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HOME OFFICE

Firefighting Options for Fires Involving Sandwich Panels

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FIRE RESEARCH & DEVELOPMENT GROUP

FRDG

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FIRE AND EMERGENCY
PLANNING DIRECTORATE
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Firefighting Options for Fires Involving Sandwich Panels

by

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ABSTRACT

The Fire Research Station (FRS) has been commissioned by the Fire Research and Development Group (FRDG) of the Home Office to carry out a review of firefighting options for fires involving sandwich panels since there is wide concern over the problems of fighting fires in buildings containing sandwich panels.

The findings of the study have identified clear differences between fires involving sandwich panels and other types of fires. There is a consensus from fire officers that any well-founded information and advice that can be provided will be most welcome. Guidance from the Home Office based upon the present study, and under-pinned as it is by brigade knowledge and experience, will provide a most appropriate method of minimising the risks associated with firefighting in these buildings. The production of such guidance is now readily feasible based on the information gathered in this study, although detailed development is needed.

FIREFIGHTING OPTIONS FOR FIRES INVOLVING SANDWICH PANELS

MANAGEMENT SUMMARY

Introduction

There is wide concern over the problems of fighting fires in buildings containing sandwich panels. There have been two firefighters killed fighting a fire in a building containing sandwich panels, but to date there have been no civilian fatalities. However, there have been a number of "near misses" and there are naturally concerns that circumstances may be different in some future event.

The Fire Research Station (FRS) was commissioned by the Fire Research and Development Group (FRDG) of the Home Office to carry out a review of firefighting options for fires involving sandwich panels. Working closely with the Fire Experimental Unit of FRDG, FRS carried out a review of available information from around the world and discussed experiences and lessons learned, both failures and successes, with fire brigade officers, of all ranks, who have had to deal with fires involving panels. The findings from the review were focussed through a Workshop held at the Fire Service College, Moreton-in-Marsh held on 16th and 17th September 1998.

A number of key issues were identified which formed the focus of the study. These were;

1. How are sandwich panel fires different from other factory fires that involve large amounts of combustibles?

2. Would it be useful to differentiate between three types of existing building? These were; firstly; those in which sandwich panels have been identified, and an action plan formed, secondly; those in which the presence of sandwich panels might be deduced, e.g. food factories, and thirdly; those in which the presence of sandwich panels is established only while firefighting is in progress.

3. What information is required in the dynamic risk assessment by the fire incident commander as to whether the building is safe to commit firefighters to fight the fire from the inside?

4. If the fire is to be fought inside the building, should different operational procedures and tactics be employed to those used in other fires?

5. If the fire must be tackled from the outside, are there different operational procedures and tactics to the conventional ones which could lead to a better control of the fire?

6. Would there be benefits in evaluating different firefighting techniques? These include; venting, the use of foam (medium or high expansion), the use of special equipment (e.g. the Snozzle), the potential of cutting "fire breaks" (and how to do it safely), and the use of specialised sensing equipment (e.g. IR).

7. What information needs to be available before the incident, what information might be available at the incident and how best to record and communicate lessons learned?

8. What form any HO guidance might take, what it should contain and how it should be presented? Some Brigades already have their own guides; could these be adapted? What research is needed, if any?

Findings

It is evident from this review, and supported by the workshop, that fires involving sandwich panels present a special problem to the fire crews attending. This special problem is primarily one of speed; the development and spread of a fire and the general build-up of dangerous conditions in a building containing sandwich panels. These fires are in most ways the same as any other fire - but much faster. This means that the Officer-in-Charge must react more quickly, must be more responsive to new information and evidence of the changing conditions, and needs to withdraw teams or call for more resources earlier, possibly before the real need is apparent.

Home Office guidance

It is clear from this study that guidance from the Home Office on special requirements for fighting fires in buildings containing sandwich panels would be widely welcome by brigades. However, such guidance would best be offered as a means of providing information and ensuring consistency for brigades in devising their own locally-relevant guidance. It would provide brigades with a distillation of current knowledge and thinking which might then be best used as the basis of individual procedures that are tailored to the local conditions, resources and building stock, in the form of local Special Incident Procedures and Standard Operating Procedures.

The production of such guidance will require wide consultation and formal procedures. However, the findings of this current programme of study appear to provide the core of the needed advice, and while it is neither appropriate nor possible, at this stage, to offer comprehensive details for such guidance, it should encompass the following in its contents;

Issues and information

- What are sandwich panels?
- What to look out for?

- Where to expect to find them?
- Industry labelling schemes
- Special features of these buildings
- Types of building
- Size of buildings, large spans, deep buildings
- Usual lack of sprinklers etc
- Formation of temporary "compartments"
- Changes to building layout
- Difficulty in identifying means of escape
- The "normal" role of sandwich panels
- Heat and sound insulation
- Quality issues in sandwich panel construction
- Types and effectiveness of fittings and suspension systems
- Second-hand panels
- How panels behave in fire - why they are special
- Need for large initiating fire
- Speed of development, speed of spread
- Poor compartmentation
- Delamination and ceiling collapse
- Hidden fire spread, fire spread in voids
- The problems of applying extinguishing agents
- Molten droplets
- Smoke - quantity, toxicity
- Fumes, flammable vapours
- Loss of stability of the building
- Environmental issues

Strategy (advanced planning)

- General planning
- Planning for specific building 1(1)d
- How to decide on number of pumps for first attendance (PDA)
- Type of building, type of installation
- Location of panels
- Layout of escape routes
- Robustness of information
- Size of compartments
- Are sprinklers present etc?
- Means of access
- Where to cut fire breaks
- Calling for additional safety crews
- Sources of information
- Training, education, records
- Availability of resources
- Water supplies
- Special equipment
- Use of retained crews - time delays, training
- Other risks - Ammonia

- Interagency communications
- Environmental issues (water, air, other)

Tactics at the scene

- Issues for Dynamic Risk Assessment
- How to recognise panels are present?
- How to recognise panels might be present?
- Information available - Fire Certificate etc, witnesses, staff, management etc
- Are people in the building?
- Are persons reported?
- Are panels present?
- Where are they?
- Communications
- How to recognise what stage the fire has reached?
- Where best to put water
- How much resources are needed?
- When to call for more resources
- Water supplies
- Special equipment, techniques
- Wayfinding
- Where is the fire? Hidden spread
- Delamination, loads on panels
- When and how to recognise the need to change from offensive tactics to defensive?
- When to expect to lose the building
- Health and safety of personnel
- Difficulty of access
- Firefighting in cold stores
- When to ventilate
- How to ventilate?
- When to commit
- Signs of danger - smoke, fumes, noise, collapse
- How to predict collapse?
- When to withdraw
- Need for rapid back-up
- Safety team for BA crews
- The need for additional BA crews
- Size of BA crews
- Cutting fire breaks
- Other risks (Ammonia)
- Protecting adjoining property
- Wind and weather - impact on firefighting
- Other agencies
- Environmental issues

Special techniques

- Use of foam
- Bulldozers and JCBs - for access
- Cutting access points
- Use of helicopters, helicopter information
- Robotics
- Explosives
- Lances
- Thermal imaging
- Nitrogen

The production of such guidance is now readily feasible based on the information gathered in this study, although detailed development is needed. For consistency of approach and training we recommend that any guidance be developed to reflect the current brigade approaches and standardise it. This guidance should therefore be a stand-alone document within the Fire Service Manual. There are a number of areas where some research is needed to support the development of guidance.

This study has concentrated on the problems in existing buildings. It may be expected that many of the problems for new buildings will be resolved by revised DETR guidance (through AD B), new designs and fire protection systems and/or improved management.

Further research

A number of areas of research have been identified, both in the review and later in the workshop. Some will need the involvement of other agencies. Most would need the active participation of brigades and some are already being addressed.

The topics that have been identified are;

- Tactical information
- How to predict imminent collapse
- What is best to limit fire spread - panels stay in place or collapse?
- More performance data on panels
- Information on performance of fixings and joints
- Effect of insulation properties on fire growth
- Effect of wind and weather
- Likely fuel loads
- Labelling of panels
- Marking of sites
- In-cab data systems
- Data bases
- Firefighter telemetry
- Techniques and new techniques
- Ventilation (any use?)
- Cutting fire breaks

- Cutting access points
- Explosive cutting
- Abrasive cutting
- Lances
- Snozzle
- Robotics
- Thermal imaging
- PPV
- Extinguishing and alternative extinguishing media
- Foam
- Nitrogen
- Water sprays, high pressure sprays, water barriers
- Does water on the outside of panels limit fire spread?
- Legal issues of standing back
- For new buildings; ventilation and smoke control, smoke curtains, drencher systems, intumescent coatings

Some of these topics would need to be studied to enhance any HO guidance on sandwich panels in the short term; others require longer term development and any results would need to be made available separately or in revisions to the guidance.

It has not been considered appropriate to develop a detailed programme of research at this stage.

Conclusions

There is a consensus from fire officers that any well-founded information and advice that can be provided will be most welcome. Guidance from the Home Office based upon the present study, and under-pinned as it is by brigade knowledge and experience, will provide a most appropriate method of minimising the risks associated with firefighting in these buildings. The production of such guidance is now readily feasible based on the information gathered in this study, although detailed development is needed.

As well as the fears for the future, the fire service within the UK is naturally reluctant to abandon a building to destruction, and indeed, such defensive tactics go against their usual method of response. But the dangers from these buildings are now more recognised.

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FIREFIGHTING OPTIONS FOR FIRES INVOLVING SANDWICH PANELS

1. INTRODUCTION

Over recent years there have been a number of increasingly hazardous fires in buildings in which sandwich panels have been present. The fire at Sun Valley Poultry in Hereford in September 1993, in which two firefighters died, focused attention on the use of these panels and their particular behaviour when involved in fire.

As a result of this both government and industry have been active in carrying out research and developing guidance to mitigate the risks to occupants and firefighters, and to reduce the commercial losses.

However, much of this work is for new buildings or major refurbishment and there remain significant concerns regarding the existing building stock and the safety of firefighters who must deal with fires in such buildings.

The Fire Research Station (FRS) was commissioned by the Fire Research and Development Group (FRDG) of the Home Office to carry out a study of the firefighting options for fires involving sandwich panels.

This report presents the results of this work.

Working closely with the Fire Experimental Unit (FEU) of FRDG, FRS carried out a review of available information from around the world and discussed experiences and lessons learned, both failures and successes, with fire brigade officers, of all ranks, who have had to deal with fires involving panels.

The review sought to encompass all possible approaches. These included conventional firefighting media, unconventional media, physical separation methods, new methods or forms of equipment, pre-planning, communications, firefighting strategies, sensor equipment and any other relevant topics. The need has been to identify crucial fireground firefighting decision parameters which will determine the main practical differences between sandwich panel fires and other types of fires.

Following the review, and subject to its findings, it was intended that consideration would be given to producing guidance for the fire service. In addition, or alternatively, it was intended to identify any gaps in the knowledge of these issues that might require further research.

The emerging findings from the review were focussed through a Workshop held at the Fire Service College, Moreton-in-Marsh held on 16th and 17th September 1998.

The workshop was organised jointly by FEU and FRS, whilst the review was still proceeding. A range of officers from the fire service were invited to discuss

experiences, common interests and differing concerns regarding firefighting options to deal with sandwich panel fires and the safety of firefighters when involved in such incidents. Attempts were made to draw together both senior officers who understand the wider issues and also more junior officers who had recent direct experience at such fires.

It needs to be emphasised that this study has addressed the firefighting issues of the **existing** building stock. Aspects of the issue that relate to new or refurbished buildings were very much secondary to this objective, but have been recorded and will be introduced into the separate debate.

2. RESEARCH TO DATE

Sandwich panels are elements comprising an insulating core within an outer skin. They are used for both the outer envelope of light weight buildings, or to create partitions within a building. Panels are typically about one metre wide and may be over 10 metres long. The cores are mostly of non-combustible mineral wool, combustible expanded polystyrene or polyurethane. They are usually steel faced. One of the biggest users of such panels is the food industry. Here the skins are often coated to provide a food safe surface that can be frequently washed down with water sprays. For day to day use, maintaining conditions in which food may be handled safely is the over-riding consideration for owners of such stores and factories. Fire safety is of lesser importance, if it is considered at all. The partition ceilings may create a large undivided roof void which is sometimes used to house plant machinery, such as ventilation equipment.

The generic term 'sandwich panel' is mostly used to refer to those composite panels which are assembled in a factory. Those which are assembled or finished on site may have very similar characteristics but will be identified explicitly where appropriate.

The industry produces many types of sandwich panel but concerns have centred on those with metal skins containing one of the three main cores; generally 50mm to 200mm thick:

mineral wool - a non-combustible fibrous material,

expanded polystyrene - a thermoplastic material made from the styrene monomer expanded to form a cellular structure; typically pure white in colour, it softens and melts on heating often before ignition. Extruded polystyrene foam is typically blue in colour (sold under the trade name of Styrofoam),

polyurethane - a thermosetting material made by mixing two components, typically yellowish/brownish/pinkish in colour, which will char on heating and could undergo flaming combustion if sufficiently heated.

