropriate fire-fighting strategies. Some of these new forms of construction may need new fire-fighting strategies to be developed.
- There was also a large fire involving timber frame laboratory under construction which did not significantly affect nearby properties (but is not a Building Regulations issue).
- There have been a number of fires which have started in the basements of commercial buildings.
- There have been a number of fires resulting from electrical faults, in particular white goods.
- There have been a number of incidents, some fatal, which have been caused by lithium batteries in devices exploding while on charge, e.g. e-cigarettes, mobile phones, electric scooters.
- There have been an increasing number of fires involving renewable energy systems both residential and commercial. There have been a number of fires involving photovoltaic (PV) systems; some have been caused by a fault in the system while in others the PV panels have hindered fire-fighting activities. There have also been some fires which involved bio-mass boilers.
- There continue to be a number of fires reported to have been caused by 'hot works'; mostly on the roofs of commercial properties and some school buildings.
- There have been a number of incidents where a person undergoing oxygen treatment has caught fire due to a lit cigarette in an oxygen atmosphere.
- There appears to be less reporting of fires on traditional media websites with most now only being reported by local news websites rather than regional or national.

In addition, the following issues, which may need to be monitored in the future, have been identified from individual, or a small number of, fires:

- Fires caused by unattended cooking, smoker's materials and candles or nightlights continue to be an issue.
- There have been a number of fires caused by mobility scooters. In one incident, the mobility scooter had been stored in the means of escape corridor in a block of flats.
- There has been an increase in the number of fires involving underground cables causing pavements to "explode".

- There have been a number of fires where clothing has caught fire.
- There have been a number of fires started due to focussed sunlight.
- There have been a number of fires where the rescue (and resuscitation) of animals (as well as people) occurred.
- There have been a number of fires attributed to poor maintenance of kitchen ductwork where there has been a build-up of grease in the ducting which has been ignited.
- There have been some fires which occurred in properties undergoing maintenance and renovation works.
- There have been some fires in buildings which have started at roof level where the buildings have green roofs.
- There have been some fires involving properties occupied by hoarders, causing difficulty for the evacuation and rescue of inhabitants as well as for fire-fighting. This has led to a warning issued by some fire and rescue services, illustrating the danger to life and property posed by hoarding.
- There have been a number of gas leaks and explosions.
- A number of fires have highlighted issues for fire-fighters:
    - Hydrants not within an appropriate distance of the fire scene.
    - The impact of strong winds.

Again, during this project, problems arose from obtaining information into investigations of fatal fires, where the incident is under investigation by the police, or with the Coroner's court or at inquest. Although follow ups were made, this is a protracted process and could extend over a period of twelve months following the incident.

4 Acknowledgements

The BRE Fire Investigation team over this period has comprised (at various times): Martin Shipp, David Crowder, Ciara Holland, Nathan Cole, Tom Lennon, Carl Sherwood, David Farrington, Deborah Morgan, Steven Abnett, and Adonis Charalambous.

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