Other types, which appear to be less commonly used, are polyisocyanurate and phenolic composite foams. Glass fibre is also used as an insulation material.

Studies of the fire safety of large insulated sandwich panels have been carried out by the Fire Research Station on behalf of the Home Office (Ref. 1) and the Department of Environment, Transport and the Regions (DETR). The issue was that panels have been implicated in a number of fires and concerns have been expressed regarding the risks that they present both to occupants and firefighters. The initial review sought to identify the particular fire safety problems with large insulated sandwich panels by examining recent fire incidents and by visiting some selected working buildings that contain panels. Causes of fire were found to vary from hot working to electrical sources, with a small number of deliberate ignitions. It would appear that the greatest risk of fire is in food process areas that are bounded by internal sandwich panel partitions.

Some laboratory tests were carried out to examine the ignitability, delamination and general fire behaviour of the panels with a view to possibly more detailed and extensive tests later. It was intended that these experiments would include all of the common types of panel currently in use, but this was not possible since some types of panel are no longer in production and in the time available FRS was not able to locate any scrap panels of these types. In the event only panels with cores of polystyrene, fire retarded polyurethane and mineral wool were tested. All of the panels proved difficult to ignite and, once ignited, only the polystyrene core panel would sustain a fire. The tests indicated that only in exceptional circumstances are sandwich panels likely to be the item first ignited, however some types could contribute to an already severe fire.

The results of this initial review support the historical evidence that sandwich panels do not present a particularly high risk to the lives of the general public or to workers in factories containing sandwich panels, i.e. a no greater risk than that from the other combustibles on the premises. However there is a clear unusual risk to firefighters who may have to enter such a building on fire, since the fire can spread rapidly within some types of panel and the jointing systems will not prevent the steel sheets from falling away.

The risks from sandwich panels can be reduced by intelligent use of the panels and by sound fire safety management. The findings have been studied by the Home Office and DETR to determine what, if any, policy, guidance or regulatory implications there may be.

Two additional laboratory studies have examined firstly; the role of fixings on the fire behaviour of panels, and, secondly, delamination. The role of fixtures was examined by carrying out fire tests on "bus shelter" constructions of panels, beneath one of the FRS calorimeters. This work is still on-going but has demonstrated the importance of edge fixings. Delamination tests were carried out on small panels subjected to radiant heat only. All types of panel (including mineral wool) were found to delaminate at skin temperatures below 270 deg.C, without the core becoming involved in the fire.

3. THE REVIEW

3.1 Background

Following the fire at Sun Valley, the Fire Service Inspectorate sought information from all brigades via a FINDS message. This information was summarised in the FRDG Publication No 3/97 'An initial review of the fire safety of large insulated sandwich panels'(Ref. 1). The report included summaries of 21 incidents in the UK but concentrated on the fire damage sustained to the panels and not the firefighting techniques used. The current review was intended to high-light operational procedures where details are available and included information on fires world-wide rather than those confined to the UK.

There is increasing emphasis on firefighter life safety since the rapidity of fire spread is now fully recognised by crews attending fires in buildings containing combustible-cored sandwich panels. The sandwich panels identified as presenting the greatest life risk once fully involved in fire are those consisting of a steel face either side of a foamed polystyrene (EPS), polyurethane (PU) or polyisocyanurate. However, even panels with non-combustible cores may delaminate, with the separation of the metal skin from the core. The panels are generally used as internal partitioning but may also be present as external cladding panels - however, few fires have been reported in the latter. The sandwich panels are rarely the item first ignited in a fire; their involvement is usually secondary and results in a rapidly developing fire in a hidden cavity. Such hidden fires are amongst the most difficult to extinguish.

3.2 Types of buildings incorporating sandwich panels

It is now widely recognised that sandwich panels are used for internal partitions in the food industry where food safe surfaces are crucial to the business. Externally the same panels may be used for cladding or the external envelope, but these are less of a fire problem. FRS is led to understand that PU products have the market lead in the external use of panels, but where cold storage is important then EPS is preferred. The latter material tends to be cheaper to install and so is preferred on cost grounds.

Another reason for the popularity of EPS panels appears to be the perception that the panels are strong enough to allow staff in the premises to walk on them. Apparently the other core materials do not offer quite the same stability.

The mineral wool producers also manufacture panels for a wide variety of uses - their product performs well in most situations but there have been concerns about the possibility of cold bridging as the mineral wool can contain some moisture. If it is penetrated then it can absorb water, which then can freeze. There are also questions regarding its hygiene properties, both from bacteria and fibres. It is usually the most expensive and the heaviest of all the panels produced.

There are serious implications for firefighters who may unwittingly enter a building containing these constructional elements during a fire. Whilst for some types of building (in particular food factories) the presence of sandwich panels might be expected, there are many other types of building where this is not possible. For example, information has been provided to FRS by manufacturers and others, that indicates that there is a well-developed second-hand market in used panels. However, it has not been possible to determine where these panels are then used. The use may be agricultural, purely for insulation purposes, possibly in stores and/or in small businesses where cleanable surfaces are important.

The following information has been provided to FRS on other buildings incorporating foamed insulation, outside of the food industry;

Hospitals

West Fife District General Hospital
New Psychiatric Unit, Stoke on Trent
Orthopaedic hospital, Stoke on Trent
Stafford Hospital
Oncology Department, Leicester Royal Infirmary - on hold
Birmingham Maternity Hospital
Kidderminster Hospital
Muswell Hill Health Centre, North London
Medial Research Unit, New Road, Tower Hamlets
Hammersmith Hospital
Lewisham Hospital
Ashford Hospital
Kingston Hospital
New Heart Research Unit, Heath Hospital, Cardiff
Poole General Hospital - main building

Nursing Homes

Heathlands Nursing Home, South West London

Schools

Stonelaw High School, Glasgow
Ling Hall School, Coventry
Brookfield School, Wellingborough
Chapel End Junior School
St Josephs Catholic School, Stanford le Hope
St George's Church of England School, Sheerness
Basseleg Comprehensive, Newport, Monmouth
Pokesdown School, Bournemouth
Devon County Council schools - to August 1997 or later

Prisons

Bridgend Prison, Mid Glamorgan
Camphill Prison, Isle of Wight
[there are probably many more as foamed insulation cladding is commonly used for roofing on new prisons]

However, at the time of writing, these types of building do not appear to be a particular problem as a result of the presence of sandwich panels. HO Prison Department have told FRS that panels used in prisons are supposed to be fire-rated.

3.3 Fire performance of panels

In the UK, panels usually achieve Class 1 in surface spread-of-flame tests (Ref. 2), M1 in France (Ref. 3). Some reports question how relevant this classification is and how long will the panel maintain that level of performance. It is not clear whether ageing of panels can have an effect on fire performance or in the rapid spread, in particular on fire-retardant treated products. The evidence available suggests that this is unlikely, as fires start at any time in the life of the panels, and older buildings do not appear to behave significantly worse than newer buildings.

Standard tests are unhelpful in obtaining guidance as to the likely performance in a real fire (Ref. 4), since for materials of these types, the small-scale tests do not provide adequate information on the full-scale fire performance. There has been much discussion of the test regimes being developed by LPC, Factory Mutual, ISO, CEN etc. These tests vary from small scale, as in the SBI (single burning item) test, to larger proportions, as in the ISO test, which uses panels of a number of square metres in area. Facade tests have been proposed, but are not yet being adopted as the sheer size of the test apparatus puts the test out of bounds to all but the largest test houses (Refs. 5 and 6).

Competition is extremely fierce between the sandwich panel manufacturers and very few produce all types of core material. Each part of the industry is seeking test methods which are not unfavourable to their product.

3.4 The incidents

As part of the earlier FRS study (Ref. 1), a large number of incident reports of fires involving sandwich panels were provided by brigades. Other reports of relevant incidents, both in the UK and overseas, were taken from FRS investigations and elsewhere. Whilst the original work focused on the broader design and public safety issues, the current study re-examined these reports to seek information on firefighting tactics and techniques.

The findings from this review are presented below. It became evident in examining the reports that two fires in particular had highlighted the problems of fires involving sandwich panels;

On the morning of 3 September 1991, a tragic incident occurred in a chicken processing plant in Hamlet, North Carolina in the USA. Twenty-five people died and fifty-four were injured out of a staff of ninety present at the time of the fire, which started around 08.15 h in the processing area in the centre of the plant. During a repair, hydraulic fluid sprayed onto a gas-fuelled cooker and ignited instantly. The gas regulator failed and natural gas contributed to the growth of the fire. Six of the eighteen people in the process area died. There were 40 people in the trimming area and the rest in the marinating, packing, shipping or rest areas. All of those who survived reported dense black smoke and obstacles to leaving from locked doors, and in one area a lorry was parked across an exit.

Firefighting was delayed while search and rescue was carried out although extinguishment in the process area was started soon after the building was entered at about 08.45 h. The NFPA identified one of the contributory factors as being the lack of adequate fire exits and too rapid a fire development to allow any first-aid firefighting.

Two years later in Hereford two firefighters died at Sun Valley when the ceiling panels collapsed soon after they entered the building to see if a bridgehead could be set up.

Until these two fires, fatalities associated with burning sandwich panels were not an issue. There had been several near misses reported in the fire press and firefighters were well aware of the risks to them and the occupants of buildings containing these components.

3.5 Summary of fire incidents

The fire incidents examined are summarised in Table 1 which seeks to bring together the data obtained primarily from fire brigade reports, relevant to firefighting in a building containing sandwich panels, so that similarities and differences in approaches may be identified.

3.6 Comments on the fires

It is clear from the summaries that in nearly all cases the occupants of the buildings concerned have time to leave safely and, usually, before the brigade arrives. Sometimes, however, occupants hold back, possibly to attempt first aid firefighting.

There is risk to firefighters not only from the speed of development of the fire and collapse of the internal structure but from smoke inhalation. The large smoke plumes may also necessitate evacuation of residents from their homes near by.

The only reported extinguishing material appears to be water, applied using hose reels and jets. Usually the fire is attacked externally, as the buildings tend to collapse quite quickly.

Food process often involves the use of conveyors which breach walls and can assist fire spread. Similarly it is rare to find any type of separation within the buildings.

The French experience is particularly interesting; in Bordeaux where the conveyors penetrate the wall, there was sprinkler protection to maintain the fire resisting nature of the wall but this was overtaken by events. The French firefighters appeared to try and cut a firebreak in the panels, but cutting proved difficult and this approach was then abandoned. Small hoses were used to limit the spread of the fire and try and get ahead of it.

Packaging stores are noticeable as a place of origin or where the fire suddenly explodes and spreads very rapidly. In Bordeaux this vented the fire and allowed a successful attack on the fire with brigade personnel removing panels from the path of the fire. This activity took five and a half hours to complete to 'fire under control' and a further seven hours until 'fire extinguished' message was sent.

The French fires also identify the problem that crews can be engaged for weeks while supervising cutting up of remaining panels during site clearance.

3.7 Initiatives within the industry

The cold storage industry is a major user of the most combustible types of sandwich panel and they have responded to the current debate by producing industry guidance.

One result of the many fire incidents has been increasing efforts by the industry in improving the fire performance of the foamed polymers and to explore different methods of fixing and to try to prevent delamination of the metal face. In parallel with these activities by industry, organisations such as the Cold Storage and Distribution Federation and Rank Hovis McDougall have been addressing management issues surrounding the use of the panels which provide a food safe environment.

The Cold Storage and Distribution Federation (CSDF) has produced a Guide on the management and control of fire risks in cold stores, and the International Association of Cold Storage Contractors' (IACSC) Guide on Design, Construction, Maintenance, Specification and Fire Management of Insulated Envelopes in Temperature Controlled Environments was published in July 1999.

One of their recommendations is for a fire safety labelling scheme, which would assist the fire service on pre-planning visits. Such a scheme might also assist firefighters at the scene of an incident. The details of how such a scheme would work are being developed for the cold storage industry by the IACSC.

Information has been provided by Rank Hovis McDougal (RHM) who are a major user of sandwich panels for cold stores etc. RHM have 55 units producing bakery and related products. RHM produce Engineering Bulletins (some in conjunction

with Northern Foods) for the local managers to use as guidance. By 1994, following Sun Valley, they were recommending the use of mineral wool for cores, except in sub-zero applications, in the expectation that the Loss Prevention Council would be restricting the use of polymer cores by 1996 and so making insurance of their premises doubtful. This has not happened. The most recent guidance, dated April 1998, suggests that for short duration, i.e. ten years, mineral wool cored panels may be used for sub-zero applications. This is in the expectation that the main manufacturers will overcome the current concerns about performance at low temperature.

It will be noted that many of these initiatives are concerned with new or refurbished buildings. However, the new management guides which are being produced by industry could have an impact on the fire risk, fire development, and occupant behaviour in existing buildings.

3.8 Initiatives from government

Building Regulations Division of the Department of the Environment, Transport and the Regions (DETR) have put forward tentative proposals in their suggested amendments to Approved Document B (AD B)(Ref. 10) with respect to sandwich panels in order to trigger informed opinion. The 192 comments are still being collated and considered. At the time of writing there are no clear alternative proposals.

Representative bodies of the fire service (notably the FBU) have approached government about the problems for firefighters in large single-storey buildings asking for sprinkler installations to be mandatory. The same arguments have been used in the context of sandwich panels generally used in large single-storey buildings (LSSBs). These issues are under discussion.

The IACSC points out that fire safety engineering approaches are acceptable alternatives to compliance with current guidance in AD B. Scottish Regulations continue to be more stringent in their requirements and are still largely prescriptive in approach. Fire safety engineered solutions are not favoured. In Scotland the combustible core is regarded as an unsealed cavity and cavity barriers are required to be fitted at designated centres to prevent fire spread between the facings. The Grampian example (at Fraserburgh) is particularly unfortunate because it occurred during construction, before the cavity barriers were in place.

In France the impetus for controls comes from the insurance industry rather than Government. In Germany there are strict controls on the performance of roofing materials, plus a minimum performance requirement for construction products used within buildings.

Again, it will be noted that many of these initiatives are concerned with new or refurbished buildings. Changes in guidance from DETR will have little or no impact on existing buildings.

Of particular relevance to the current building stock is the new Fire Precautions (Workplace) Regulations (Ref. 8), since it might be expected that building owners will need to identify the presence of sandwich panels, and the associated fire risk. At the time of writing it has not been possible to establish from government departments whether there is a legal responsibility on owners to then notify the local fire service.

4 THE WORKSHOP

4.1 Objectives

The objective of the Workshop was to provide an input to the overall review by obtaining information and views from those for whom the research was being undertaken; the fire service, since any findings, or eventual guidance, would have to be underpinned by experience from real fires.

A range of officers from the fire service were invited to discuss experiences, common interests and differing concerns regarding firefighting options to deal with sandwich panel fires and the safety of firefighters when involved in such incidents. It had been intended to bring together both senior officers who understand the wider issues and also more junior officers who have had recent direct experience at such fires. In the event the majority of those attending were from the upper ranks of their brigade.

As discussed above, the review was intended to encompass all possible approaches, including conventional firefighting media, unconventional media, physical separation methods, new methods or forms of equipment, pre-planning, communications, firefighting strategies, sensor equipment and any other relevant topics. It was hoped to identify crucial fire ground firefighting decision parameters that will need to determine the main practical differences between sandwich panel fires and other types of fires.

Delegates understood that, following the review, consideration would be given to producing Home Office guidance for the fire service and identifying any gaps in the knowledge that may require further research.

4.2 Programme and participation

The workshop was organised at the Fire Service College, Moreton-in-Marsh, jointly by HO FRDG FEU and FRS on 16th and 17th September 1998.

The participants for the two days are shown in Appendix A. Delegates were distributed into four groups for the workshop sessions.

The workshops were intended to be "brain storming" sessions, in which even unlikely options would be considered, with the possibility of stimulating an original, and feasible, alternative idea. Delegates understood that while the meeting

would have to be focussed to seek consensus views, all ideas would be preserved for future use if appropriate.

4.3 Key issues

Prior to the Workshop, a number of issues had been identified which could form the focus of the meeting. These were;

1. How are sandwich panel fires different from other factory fires that involve large amounts of combustibles?

2. There may be a need to differentiate between three types of existing building;

   - those in which sandwich panels have been identified, and an action plan formed,

   - those in which the presence of sandwich panels might be deduced, e.g. food factories, and

   - those in which the presence of sandwich panels is established only while firefighting is in progress.

3. What information is required in the dynamic risk assessment by the fire incident commander as to whether the building is safe to commit firefighters to fight the fire from the inside?

4. If the fire is to be fought inside the building, should different operational procedures and tactics be employed to those used in other fires?

5. If the fire must be tackled from the outside, are there different operational procedures and tactics to the conventional ones which could lead to a better control of the fire?

6. There are a number of firefighting techniques that may need evaluation. These include; venting, the use of foam (medium or high expansion), the use of special equipment, the potential of cutting "fire breaks" (and how to do it safely).

7. The use of specialised sensing equipment (e.g. IR).

8. What information is available before the incident, and what at the incident.

9. How to record and communicate lessons learned?

10. What form any HO guidance might take, what it should contain and how it should be presented. Some Brigades already have their own guides; could these be adapted?

11. What research is needed, if any?

It was therefore proposed that the three sessions at the workshop have in turn the following issues to discuss;

Session 1: How are fires in existing buildings involving 'sandwich panels' different from fires in other buildings that contain other combustibles?

Session 2: Were the problems identified in Session 1 an issue for you?

If so, how were they dealt with?

If not, why not?

Session 3: If HO Guidance were to be produced:

what should go in it?

what do we know now that we can put in it?

where are the gaps?

In the event, there were some changes made to these issues as the days unfolded.

During both the workshop sessions and the plenary sessions other related issues arose that were not part of the mainstream discussion. These were also recorded and are presented at the end of the transcription.

Nominated members of the workshop sessions presented their group's findings after each session using the flip-charts and other notes made. In this way all of the delegates were made aware of each other's thinking. The facilitators and organisers tried not to lead the discussion, although they had prepared topics to raise should there be a lull. In the event, there were few, if any quiet periods, as all those present were well-informed about the problems of sandwich panels in fire, were keen to present their ideas and experiences, and were intent on coming up with workable solutions to the problems set.

4.4 Outcome

The results from the sessions (mostly flip-charts) have been transcribed and are summarised in Appendix B.

All the delegates participated fully in the discussions and contributed to the event. Some provided copies of guidance documents produced by their own brigades. There was a wide range of experiences, from those who had had to tackle a number of fires involving sandwich panels, to those who had never been to such an incident. Different brigades were able to call upon different levels of resource.

4.5 Findings

Session 1

For Session 1 the delegates were asked how fires in existing buildings involving 'sandwich panels' were different from fires in other buildings that contain combustible materials.

The following notes are a summary of much longer discussions on the issue by the four groups and the report back to all those present. (As mentioned above, edited transcripts are given in Appendix B and the complete transcripts are available in electronic form.)

One comment summed up the concerns; that a fire involving sandwich panels was 'a fire *of* the building, not a fire *in* the building'.
There was a recognition that the buildings are not generally designed to maintain stability in a fire and once collapse occurs then the application of water cannot be effective. Lack of structural stability, very early ceiling collapse, and resulting damage out of proportion to fires in equivalent sized buildings were all common comments.

The size of the buildings, whether for process and/or storage, was noted, these being of large volume and with high roofs, and usually without sprinklers. The buildings are difficult to ventilate before the roof collapses. This has implications for firefighters as it was widely seen as being very dangerous to commit crews into one of these buildings, whereas the traditional approach is to attempt extinguishing a fire in a building's contents from inside.

Participants showed a good understanding of the sequence of fire development in any building. They were aware that there was a point at which fires in buildings containing sandwich panels suddenly differ from the expected. There was a strong shared view that once the fire involved the polymer core of the panels the evolution of thick black hot smoke would make firefighting inside the building very difficult because of poor visibility and heat effects.

There was recognition of the rapidity of fire spread where the structure of the building contributes to that spread. Further, vertical as well as lateral fire spread is to be expected. Much was made of the unpredictable nature of a hidden, rapidly spreading fire.

Fixings and orientation of the panels all play a part in the development of such a fire, with delamination occurring without warning early in the fire followed by sudden collapse. Because the metal faces of the panels interlock or overlap, these will prevent water entering and reaching the burning core.

Because of the polymeric core the effective fuel loading was felt to be disproportionate to both the building and/or the process. Concerns were also expressed about flammable vapours getting into the roof void which may ignite

once a panel has collapsed. Once a panel had collapsed very large areas of the building will be affected as the panels can be very large.

It was also clear that firefighters inside the building are often unaware of what is happening around them and have to rely on officers outside the building to spot that conditions are changing. Markers for this were identified as paint effects at high level, signs of buckling and noises of metal moving.

There was a widespread wish for information about buildings, starting with the architect and including all of the agencies involved with the construction and use of the building.

Techniques for firefighting depend on information about the building; there are buildings where pre-planning is possible and there are those where the fuel, in terms of both structure and contents, comes as a complete surprise. Water supplies and travel distances for support pumps were mentioned along with several comments on difficulty in access and the problems associated with having to tackle the fire from outside. There were very rare examples of fires where extinction of the original fire was possible with the minimum damage to the sandwich panels present, or to the rest of the building.

Discussions regarding information at the fire scene included the potential for the use of thermal imaging, temperature sensing and head-up display telemetry. Methods for the effective removal of panels, for access or as a firefighting technique were discussed. However, the impracticality of making fire breaks by removing large numbers of panels quickly was noted. Positive pressure ventilation (PPV), and related techniques, were discussed but there was also the feeling that such specialist techniques and equipment were not always available to retained crews. Similarly reactions were expressed regarding the use of firefighting foams, since it was too specialist a technique for ordinary crews. Such equipment would come from a central station, but would probably arrive too late to be of use.

Session 2

For Session 2, delegates were asked three questions that picked up from Session 1 and the general discussion that had followed, with the intention of examining their personal experiences of the problems in real incidents;

- Were the problems identified in Session 1 an issue for you?
- If so, how were they dealt with?
- If not, why not?

To ensure that the groups covered all of the key issues, twelve topics were identified from Session 1. As before, the following notes are a summary of much longer discussions in which the questions above were focused around the twelve topics identified for the four groups to discuss and report back to all those present.

The information and ideas presented were all derived from direct or indirect experience with actual fires.

1. Hidden fire spread/growth.

Where the fire is spreading overhead firefighters are unable to locate the seat and spread of the fire. The greatest concerns were expressed about the rapidity of spread and growth. Education and training of firefighters was an issue; any presentations must include a description of hidden fire spread; the importance of recognising the unpredictable nature of fires in these buildings. The role of videos for retained crews was raised, to help explain and demonstrate the problems.

2. Preplanning for particular buildings.

Of particular concern was the strategy regarding when to commit crews into the building. There was an appreciation of the concept of pre-planning but many felt that it could not be relied upon because the building changes. The most important information needed at the scene was to know or confirm that sandwich panels were present. Any pre-planning may not be appropriate on the day if the building has been altered. Brigades need the right information for the first crew attending.

Similarly, there was a concern that information in a fire safety plan may not tell the operational crews what they want to know at the incident.

3. Education and training for crews and how to gain experience.

Many believed this to be the biggest issue. Awareness of the presence of panels is the most important factor. There is a wish for a simple aide-memoire, which recognised the need for flexibility, but with a few key words regarding what to do. There were questions about the cost of obtaining this information. Surrey FB have looked at HSE Improvement Notices Risk Register and found that there were no premises with sandwich panels recorded.

4. Difficulty of access (including firebreaks) and the need to remove panels.

This discussion concerned the need to cut through panels to gain access to the interior of the building, to ventilate the fire, to vent smoke and to create fire breaks. Generally, the fire will grow exponentially and unless it can be ventilated very quickly there will be many problems for firefighting, both inside the building, for BA crews, and outside the building for the required application of water. There will usually be very little access to the roof space. Cutting and peeling the panels was suggested and the group concluded that because of the size of the panels there were no practicable ways of doing this; the only answer would be a special cutter - "a giant tin opener". No one was clear on how to stop individual fires. Roof venting would slow the progress of the fire if this was achieved sufficiently early.

The fuel load in the contents is critical in determining how important cutting a fire break might be, or how quickly it must be done. Cutting equipment is needed on the first appliances. There was discussion of the role of explosive devices (see also Appendix D).

5. Should the brigade let the building burn?

There was a strong consensus from the delegates that one must not commit crews if the Officer-in-Charge (OIC) was not sure that it was safe. Crews should only go in to a building if persons are reported. The legal position was touched on, if the brigade stand back. The available water supply is crucial in making such a decision. The group were keen to see the option of letting the building burn stated somewhere in guidance, to help clarify the legal position.

Information obtained from the 1(1)d inspection should include the construction (in particular the presence and location of sandwich panels) and the age of the building.

6. Rapid development of fire in combustible materials.

This will depend on the contents of the building and the processes being carried out. Any fire or smoke venting needed to be early and substantial. Rapidity of fire growth could be predictable if officers present really know the building.

7. Rapid collapse.

Reference was made to several incidents, such as Aylesbury, where there was a serious fire found on arrival; crews committed well away from the seat of the fire and then had to be rapidly withdrawn once the person reported was accounted for. A second example was a building where a partition wall collapsed 2 minutes after the BA crew were committed. In this case the presence of sandwich panels was not known by the attending crew. Another example was where crews were withdrawn because buckling of the structure was seen; with a second incident where the noise of the panels just before collapse triggered withdrawal. At Sun Valley there was no warning of the collapse but something was heard. There was one example, in Evesham, of collapse onto the crew, but who were able to leave safely with only minor injuries; in another case in Cornwall the crew had to be persuaded out by the OIC.

BA crews often reluctant to be pulled out when they are quite comfortable. However, it may be that the OIC, outside the building, can see that there is high level damage. In a London fire roof-lights were present and the fire vented, but OIC resisted the temptation to send crews into a building where he was aware of the presence of panels and was alert to the issues.

It was mentioned that collapse of the panels can be useful if it allows smoke to move up above the firefighters and can improve visibility.

8. Smoke within the building is dark, very hot and toxic.

It was considered that there was a risk of a backdraught or smoke explosion. Smoke outside the building is a threat to the local community, particularly if there are very high winds. There is also a danger to crews not in BA outside the building. In one fire the compartmentation was breached by conveyor belts and ducting and so the smoke was not contained.

Venting will not only clear the smoke but will also reduce the effect of heat on the structure. It was noted that the effect of venting is calculated on the basis of the fire load and whether there are sprinklers present. However most of the fires being discussed are in unsprinklered buildings. In another case PPV was used successfully; this was a vacant building with almost no contents.

The effect of wind on these fires was discussed.

9. Environmental issues.

These include the effects of smoke and contaminated firefighting water reaching the water table. These issues should be addressed as part of the whole problem. No one was aware of any plans for further legislation in this area. There was concern that there are legal implications for the brigade if they stand back and let the building burn, as well as the environmental repercussions. It was understood that if there is no causation then the brigade are not liable. But, if by their actions they make matters worse, then they are liable. If other agencies such as Environmental Health are consulted then actions are the result of a joint decision and the brigade would not be liable. The position is becoming clearer with inter-agency liaison giving rise to corporate decisions.

10. How to get information on the building?

One brigade obtained information from manufacturers via a list of customers. Environmental Health have a list of food process in their areas; Devon reported that there were public houses with sandwich panels in their area. Greater information exchange between applications for Building Regulation Approvals and Environmental Health, existing 1(1)(d)'s and local fire ground knowledge would be helpful. In Scotland and Bedfordshire they have supplied 1(1)(d) forms with an additional form on significant risks, as well as writing to the owner/occupiers. As yet there appears to be no requirement for fire safety officers to ask specific questions during inspections, but they will need to have handout information i.e. there are both operational and fire safety needs for the information. The insurance industry should be a fruitful source of information but no one is aware of how to gain access to it.

Hereford and Worcester were looking at a way of combining information in order to produce an Operational Risk Assessment. CAFOA are looking at this approach as a way of upgrading the 1(1)(d). Insurance companies were again mentioned as possible sources of information. It was also noted that Building Control Officers are really only concerned with surface spread of flame rating, because of the requirements in AD B.

There was a lot of concern regarding fires where the crew first attending entered the building without realising that sandwich panels were present.

11. How to extinguish the fire since the panels repel water?

The cooling effects of water were significant; if it were possible to punch a hole into the building (as was done in Aylesbury) then this could be very useful since water could be applied more effectively. In future brigades should insist on sprinkler/detector installation if there is an attendance time of more than 5 minutes. It was noted that most food processing factories are well out of town. Similarly, fixed firefighting foam installations could be very effective. A mechanism for tearing off panels to gain access was also suggested. There was also concern over vandalised hydrants.

12. Ventilation.

There was much discussion on how to force entry to the roof in order to provide venting. The options appear to be: an explosive system (such as that used in Sweden), to pull off the panels to remove the radiant heat gas layer (this would be useful at any time), or peel off the roof. There was discussion on how big a hole in an unsprinklered building would be appropriate; several holes will be needed. In the Leicester fire in a DIY retail warehouse, the melt-out roof panels did not react as intended because the wind blew the smoke past the panels when the loading doors were open. One suggestion was for buildings to be marked with 'cut here' as is done on aircraft. Delegates were not clear how they would know, at an incident, whether ventilation would be worthwhile.

The general plenary discussion touched on all these issues. Also discussed was that many of these fires are the result of arson, and that sandwich panels are being used in non-food factory applications. However, there appear to be very few major fires in these other types of building.

Session 3

Session 3 was to bring together all of the previous discussion and concentrate on the issues, information and advice that might affect the firefighting at an incident. If these could be identified, then pre-planning, training and wider strategic issues could

be assessed later. Delegates were therefore asked to concentrate on the Dynamic Risk Assessment (DRA);

- what information was needed at the scene in order to make the decision to commit crews into the building?

- what special tactics were needed once committed and fighting the fire inside the building?

- when to withdraw and fight the fire from outside?

The intention was to consider whether HO Guidance might be produced:

- what should go in it?

- what is known now that could be put in it?

- where are the gaps?

Information required for the Dynamic Risk Assessment

This is most easily summarised as a series of bullet points, again Appendix B provides more details:

- Is there a responsible person present who can provide information on any persons still inside the building? Are there any eye witness reports?

- How much is known about the building structure? Is there any fixed suppression system present, such as sprinklers?

- What is in the building? Is it obvious that sandwich panels are likely to be present? Has the pre-determined attendance (PDA) taken account of the sandwich panels? Could information be made available in the cab (as is now done in Hereford and Worcester)?

- At what stage is the fire growth? Can smoke be seen on the way to the fire, or outside the building? If so what colour is it?

- Are any flames visible? Specifically; where is the fire?

Once at the scene the Officer-in-Charge will have to decide what additional resources to call on. This will in part depend upon what is available before commitment and how experienced the brigade personnel are in these type of incidents.

Once crews are committed

The DRA must be constantly re-evaluated with a Safety Officer appointed early. Fire ground communications between officer and officer are crucial; it was strongly advised that the initial OIC should stay with the Senior Officer on site.

The importance of using water sprays to cool the panels and get water into them if possible as a means of preventing fire spread was stated. The use of thermal imaging equipment or other imaging equipment was felt to be beneficial. The possibility of using PPV was popular but would need an exit for the smoke; it was noted that this is a late tactic as specialist crews may be needed. For both PPV and general smoke clearance the question was could the building be vented at a distance from the original fire?

Indicators to withdraw the crews

Crews inside the building may not be aware of what is happening and will depend on external information, such as changes in smoke patterns, structural movement and the noise of moving metal. If visibility is maintained within the building they may see black lines at the top of the sandwich panels due to heat, signs of delamination, pulsating flames, burning droplets and/or a flow of burning material at the base of the panels.

Fighting the fire from the outside

It was clear from the discussions that the participants do not enjoy fighting fires defensively. It came over strongly that they want to maintain access to the building and were very keen to find some way of venting the fire effectively in order to stay inside longer and to allow cooling water to be used at a distance from the origin of the fire. The use of aerial monitors, "snozzle" and other devices, such as explosive cutting, were all mentioned. The use of high expansion foam (as demonstrated at the IFE meeting in April 1998 (Ref. 9)) was considered interesting but regarded as impractical as the time needed to set it up precludes its use.

The polluting effects of the smoke plume and the run off water were clearly a concern and it was emphasised that the Environmental Agency must be consulted about these effects and the potential necessity of evacuating nearby residents.

General points

A major issue of concern was the question of whether it was sensible to put men into the building at all, or accept that firefighting was a waste of resources. It might be more logical to let the building burn.

Contents of potential Home Office guidance

The contents of any Home Office guidance was then discussed and can be summarised as follows.

- Introduction
- Description of Sandwich Panels and construction methods
- Firefighting tactics / techniques
- Information gathering
- Scenarios
- Building fire
- Contents fire
- (Communications) Feedback at various levels
- Pre-planning
- Implementing contingency plans
- H&S for crews and public
- Environmental issues
- Augmented first attendance (e.g. turn-table ladders or aerials for high level attack)
- Risk Assessment

It was felt that there was information already available from a variety of sources that could be included. Information from this workshop could be amalgamated with material from elsewhere in the UK, Europe, the USA, FRS and brigades not represented at the workshop. In addition, the insurance industry and manufacturer's associations such as BRUFMA (British Rigid Urethane Manufacturers Association) could all contribute. One particular area requested was for information on fixings, and how they work, so that an evaluation of what if likely to happen in the fire can be made.

Research needed

- Labelling of panels
- Marking of sites
- Alternative media - CO_2 total flooding
- Jointing, fixing and sealing systems
- Ventilation, smoke control, smoke curtains
- Drenching systems.
- Alternative firefighting techniques
  - PPV
  - robotics
- Access and implications for use of existing kit
- Ways to gain access to buildings;
  - Explosives
  - Opening panels up

- Intumescent coatings
- Fire breaks – how to create them
- Alternative media : nitrogen extinguishers

What would you like to see in New Build?

As the guidance in Approved Document B is still not finalised, participants were asked what they would like to see as requirements in new build. This is presented in Appendix C.

Discussion of the Workshop

There was a very strong wish by all the participants of the workshop to move the subject forward. All agreed that there was a specific problem in dealing with fires in buildings containing sandwich panels with polymer cores. There was also strong support for the use of Special Incident Procedures (SIPs) (as outlined by Devon, see Appendix B) which are being planned by many of the brigades represented. This is in addition to the Standard Operating Procedures (SOPs) which are in common use.

With existing buildings the greatest threat to occupants and firefighters was seen to be in rural food process facilities where first attendance is likely to be of retained crew. This concern was largely related to the response time lag inherent where there is attendance by retained crews. Although they are trained regularly, they may have little experience of sandwich panel fires. The issue was typified by the poultry fire in Norfolk in August 1998 where retained crews attended. It was evident that one of the most important elements in the DRA on-site is the experience of the firefighters on the scene.

Many of the responses may have been predictable, but there were many new and additional comments and experiences which provides a much rounder description of the problems as perceived by the brigades. Although no one actually used the phrase 'throwaway building', discussion on whether to ever commit crews came very close to this concept. There is a complete willingness by brigades to tackle these fires and to become more effective in fighting them. That the workshop concentrated on existing buildings was appreciated by the delegates since it was expected that regulatory controls and influences from building owners and their insurers will make new buildings less susceptible to fires and also more equipped to extinguish them by the use of sprinklers, drenchers or fixed foam systems.

There are serious concerns about situations where crews are surprised to find combustible panels at the fire scene, because there were no indications that it might be present. It was accepted that food production and storage buildings are highly likely to contain sandwich panels, but the list of other buildings also containing them, such as schools, was unexpected by many delegates. Anecdotal evidence regarding the second-hand use of panels is a cause for concern. Following the concerns expressed at the workshop, information has been exchanged by FRS and ABI Fire Surveyors, regarding information about second-hand use. It is reported to FRS that a hand-made crisp company had been advised to fit sandwich panels to

improve hygiene. They had chosen second-hand panels with existing, but now unnecessary, holes for pipe-work. This information will now be passed to the local fire safety office.

There was a clear demand for readily accessible up-to-date information, such as the system to gather information and make it available in-cab to the Hereford and Worcester crews. While this indicates a way forward it must be recognised that there are cost implications.

The potential Home Office Guidance would be welcomed but was seen primarily as a means of providing information and ensuring consistency for brigades devising their own locally-relevant SOPs and SIPs. It would need to be simple enough to be assimilated, while being comprehensive enough to be useful in practice.

Two brigades, and the College, offered their own information sheets on these buildings (Refs. 10, 11 and 12).

Following the workshop, further information has been obtained regarding the use of explosives to cut access points. This is reported in Appendix D.

5 DISCUSSION

It is evident from this review, and supported by the Workshop, that fires involving sandwich panels present a special problem to the fire crews attending.

This special problem is primarily one of speed; the development and spread of a fire and the general build-up of dangerous conditions in a building containing sandwich panels. These fires are in most ways the same as any other fire - but much faster. This means that the OIC must react more quickly, must be more responsive to new information and evidence of the changing conditions, and needs to withdraw teams or call for more resources earlier, possibly before the real need is apparent.

In considering the way forward, the development of Home Office Guidance is a clear and realistic step. It would provide brigades with a distillation of current knowledge and thinking which might then be best used as the basis of individual procedures that are tailored to the local conditions, resources and building stock, in the form of local Special Incident Procedures and Standard Operating Procedures.

The production of such guidance will require wide consultation and formal procedures.

However, the findings of this current programme of study appear to provide the core of the needed advice, and while it is neither appropriate nor possible, at this stage, to offer comprehensive details for such guidance, it should encompass the following in its contents;

Issues and information

- What are Sandwich Panels?
- What to look out for
- Where to expect to find them
- Industry labelling schemes
- Special features of these buildings
  - Types of building
  - Size of buildings, large spans, deep buildings
  - Usual lack of sprinklers etc
  - Formation of temporary "compartments"
  - Changes to building layout
  - Difficulty in identifying means of escape
  - The "normal" role of sandwich panels
  - Heat and sound insulation
  - Quality issues in sandwich panel construction
  - Types and effectiveness of fittings and suspension systems
  - Second-hand panels
- How panels behave in fire - why they are special
  - Need for large initiating fire
  - Speed of development, speed of spread
  - Poor compartmentation
  - Delamination and ceiling collapse
  - Hidden fire spread, fire spread in voids
  - The problems of applying extinguishing agents
  - Molten droplets
  - Smoke - quantity, toxicity
  - Fumes, flammable vapours
  - Loss of stability of the building
- Environmental issues

Strategy (advanced planning)

- General planning
- Planning for specific building 1(1)(d)
- How to decide on number of pumps for first attendance (PDA)
- Type of building, type of installation
- Location of panels
- Layout of escape routes
- Robustness of information
- Size of compartments
- Are sprinklers present etc?
- Means of access
- Where to cut fire breaks
- Calling for additional safety crews
- Sources of information
- Training, education, records
- Availability of resources
- Water supplies

- Special equipment
- Use of retained crews - time delays, training
- Other risks - Ammonia
- Interagency communications
- Environmental issues (water, air, other)

Tactics at the scene

- Issues for Dynamic Risk Assessment
- How to recognise panels are present?
- How to recognise panels might be present?
- Information available - Fire Certificate etc, witnesses, staff, management etc
- Are people in the building?
- Are persons reported?
- Are panels present?
- Where are they?
- Communications
- How to recognise what stage the fire has reached?
- Where best to put water
- How much resources are needed?
- When to call for more resources
- Water supplies
- Special equipment, techniques
- Wayfinding
- Where is the fire? Hidden spread
- Delamination, loads on panels
- When and how to recognise the need to change from offensive tactics to defensive?
- When to expect to lose the building
- Health and safety of personnel
- Difficulty of access
- Firefighting in cold stores
- When to ventilate
- How to ventilate?
- When to commit
- Signs of danger - smoke, fumes, noise, collapse
- How to predict collapse?
- When to withdraw
- Need for rapid back-up
- Safety team for BA crews
- The need for additional BA crews
- Size of BA crews
- Cutting fire breaks
- Other risks (Ammonia)
- Protecting adjoining property
- Wind and weather - impact on firefighting
- Other agencies
- Environmental issues

Special techniques

- Use of foam
- Bulldozers and JCBs - for access
- Cutting access points
- Use of helicopters, helicopter information
- Robotics
- Explosives
- Lances
- Thermal imaging
- Nitrogen

A number of areas of research have been identified, both in the review and later in the Workshop. Answers from some of these would be required for inclusion in any guidance, but others need a longer detailed research programme. Some will need the involvement of other agencies. Most would need the active participation of brigades and some are already being addressed.

The topics that have been identified are;

- Tactical information
  - How to predict imminent collapse
  - What is best to limit fire spread - panels stay in place or collapse?
  - More performance data on panels
  - Information on performance of fixings and joints
  - Effect of insulation properties on fire growth
  - Effect of wind and weather
  - Likely fuel loads
  - Labelling of panels
  - Marking of sites
  - In-cab data systems
  - Data bases
  - Firefighter telemetry
- Techniques and new techniques
  - Ventilation (any use?)
  - Cutting fire breaks
  - Cutting access points
  - Explosive cutting
  - Abrasive cutting
  - Lance
  - Snozzle
  - Robotics
  - Thermal imaging
  - PPV
- Extinguishing and alternative extinguishing media
  - Foam
  - Nitrogen
  - Water sprays, high pressure sprays, water barriers
  - Does water on the outside of panels limit fire spread?
- Legal issues of standing back

- For new buildings; ventilation and smoke control, smoke curtains, drencher systems, intumescent coatings

This study has concentrated on the problems in existing buildings. It may be expected that many of the problems for new buildings will be resolved by revised DETR guidance (through AD B), new designs and fire protection systems and/or improved management.

6 RECOMMENDATIONS

6.1 Home Office guidance

It is clear from this study that guidance from the Home Office on special requirements for fighting fires in buildings containing sandwich panels would be widely welcome by brigades. However, such guidance would best be offered as a means of providing information and ensuring consistency for brigades in devising their own locally-relevant SOPs and SIPs.

The production of such guidance is now readily feasible based on the information gathered in this study, although detailed development is needed. For consistency of approach and training we recommend that any guidance be developed to reflect the current brigade approaches and standardise it. This guidance should therefore be a stand-alone document within the Fire Service Manual. There are a number of areas where some research is needed to support the development of guidance.

6.2 Further research

A number of topics which require research to pursue the problem of sandwich panels have been identified. These have been listed above.

Some of these topics would need to be carried out to enhance any HO guidance on sandwich panels in the short term; others require longer term development and any results would need to be made available separately or in revisions to the guidance. Some will require the active involvement of other bodies, such as sandwich panel manufacturers, the insurance industry or other government agencies.

It has not been considered appropriate to develop a detailed programme of research at this stage.

7 CONCLUSIONS

There is a wide concern over the problems of fighting fires in buildings containing sandwich panels. There have been two firefighters killed fighting a fire in a building containing sandwich panels, but to date there have been no civilian fatalities. However, there have been a number of "near misses" and there are naturally concerns that circumstances may be different in some future event.

The findings of this study have identified clear differences between fires involving sandwich panels and other types of fires. The special problem is primarily that of the speed of the development and spread of the fire and the general build-up of dangerous conditions in a building containing sandwich panels. These fires are, in most ways, the same as any other - but much faster. This means that the OIC must react more quickly, must be more responsive to new information and evidence of changing conditions, and the need to withdraw teams or call for more resources earlier.

Other differences result from the form of the sandwich panel structures. The layout of panels can result in complex geometries within the buildings and create difficulties for firefighting. The fire can grow within or behind the panels, with hidden spread of fire and smoke. The steel skins of the panels can also restrict the application of extinguishing media.

There is a consensus from fire officers that any well-founded information and advice that can be provided will be most welcome. Guidance from the Home Office based upon the present study, and under-pinned as it is by brigade knowledge and experience, will provide a most appropriate method of minimising the risks associated with firefighting in these buildings. The production of such guidance is now readily feasible based on the information gathered in this study, although detailed development is needed.

As well as the fears for the future, the fire service within the UK is naturally reluctant to abandon a building to destruction, and indeed, such defensive tactics go against their usual method of response. But the dangers from these buildings are now more recognised.

REFERENCES

1. Shipp M P, Morgan P, Stirling C, Jones D and Malone S. `An Initial Review of the Fire Safety of Large Insulated Sandwich Panels`. Home Office Fire Research and Development Group FRDG Publication Number 3/97, May 1997.

2. BS 476: Part 7:1987 Surface spread of flame

3. B Parlor. Private communication (French test under development)

4. BSI. Memo to manufacturers 'Don't be a flaming liability' London, BSI, 1988

5. D Smith and K Shaw. Evolution of the single Burning Item (SBI) Test. Paper given at Flame Retardant '98 Conference. Interscience, London, February 1998

6. K Shaw. Private communication to FRS 1998

7. Building Regulations 1991, A Consultation Paper on Proposed Amendments to Part B and its Approved Document, DETR December 1997.

8. Fire Precautions Health and Safety, The Fire Precautions (Workplace) Regulations 1997, Statutory Instrument 1997 No. 1840.

9. Institution of Fire Engineers, East Midlands Branch "The Sandwich Panel Debate - Final Solutions" 28th and 29th April 1998, Bedford.

10. Hereford and Worcester Fire Brigade; Junior Officer Handbook - Issue No. 1 - 13/12/96 Sandwich Panels.

11. Durham County Fire and Rescue Brigade. Operations; Information directive No. 21/96. Light Insulated Structural Panels.

12. The Fire Service College; Large Insulated Sandwich Panel Buildings LISP. Watch Commanders Course.

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Special thanks go to Andy Goves (Bucks FB), Andy Roberts (Hereford and Worcester FB) and Les Mann (Kent FB) for their assistance with this project.

The Workshop will enable moves forward on this very important topic but it needs to be recognised that simple solutions may not be forthcoming. However, any findings will be worthwhile and sincere thanks go to the participants for their help, for the co-operation of so many fire brigades, and to the Chief Fire Officers of all the brigades that participated for permitting their staff to contribute.

Table 1 Summary of fire incidents

Location and occupancy	Injuries, fatalities and rescues	Comments
Hamlet, North Carolina, USA in chicken process 3.9.1991	54 injuries, 25 fatalities, 6 rescues and 18 bodies recovered	No sprinklers
Sun Valley, Hereford in chicken process. 6/9/1993	Occupants safely evacuated but 2 fire-fighters died, rescue hampered by fallen debris	No sprinklers
Pontefract , extension to cold store. 3/8/91	Building unoccupied but 8 spectators nearby suffered smoke inhalation.	Under construction; 10 pumps 2 aerials
Crewe, Cheshire in cold store	Electrical fault in cable at base of sandwich panel. No injuries	No sprinklers
Hempnall, Norfolk in glass house with internal cold store. 18/2/95		Fire limited to this area of the glass house
Shropshire, in a creamery. 12/1/96	Evacuation completed before brigade arrival	No sprinklers. 11 pumps, 1 TL, 1 HP
Wolverhampton, in poultry process. 14/2/96		8 pumps to maintain BA for firefighters. Because of black smoke; thermal imagers used
Aberdare, Mid Glamorgan in food process. 1/11/95	Evacuation completed before brigade arrival	Fire fought internally until flames and smoke at high level caused BA crews to withdraw
Hull, in Yorkshire pudding factory 6/7/95	Evacuation incomplete, 14 firefighters suffered exposure to ammonia	First-aid firefighting unsuccessful but continued until brigade arrival when two staff were escorted out of building.
Abergavenney, in poultry process. 4/9/93	Evacuation completed before brigade arrival	Smouldering fire in panels successfully extinguished
Hereford, in meat pie factory		Brigade action contained fire to area of origin
Milton Keynes, in meat process17/7/89	All staff evacuated	Main firefighting done externally
Uckfield, West Sussex in poultry process 17/11/91	Both staff left before the brigade arrived ; 3 firemen suffered minor injuries	9 jets in use and up to 16 BA firefighters within the building
Uckfield, on the same site as above 19/7/95	Storage building unoccupied. No injuries	Straightforward firefighting

Table 1 Summary of fire incidents (continued)

Location and occupancy	Injuries, fatalities and rescues	Comments
Broxbourne, West Lothian in food process 24/10/92	Security man spotted fire	Firefighting began inside building then outside as damaged panels became involved
Buckingham, abattoir 26/11/94	35 staff outside when fire started, later discovered in cutting and boning room.	After one firefighter found an internal fire, all operations were external to the building
Falmouth, Cornwall, meat process. 21/2/95	No injuries. All staff evacuated safely. Falling panels blocked access for firefighting.	90 BA crew. 8 jets
Farnborough, Hants in rubber mouldings factory. 22/6/95	7 staff left safely	4 jets, an HP and 8 BA crewmen on ground floor fire with total response being 12 pumps and 2 HPs
Gateshead, Tyne and Wear in a factory. 21/9/95	4 contractors on site left safely	5 pumps and one TTL
Durham, bakery and food maufacturer. 11/12/95	One person missing on brigade arrival. 5 mins later accounted for. Ceiling panels collapsed putting BA crew at risk	5 jets, 6 BA ,TL monitor. Fire hydrant outlets missing - difficult to obtain water
Dunstable, disused food process 20/3/96	Unoccupied	Roof-lights burned out venting the fire so brigade able to control the fire
West Midlands, in brick kiln. 10/7/95	Staff left safely	Although a small fire thermal imaging used to check extent of spread
Swindon, Wilts. in hospital laundry. 24/7/95	No injuries	3 jets, 2 HR, 10 BA. Self heating in laundry spread to external sandwich panel cladding
Truro, in fish process 18/6/96	50 occupants left safely before brigade arrival. Smoke affected public and brigade personnel	ALP monitor , 8 jets
Chippenham, Wilts in food process 23/6/96	Only cleaners and security present at time of fire, all left safely.	15 pumps, 2 aerial monitors, 8 jets fire contained to 3 year old extension separating wall used as bridgehead which allowed some internal fire-fighting.

Table 1 Summary of fire incidents (continued)

Location and occupancy	Injuries, fatalities and rescues	Comments
Aylesbury in food process19/6/97	Staff assembled in area remote from building - Sub O informed all out - however one was delayed in his exit by re-arrangement within building. This was almost a 'persons reported'. No injuries	3 rescue pumps, 9 pumps, 2 aerials, 2 OSUs, 1 HLL, 1 CU, 1 CaV and 1 W Shops
Sittingbourne, Kent in chilled fruit store 4/8/97	Evacuation in progress when brigade arrived. No injuries.	25 pumps and 9 special appliances
Southall, London in food process 4.1.98	5 staff in canteen when fire alarm sounded	20 pump
London, external to light industrial specialist dry cleaner 24.5.98	Night time lorry fire penetrated unoccupied building. No injuries	8 pumps?
Northern Ireland, in pig factory June 98	No injuries. Fire spread to temporary buildings at perimeter. Ammonia leak meant additional BA teams	At height of fire 12 jets and two ground monitors in use PU panels failed, min wool panels survived
Pewsey, Wilts in salmon process 9/2/98	No injuries to occupants. Falling panel caused shoulder injury to fire fighter	5 BA, 105 ladder in use to make vent in roof
Chicken process, Banham Norfolk 3/8/98	No injuries.	
Strathaird salmon, Inverness, 1/8/98	No injuries	HP and all 5 appliances from surrounding area used. 12 BA crew fought fire inside

Table 1 Summary of fire incidents (continued)

Examples of fires in mainland Europe		
Cheese manufacturer in Le Lutin. 17/3/92	None reported	10000sq m lost in an hour then into a packaging store bypassing a fire door
Coeur de Lion, Ducey in a dairy famous for its cheese 18/2/94	20 staff on duty 4 slightly poisoned(smoke inhalation) one fireman with acid burns to hand	Fire-fighters from 7 stations 9 large water pumps, 2 on ladders, 6 small pumps, 80 men deployed water barrier at holes in wall
Boulogne-sur-mer Fish station 24/9/95	None reported	Started with a lorry fire , 35 min after arrival fish station collapsed
Collet Slaughterhouse, Chateauberg 25/8/95	None reported	First aid firefighting by staff/auto extinguishers in packaging store, spread to involve 1000 sq m, wind changed direction lost the rest 7500 sq m
Cold store in Gennevilliers 9/8/96	None reported	Staff fight day time fire driven back by smoke
Abbatoir and cold store in Brussels 24.4.96	None reported	Fire spotted by crews returning from an incident . Large part of 52000 sq m complex saved ~ 4000 sq m lost
Meat complex in Bordeaux Jan 97 fire started in head peeling workshop	Safe evacuation of all staff	Fire extinguishers and HR from on-site fire stations unsuccessful. Fire wall penetrated by 1 sq m holes for conveyor belts. Fire advance stopped by removing panels. 7 hoses on one side and a cannon hose on the roof

APPENDIX A List of attendees

Organisers and Facilitators:

John Foster	FEU	Penny Morgan	FRS
Martin Shipp	FRS	Martin Thomas	FEU
Sally De Alwis	BRE	Ursula Garner	BRE
Denice Jaunzens	BRE	Sue Rogers	BRE

Delegates:

Terry Adams	London FCDA
Philip Appleby	Wilts FB
Brian Bamford	Kent FB
Andy Barnett	London FCDA
Dave Berry	FSI *(16th only)*
Stephen Bishop	Bedfordshire and Luton FRS
Bill Brookman	Mid and West Wales FB
Paul Bullock	Norfolk FS
Terry Calpin	West Yorkshire FCDA
Nigel Charleston	West Yorkshire FCDA
Mike Connelly	Devon FB
Chris Cooke	Hampshire FRS
Geoff Cutting	County Durham and Darlington FRS
Brian Docherty	Nottinghamshire FRS
Steve Dyer	Greater Manchester FCDA
Phil Goodwin	Hereford & Worcester FB
Andy Goves	Bucks FRS
Mervyn Hampshire	Wilts FB
Julian Hancock	Wilts FB
Graham Jackson	Mid and West Wales FB
Alan Jones	Surrey FRS
Barry Jones	Greater Manchester FCDA
Jim Laker	Devon FRS
Les Mann	Kent FRS
Charles Mcllwhan	Norfolk FS
Tim Moss	Leicestershire FRS
Martin Muckett	FSI *(Wednesday lunchtime onwards)*
Pete Penney	West Mids FS
Phil Reed	Grampian FB
Peter Rennie	Dumfries and Galloway FB
Andy Roberts	Hereford & Worcester FB
John Roberts	Shropshire FRS
Mike Robins	FSC
Ian Scade	Strathclyde FB
Pat Scott	East Sussex FB
Julian Sears	Bedfordshire and Luton FRS
Ian Shaw	FBU /Derbyshire FB
Bob Smithson	Bucks FRS
Stephen Todd	Northern Ireland FB

APPENDIX B Edited workshop transcriptions

These transcripts are simply reported from the notes and flip-charts from Sessions 1, 2 and 3 with only minor editorial consolidation. Most of the discussions in Session 2 have been summarised in the main text.

Session 1

Question; How are fires in existing buildings involving 'sandwich panels' different from fires in other buildings that contain other combustibles

- *characteristics*
- *problems etc*
- *key characteristics problems they pose.*

All the groups were asked to indicate whether they agreed that sandwich panel fires are different and not just an example of hidden fires.

Fire Behaviour

Early stages of fire
No difference in comparison with other materials
Once panels are involved a different matter because of rapid spread
Where the fabric/structure can contribute, in the early stages of involvement, to the rapid development of fire.
Running droplets of molten material (polystyrene)

Sandwich infill affecting fire growth
No sign of collapsing
Change within minutes from smoke to flames, a rapid increase in smoke – logging and build up of heat within the building.
Damage caused by fork lift trucks can effect the fire resistance of SIPs on internal walls, not so on normal construction.
Can assist in early development of fire.
Synergy in food production eg ammonia/packaging/polypropylene/foodstuffs being combustible
Penetrations including wiring and conveyor belts

Unpredictable behaviour
Fire can spread behind or within the core of the sandwich panels.
Fires usually travel long distances undetected.
Rapid collapse, rapid spread of fire in voids undetected.
When sandwich panels are used and covered in by other materials / panels concealed cavity, will assist with the development and spread of fire.
Uncompartmented
Rapid build up of hot gases, flammable gases and smoke.
High Volume of thick dense smoke.
How to predict time to collapse? -> delaminate -> safety of crews. (same as sheds)

(Time of call to present?)
Spread of fire development - have to predict resources for time ahead (not short term)
Rapidly developing fire.
Compartmentation - is it breached? Is there any?
Access to fire in panels
Increased risk of flashover

Pollution issues due to fumes and firefighting water run-off.
Environment
Environmental Hazards - risks to public, crews

Smoke generation
High volumes of smoke, Significant increase in smoke volume (Colour and density)
Rapid evolution of dense toxic smoke

Insulation properties
Because the area is insulated there will be a rapid build up of heat and flashover conditions are reached earlier than in normal / building construction.
Cool conditions making finding the seat of fire difficult – can give off very cool smoke due to insulation.
They tend to have a lot of *service openings in the partitions* which encourages fire spread

Worst Case Scenarios
Internal Unseen Fire Spread
Fire in the Structure
Structural collapse with little or no warning and rapid fire spread without much warning.
Hence, rapid collapse of internal walls and ceilings, structural steel and sandwich panel.

Orientation
Depends whether panels are vertical or horizontal; when fixed in a horizontal plane sandwich panels can drop down without any warning during a fire.

Fixing
Panels may not be fixed to structure of building but clipped together.
Panels may be supported by low melting point fixings which when exposed in heat layer will cause their collapse even though the panels may not be involved in fire at the time.
Sandwich panels are normally interlocked. Their construction will take into account normal expansion and construction, however in fire situation the expansion which will occur will cause buckling of the outer skin thereby exposing inner core or causing collapse.
The supporting steel will give way (perhaps remote from the fire) – collapse of unaffected panels (nylon bolts).

Fuel load
Due to nature of sandwich panels the effective fuel loading within the building can be disproportionate to both/either building and/or process.
The combustible panel core contributes to the fire loading of the building and generates large quantities of thick, dark smoke and toxins.
Easily ignited

(Possibly) The panels will give off flammable vapour which will ignite in the roof space once a panel is dislodged.

Rapid Structural Collapse – remote from origin of fire
If the structure of a sandwich panel building is affected by fire the probable outcome is total loss – decision on this affects strategy.
Unlike other building materials sandwich panels are quite large and therefore when they fail, one can expect large areas of structure collapse to take place.
More falling debris
When used as supporting structure, rapid strength reduction will occur in a fire situation.

Re-Use of Panels.
How does a Property Developer find secondhand sandwich panels for re-use .
Fire load / Occupier putting these in.
Building Regulation Provision? How?
What are they used for
Often caused by a fire that would not otherwise threaten the building

Firefighting water is shed off the metal sheet – away from fire.
Extinguishment / Spread

Actions

Architects should provide information to the brigades about schemes incorporating sandwich panels
It is necessary to recognise that building owners and users are likely to delay calling in the brigade if, in their experience, professional fire-fighting can lead to shut down of a process for a period. Hence, they will place emphasis on first-aid firefighting.
The interiors of food factories are often flexible, and can be changed very easily and at short notice.

BUILDING DESIGN
With a conventional large storey building there are signs of collapse indicating site of fire

Do buildings involving sandwich panels react in fire in any similar manner to traditional buildings
It is a new method of construction which uses materials which do not perform in fire to any defined standard.
Fire of building not fire in building
If a fire gets a good grip of the building fabric the result will almost always be a total loss of the building.
Damage out of proportion to fire
Affects all categories

Generally these buildings are designed to collapse in upon themselves and once this has happened the application of further water cannot be effective or the weatherproofing isolates the remains of the burning material
Fabric of the building burning (Not just contents) to a greater extent than normal

Higher risk when damaged

Very early ceiling collapse
Light construction, hence early structural failure
Rapid loss of structural stability of building, resulting in early collapse of structure – risk to firefighters
Correct installation critical
Workmanship / quality control - construction standards.
Type of fixings affect stability

Structurally unstable during fire

High Buildings, especially to roof void ridge.
Concept of building within a building – inability to fire fight safely
Services breaching wall surfaces

Buildings are
- Usually large
- Usually limited access
- Large compartments
- Easier to bulldoze rather than re-build
- Windowless building

Types of buildings;
Large single storey
Large spans covered
Sandwich panel buildings are (in the food industry) are likely to be unfenestrated.
Insulated (as a fire compartment)
Due to low cost build they are not often sprinklered

Performance of panels
Tensile strength >600°C
Thin sheet metal quickly reaches temp where steel becomes "plastic" in nature as opposed to "elastic", ∴ buckles and bends quicker than RSJ/beams/columns etc.
Can spread through core be stopped?
Little if any warning of delamination of adhesives giving at 270°C.
Delamination of side panels, may happen at early stages of fire.
Heating of steel sheet causes them to peel away from the core.
1. loss of structural integrity
2. exposes possible fire load (PU or PS type)

Type of fixing
Age?
Edging - Fire Resistant.
Consideration of flashover potential for more than one

Voids and compartmentation
Fires in panels tend to travel in the voids created by the building of internal boxes within boxes thus allowing fire to travel unnoticed.

Insulation core prevents heat travel from one surface to another. Inner face does not discolour to indicate fire behind.

Lack of effective compartmentation

Masking evidence of fire spread, particularly ceiling void

Metal sheets lapped or interlocked
Prevent water entering
∴ increasing difficulty in extinction of fire
Panels can be used as temporary compartments in a building
Lack of compartmentation – impossible to offensively fire fight [safety of crews]

Ventilation
Ventilation Techniques
- method of
- weight of
- how?

Lack of ventilation

Difficulty ventilating.

Techniques

Implications for firefighters
Due to the possibility of rapid and extensive collapse it is very dangerous to commit firefighters to the building as would be the traditional approach when extinguishing a fire in buildings contents, hence difficulty in attacking the fire
Limited structural fire separation limits bridgeheads
Health and safety implication for operational personnel ie falling debris.

Biological Hazards
- washing
- cutting

Safe Egress for public and fire service personnel
Water Supplies and Support Pump Travel Distances
Install – water supplies
Backup – water supplies - dirty? recycled?
Difficulty in access due to modern construction
Difficulty of access for firefighting operations

Dense Smoke
Wayfinding
Ventilation
thermal imaging
external effect
environmental
evacuation
Heads up display telemetry

Temperature sensing of hot gas layers
Once fire has penetrated the sandwich panels it can travel rapidly and unseen along the whole perimeter walls of the building. Thermal imaging may be the only way to see the spread before it breaks out elsewhere.
Telemetry on BA

Aerial Appliances
Roof collapse will still prevent successful aerial attack

Preventative/ Aggressive tactics
Firefighting techniques?
Fight fire using what?
- water?
- removal of panels?
- foam?

Fire-fighting tactics
- machinery
- voids
- separation
- PPV.
- H_2O Pressures

Currently requires firefighting from outside

Curtains – no one looks
Removal of panels as firefighting techniques
Inability to penetrate structure through external metal skin [weatherproofing]
+ Tactics
Difficult to extinguish
Difficult to attack
Fire breaks often impractical
Spread to other buildings
Sound insulation (ADSUs, whistles, etc.)
Difficulty in observing fire spread (visually)
Inability to restrict/prevent fire spread through sandwich panels.

Difficulty in applying water.

Old perception "let it burn".
Difficult to fight because the steel outer of the sandwich makes it difficult to get water or other extinguishing media on to the fire.
Sandwich panels by their nature of construction are protected in the most part from water penetration and therefore prevent water from firefighting jets to reach areas of burning.
Difficult access to ascertain fire spread in early stages of fire and for firefighting media to be effective.
Difficulty in applying water to ceilings

Difficult PPV

- can't pressurise need lots of fans
- is this possible?
- NV doesn't work
- PPV – inert gas into voids

Time factor

Creating a fire break
- vertical rather than lateral fire spread
- roof vents would solve a lot of problems

Firefighting procedures due to the type of building involved eg single storey – no persons involved – fight from outside.

Fighting fire in concealed spaces.
Usually have stacked product close to walls
H/ex foam injected into cavity rather than water.

Communication (or Pre Planning Risk Information)

Before call - late detection
On attendance – if can't see the fire in structure not in building.
Tactics / Strategy / Info
1) Do we have info before incident?
Do we find out at incident?

No on-site warning of panels
Identification
What type of panels / location
Movement
Part Building /
Insulated Panels
Are people still inside building, whether persons reported
Information in the cab

CONSTRUCTION
Construction / Old / New
Pre-incident knowledge of presence of sandwich panels ie preconception of contents of building by location/name of occupier
Sandwich panels can be concealed behind other building structural materials.
Not know if there or how fire travels = fire behaviour
Voids and roof spaces
'Inner' SP construction within existing shell – only purpose weather/element protection – hidden from view.
Flexibility – changes in layout of rooms etc. in response to seasonal / product requirements
Sandwich panels can be moved around and the layout of buildings changed.
Ventilation ducts, services not permanently fixed

Portable plant eg refrigeration on top of 'panel ceilings'.
Compartmentation / Breaks

Site Information
Availability –Location
- Simple
- Relevant

Limited info on most buildings
Difficulty with communications

Any structural fire resistance at all in building?
Unknown construction ie
- Polystyrene
- Polyurethane
- mineral wool

Existing Buildings
Location of building
- size
- construction
- processes
- life risk
- storage
- weather
- height

Building Regulations requirements?
Transfer of information at construction stage?
IID difficulties
Lack of pre knowledge

SOURCES OF INFORMATION
Insurers
Building Control records
Local knowledge
Risk Information "Warning" (Workplace Directive?)
Develop IT/ Databases
Control of substances hazardous to health.
re: Health and Safety Issues

Communication (needed for); Architect to Builders to end user to Fire Brigade
Occupiers don't understand the problem

Increase awareness of owners
Owners do not share the findings of risk assessments when the likely outcome is likely to be total loss.

Local environmental concerns can run out-of-control, in cases where intervention is ineffective.

Post fire. Educate public
Management controls
Employees/Maintenance/ Training
Training as firefighters not experienced in fighting fires.
Tactics/technicians

All crews inc backup, need information quickly - without knowledge to contrary internal appearance to firefighters can be deceptive – need details.
The sound and heat insulation qualities mean that firefighters are unaware of the extent of danger above false ceilings = need training / pre planning.
Passing on experiences until awareness increases
(Finds/Info – need more/ filtering)
Home Office / FRS to request specific FDRI reference to SIP involvement, major and minor.
Need prompt to include additional info.
Use of SIPs should be specifically sought in inspections, 1(1)(d) visits, etc.

Evaluation of building compromised by insulation:
- decision to evacuate
- deep building can't hear evacuation should alarm system ie sounded throughout.

Delay in evacuation caused by more than single stage fire alarm

Need to know everyone out.
[How can we pass this info onto employer]
as fire cannot be seen
decision to commit

1. At the design stage of the building there needs to be more exchange of information between the fire safety and the operational people.

2. Existing buildings (and some new ones) may contain LISPS without the knowledge of firefighters who may be committed to the building and the difficulty of identifying existing stock of buildings which contain them.

3. Fully involved buildings may be present on arrival of first pumps especially in rural areas.

4. Command and control need to be aware of the following:
- Nature of filling – "chemicals involved... "
- Risk assessments
- Link between building control and boys on ground
- Nature of insulation provides sound insulation as well as thermal – verbal orders and evacuation signals may not be heard.
- Must inform employer
- Info on every panel?
  Problems of identification
  - pre-planning for spec. buildings (firefighting tactics).
  - change over from win to lose

- education's public and liaise as to what you are doing
- control measures
  - equipment
  - supervision
  - liaison with other bodies
- offensive / defensive risk no different
- fire break
- need something to defend
- no win situation
- something in between
- when were seen to be putting out fire we are not.
- fire ground can be transitional
- difference is when building becomes the fire
- the method
- after a certain time you will lose a building
- flexibility to allow for resources / staff

Attendance times

Risk area factor to be considered in respect of development of fire
Resources
Water supplies
Inability to predict and notice 'signs of collapse'
Assumption that the building is going to collapse.
PDA info incomplete. LISP may not be identified.
New method of construction is not matched by changes in building regulations.
Fires are not a regular event.
'Opportunity to train'.

- rapid spread in void
- move towards insulation - u values
- intense thermal radiation
- smoke logging
- smoke turbulence (lots have been cold stores)

Strategy / Tactics

Environmental issues
- run off, waterborne
- pollution
- smoke (atmospheric)
- air pollution
- water courses (run off) (but same as chemical stores)

Creates pollution + fire behaviour
Environmental impact
Notifying other agencies

As the fabric of the building is consumed the amount of 'smoke' and fire-water run off has a potential to cause much greater environmental pollution than a similarly sized traditionally constructed building.
Potential fuel present can/does present environmental/health implications to near middle and far neighbourhood.
But if withdraw crews causes problem consider evacuation of further afield.

Off site dangers

Consideration of not committing fire brigade personnel into building.
Signs of Collapse
Panel angles
Withdraw crews and allow building to burn/collapse?
- legal implications?
- public relations?

More frequent loss of buildings
+ Strategy / FB fire behaviour

Information to crews
Identification of insulated panels
Will / do I need to commit crews?
Resources
- availability of
- time to accumulate

Large numbers of BA wearers required
+ Technique
Fire fighter safety
Early withdrawal of firefighters
Safety
Dynamic Risk Assessment

Risk categorisation effects
Initial dynamic risk assessment, by 1st attendance OIC, can commit crews to firefighting from out-with premises only.
Tactical firefighting issues
Techniques
Creates early danger to firefighters
+ Fire behaviour

Access / Height
Difficult Access
Access to Building , to panels
Access to site / on site.
Firefighting access has to account for firefighting and personal protection for approach, wind change etc.
Comm. techniques
Structure
Usually rural (that's where animals are / produce is)

Water supplies? – uncontrolled fires, water supplies required.
Manpower required.
The construction takes away any confidence in the building and firefighting tends to take place from outside. This normally results in total loss of the building
Cost Implications
Both sides ie
- fire costs
- ins costs /
- build costs

Large fires (insurance premiums)
Size and amounts
+ FB / BS
+ Car park
Water suppliers
+ Techniques
Due to size of SPs and construction, large-scale collapse and blocking of MOE for fire-fighting operations

Hidden fire spread – large internal cavities [ie roof voids]
Fire behaviour
+ Structure / FB
Application of additional quantities of water is not effective on the outer skin if the panels prevent it from reaching the burning filling of the sandwich.
Absence of fire defence mechanisms eg
- automatic sprinklers
- compartmentation

+ Structure
+ Communication
Identifying buildings constructed with panels not easy
∴ unable to plan appropriate action
Ceiling collapse is likely to occur remote from the original site of fire.
Affects decision to commit protection of egress
Sandwich panels have structural integrity by interlocking if one fails all can fail.
there is a high possibility of catastrophic collapse of the ceiling. (ie without warning and complete).
They tend to have few windows and sheet metal roofs which make it difficult to ventilate the products of combustion. – can't effect rescue easily.
Usually lots of plant and air conditioning systems in close proximity.
Assists spread of fore
Avoid end point or head off at pass.
Very often buildings of very large capacity.
Very often buildings are of large open structures making searching difficult
Affects numbers sent in.

Difficult to create fire breaks – panels lose integrity if cut.
Need to know where they are.

Structural compartmentation ie fire separation. Compromised where otherwise believed to be sound.

There tends to be a lack of reliable fire compartmentation in these buildings.
Large uncompartmented buildings ∴ can't make stop
∴ need to send in a lot of resources

High Fire load

There is extensive use of the space above panels for pipe runs etc – these may fall through the panels.
Buildings involving SPs can be prone to early/premature total collapse.
If know SP will have policy.
Difficulty in assessing fire travel behind protected panels.
∴ difficult to devise a strategy.
Lack vent

Other

Ops personnel and risk assessors have to understand the arguments of developers and building operators which favour the use of SIPs.
Compartmentation is unlikely to extend to outside of building.
SIPs are a fact of life that fire personnel have to learn to cope with.
Effective fire compartmentation may not either be required or, where it is, be ineffective
Smoke curtains will not provide a barrier
In England; undivided 'space' / room of indeterminate size refer to Approved Doc B

Session 2

Question; Were the problems identified in Session 1 an issue for you?
If so, how were they dealt with?
If not, why not?

- information on Sandwich Panels
- putting out the fire
- ventilation – is this possible and how.
- hidden fire growth
- how to pre-plan
- commit or not?
- education and training.

Safety is a major consideration
It may be necessary to employ safety officers within the building ∴ tying up larger numbers of personnel
Whenever possible both internal and external investigations are to be made using sight, touch, T.I. camera to ascertain if S.P.'s have been penetrated and to what extent.
'Enhanced' BA - Comms
commitment

B.A. Teams to be very closely monitored

- Comms
- Safety Officers
- Stay between fire and point of egress

Critical Point

Is the structure's fabric adding to the development of the fire; or is the structure adding to the developed fires.

In case of a fire in a building have persons specifically responsible for seeing if the building becomes involved in the fire.
Possibly remove gable end(s) - use of p.p.v. over false ceiling in conjunction.
If fire fought from within.
B.A. teams should not consist of less than 3 persons.

Enhanced BA commitment
To allow RQR
Protecting surrounding risk
Deployment/redeployment of appliances equipment in light of 'weather conditions'
Police/Ambulance/LA

Liaison due to possibility of 'environmental pollution'

Session 3

There were two elements to this session, one was to consider information for the proposed Home Office Guide based firmly on the experience and needs of the fire officers present. The second was to indicate a contents list and any further research needed.

What do you need to know for the Dynamic Risk Assessment?
What do firefighters do when they get to an incident?
What should go into the Guide?

Reworded as;

1. *What information is required in the dynamic risk assessment by the fire incident commander as to whether the building is safe to commit firefighters to fight fire from inside?*
2. *If the fire is to be fought from within the building, should different operational procedures and tactics to be employed to those used in other fires?*
3. *If the fire must be tackled from outside are there different operational procedures and tactics to conventional ones which lead to better control?*

Look at Worst Case Scenario

- Is there anyone in the building? Dynamic Risk Assessment
- contents (nature) fire or building (intelligence) fire.
- info. re: fire.
- structural behaviour / protection of building - plans can "throw you" make access points
  sprinklers going off? block wall? Officer-in-Charge should be able to interpret.

- compartmentation. Unless you have something there, STAND BACK! Don't rely on it.
- Voids may be present.
- Do I hear fire protection alarm going off?
- flow chart?? -> develop thought process – aide memoire.
- we could have SPs.
- volume and colour of smoke – to indicate eg plastics? Speed. Compare with contents of building / wind direction
- PDAs – what do you need to back you up. Should be considered early. Got to have flag. (1st person – might be control op.)
- At the beginning it is a good idea to marshal additional resources such as extra pumps. Flexibility is the key
- pumps: once you get above 5 pumps [affects on crew]. Time factor of essence. should be going through same procedures ie speed you do it..

DRA

Done on the hoof
Does gain outweigh risk.
Guidance v. technical bulletin
"you can expect ... ...

Cutting into buildings: [other access points]
firebreaks
potentially dangerous tools [another consideration is the relevance of the tools for all fires]

- fork lift
- sub gun [no current guidance – good to include here}

Officers in charge
should consider shortening travel distance for getting in and out.
[getting mental picture for start]

Thermal Imaging

Useful tool.
Consider use of Aerial plans - ventilation.
How serious is fire when you first arrive?
Helicopter – need at start. Thermal imaging.
Still need people, but useful tool.
Smouldering fire – don't usually develop.
Consider: let it burn out.

Compartment fire – whole lot will go.
- Safety crew / observer – standing back for signs of collapse / protect escape route
- men inside – look for access points
- PPV ventilation – size of opening relevant

speed and weight of attack
increasing issues around water pollution
needs of other agencies

Reduce machines to what I need.

Tactical changes

All BA crews need radio communications.
- no advantage sending in 4 rather than 2 . Double risk.

Search & rescue:
Do we need to put in men at all?
Consider: let it burn.
How would you make decision to let it burn?
Evidence: change in nature of smoke – experience.
Contents: site, but consider extra safety in SP
Travel distances.
What water supplies available?
[Insurers may take Fire Service to court for not saving building.]
Legal situation: how dangerous these fires are.

Water sprays:
If you have to commit have safety crew behind with sprays

What information is required in DRA to enable you to decide to commit

- Contact responsible person
- where the fire is
- persons
- what's involved: contents or panels or both
- likely spread
- Identify stage of fire growth
- thermal imaging
- observations of person in charge
- en route / on arrival
- fire size
- how long has it been burning
  speed of development
- building size and composition.

1st Stage - Incipient Fire Contents

Normal firefighting
Awareness of SP
Thermal imaging
Water

2nd Stage - Spreading to Panels

Offensive

- Water
- Hard hitting jet
- Reinforcements
- Concentrate on panels
- Signs of early collapse
- Safety crew
- Inhibiting other panels
- Ventilating
- PPV
- Robotics
- 'Open up panels'
- Transitional to ...

3rd Stage - Panels involved

Defensive

- Listen for signs of collapse
- Partial withdraw
- Monitors
- Safety crews
- Lots of water (environment)

Inside – how to fight

- depends on stage / size of fire
- robotics
- curtain of water
- minimum crew
- safety crews watching
- quick knock down
- primary jet on panels, 2nd put to fight fire
- transfer from stage 1 – 3 rapid
- 2nd stage is of concern

Fighting from the outside

- loads of water (run off)
- protecting exposures
- aerial appliances
- monitors
- talking to other agencies, eg Environmental Agency
- controlled burning
- keep resources
- situation may change
- pull off panels
- explosives
- penetrating the (outside) structure

Are sandwich panels present Yes or No
Where is the fire and what is involved.
Degree of involvement of SP
The specific construction of the building will be required at an early stage. This may be from HDs, risk assessments, local knowledge etc
Compartmentation (particularly over ceiling level).
Eye witness info
Means of getting out of the building
Appointment of Safety Officers to watch for signs of collapse and protect egress of crews committed.
Are there persons reported?
Where is the fire located?
Are there any known compartment walls that can be relied upon?
Are the available water supplies adequate to maintain a concentrated attack at the fire.
Identification of type of SP used in construction
% of building or the location of SP's.
Location of fire breaks, if any.
Provision of fixed installations.
Information required on spread of fire.
Roof vents. Automatic or manual, would help in collating some information.
Fire Alarm / Detection - zones affected.
Materials of primary involvement, if known.
Type of construction - portal frame traditional.
If fire fought from within building then greater control of BA teams would be required.
Radio communications would be essential.
Clear and easy egress routes.
Better evacuation procedures than whistles.
Type and extent of panels.
DRA info. Time taken to arrive.
Location and function of SIPs in structure.
Premises floor plans (essential component of VMDS).
Fire Alarm / Smoke / Heat detector actuation print out (relate to plans/elevations).
Assuming Yes, plan layout elevation (ceiling voids above ceiling 'plant') practice.

- hidden fire growth
- how to pre-plan
- commit or not?
- education and training.

Info required in DRA

Are persons reported: would commit? - should depend on if building is safe > changes balance
Check voids above sp before commit. If you know sp involved depends upon intelligence of Fire Alarm System.
Need to know about building structure. Can be done. Go beyond 11D. Not blanket availability.
Need to know what's in building.
Only if arrive quickly

need to go in to determining
worry due to sudden collapse
Diff type sp vs contents? NA/w
Collapsing sp in doorway
Smoke may block view - ∴ another sign
May not see smoke if sealed building
Need to know if sp involved - time of and where arrival from origin of fire
- won't go in if) persons - see occupier
- will go in) s panels involved (external and T/C. T/.Cs can give false reading - sun)

SP add to fire in later stages ∴ gone past crit point. Structure unsound. When developed – need to know if sprinklers.
Operating sprinklers give confidence in entry.
Sprinklers in voids cool hot gas air but won't stop *clean*
Rely on core knowledge of first attendee being passed on.
Danger of categorising SP fires – overload ffighters with aide-memoir's (eg cylinder fires)
- only need to know if min wool or polystyrene
- H&W risk assessment check list
-

1 Going in (have made decision to commit)

Every team have radio / BA (cost implication)
Back up with people searching for visual cues / crew
(need good risk indication system) and compartmentation knowledge
Addit BA crews introduced at early stages as Safety Officers extra pump on PDA.
IR cameras may not be good enough - insul.
Check voids from outside.
Consider 3 person teams (2 with hose & jet, 1 checking above/behind).
Could be problem retained service.
Don't enter until sufficient crew.
Safety teams inside. Safety Officers outside.
Good info needed before ppv. Must be late tactic.
No doors/widows to open. Doors = moe - external wind affects.
First strategy may be break out panels above false ceiling – in side walls. Use for Xvent and poss ppv.
Once fire in roof void = total loss ∴ not warned about fire getting away.
Auto smoke vent ok.
Vent by breakout and gets away = > liability
∴ Vent when fire out of control does this equal fire in roof void. What legal position.
Need to be vent end where fire is.
(Incorporate heat trace within outer panel – link to both sides of panel.)
Water on fire : need to inject into core.
Anything gained by ripping of skin.
Firespread from panel to panel is key. (Protect ends NB)
Crew penetrate single panel axe – inject water.
Side/ceiling.
Test temperature of void at back – spike / (structurally unstable).

Try not to expose surface. Need to know core ignition temper. Mixture of gases above void.
Delamination is key.
Spray – cool metal to delay delamination.
Need to know where occurring.
Command and control.
Make additional access points within building at time of firefighting whilst still possible to be proactive – can get jets in at low level. Establish fire break used JCB. Steel panel needs cutting! 3ph!
Pre-planning would know X = OK to break through.

2 Fighting from outside

Level of info required depends upon time of arrival not grade.
Some strategic info for higher levels when protracted incident possibly.

- can vent from outside
- may consider before lost
- is it possible to introduce f/x foam; possible action

when know lost building to achieve quick extinguish; consideration

- IFE meeting discussed. Would like info
- medium expansion for foam filling voids?
- depends on size of compartment
- risk to neighbouring occupants - consider evacuation. LA emergency plan.
- fog into voids from outside - if hot H_2O > steam
  - if cool > water drops

How get up there? Main lines can make fog but can't get
Worth having there into void.

- Access panels essential

Depends on roof type - asbestos easy to penetrate
Safe access problem
PDA to include aerial gear - attack side at H level
Use TICs to spot problem

Devon

Hazard: Risk: Action/Consider:

What in the DRA will allow you to commit?

- Observations en route, + (a) + (b)
  INFORMATION GATHERING
- Are persons reported?
- Layout of building
- What is involved in the fire?
- Is there any separation?

- Initial fire plan to be formulated.
- Where is the fire? - travel distance
- Water supplies.
- Smoke levels - type, colour, density and heat layer.
- Fire resistance of the structure. Area where fire – potential for sandwich panels to be involved?
- (a) Resources before commitment.
- Premises file.
- (b) Experience of crew and officer.

What do you do once committed?
- Re-evaluate DRA - safety of crew. Who? O/C and BA
- Fireground communications.
- Safety Officer appointed early.
- Ensure Officer/Officer information passed effectively.
- Initial O.I.C. stays with Senior Officer on site.

CONSTANT RE EVALUATION
- Use of technical equipment – internal and external.
  (thermal imaging, heat trace equipment, telemetry, $D1_2O$, supplies)
- H_2O supplies.
- BA communications.
- Take in sufficient firefighting equipment.

Indicators to take crews out
- Structural changes.
- Smoke pattern changes.
- External indicators.
- Rapid fire spread / Increase in temp.
- Info from crews, sector commanders.
- Black lines at top of panels.
- Noise / No Noise.
- Delamination.
- Burning droplets and flow at base of wall panels.
- Heat layer.
- Pulsating flame.
- Size of fire - fire development - potential panel involvement.

What do you do if outside?

Holes in roof - venting (early)
Protect Fire Resisting Structural Areas.
REST. Allow to burn with Water Application Evacuation

If HO Guidance were to be produced:
- *what should go in it?*
- *what do we know now that we can put in it?*
- *where are the gaps?*

Home Office Guide CONTENTS

1. Firefighting tactics / techniques
2. Introduction
3. Information gathering
4. Scenarios
5. building fire
6. contents fire
7. (Communications) Feedback at various levels
8. Pre planning
9. Implementing contingency plans
10. H&S for crews and public
11. Environmental issues
12. Augmented first attendance (aerial)
13. Risk Assessment

Information that can go into guide

- available info from UK + EU + US
  FRS, brigades, workshop
- insurance industry feedback
- manufacturers (BRUFMA)

construction (pos + neg) fixings / fittings

Research needed

1. Labelling of panels
2. Marking of sites (NAMOS)
3. Alternative media - CO_2 total flooding
4. (jointing/fixing/sealing)n.b.
5. ventilation, smoke control, smoke curtains, drenching systems.
6. alternative ff techniques
   ppv
   robotics
7. explosives
8. access to buildings
9. opening panels up
10. intumescent coating
11. fire breaks - how to create
12. Fire breaks / access and implications for use of existing kit
13. PPV
14. media : nitrogen extinguishers
15. marking of sites

DEVON

	Primary info for premises SIP		
	Brief crew of Hazard		
	Are SIP involved		
No	Yes		Persons Reported
Deal as normal	Make up for Man Power and Equipment		
	Consider committing BA	Offensive FF Early Stages	Defensive FF Fully developed Fire

Car park – other issues

Delamination can occur without warning to firefighters
Hidden fires travel in voids or between panel layers.

What would you like to see in New Build?

- Control of compartment size through to roof
- Fire performance evaluation of the building
- Drencher wall system
- Improvements in building design. Less unprotected steelwork.
- Automatic roof vents
  Explore roof venting – mechanism.
  Lance (would have to be on truck not at site)
  Drenching systems - other than H_2O
  Inhibitor in polystyrene panel
  Inject into cavity

Fine Droplet

Success

1. External Panel
2. Localised Burning (inside core) - (Salmon)
   - (Laundry)

APPENDIX C Other issues relating to new or refurbished buildings or the upgrading of buildings during rebuild or refurbishment

Methods to improve fire safety;

1. Increased compartmentation of the building,
2. Smoke control system,
3. AFD system,
4. Sprinklers (see below)
5. Fire shutters where fire walls are penetrated by conveyors
6. Reduce packaging materials within the buildings to that needed for one day or shift
7. Use mineral wool sandwich panels in hot working areas
8. Allow local fire-fighters to become familiar with the buildings

Sprinkler fire protection

At the recent IFE conference on sandwich panels in April 1998, papers were presented by Wormalds and Factory Mutual both of whom are addressing the effective use of sprinklers. Wormald stated that over 50% of installations are retro-fit so we presume that there must be substantial experience in this area. Wormalds have been exploring the use of sprays and mists and have had encouraging results so far but need funding to continue their work. FM on the other hand reported work on progress which indicated that positioning and discharge rate of sprinklers is crucial to effective fire suppression; note that in this context suppression is needed not just for the control of the fire before the brigade arrives, but may also have a role in limiting the number of fires which the brigade attend. All the experience is of very rapid and fierce fire development which can put firefighters lives at risk.

As the guidance in Approved Document B is still not finalised, and as part of the final Session, we asked participants what they would like to see as requirements in new build. These are listed below:

- Control of compartment size through to roof
- Fire performance evaluation of the building
- Drencher wall system
- Improvements in building design. Less unprotected steelwork.
- Automatic roof vents
- Explore roof venting – mechanism.
- Lance (would have to be on truck not at site)
- Drenching systems - other than H_2O

- Inhibitor in polystyrene panel
- Fixed system allowing foam to be injected into the voids in the building
- Use of smoke curtains

APPENDIX D Further Information on the Swedish Explosive Cutting System

During the Workshop there had been some discussion regarding the potential for explosive cutting as a rapid means of obtaining access to buildings. One technique mentioned was that developed by the Swedish Fire Service to aid smoke venting through the roof of buildings. It involves the use of a hollow frame, of approximately door size, in which is placed a charge. The frame is secured to the roof. Personnel retreat to a specified distance and the device is detonated. A hole of roughly the dimensions of the frame is cut in the roof.

Consequently, following the Workshop, a meeting was held with Captain Philip Moore, of 621 Squadron, Bomb Disposal, RAF Northolt, on Monday 7 December 1998. Those present were; Capt. Moore, ACO Goves (Bucks fire brigade), Martin Shipp (FRS) and Penny Morgan (FRS).

The meeting was arranged by ACO Goves to discuss the Swedish system of venting steel clad buildings using an explosive device, and to seek advice as to its applicability in the UK.

Capt. Moore identified the Swedish system as an example of BLADE, a shape charge devised to gain access to the inside of a tank. It is an EFR i.e. explosive force projectile. He pointed out that the projectile will only be stopped by reinforced concrete. It is also very fast moving and can travel many hundreds of meters. It relies on the use of high explosive which is not to be recommended without specialist training and licensing. There is also the matter of storage of the materials used i.e. the magazine and the distance for the safety cordon i.e. 150m. If just a blast charge is used the overpressures can be quite high, 5 bar is fatal in these conditions. Capt. Moore also said that if anyone is killed by such a charge it is automatically manslaughter. Ear protection is essential and anyone inside the building will be at least disoriented.

The Giles Foods building contained a gas mains. FRS has advised on a warehouse where all the services are now 3m above ground to allow access to the emergency services.

Capt. Moore was then asked if there was anything that the brigades could use. Dedicated rooms in the corners of these buildings with inner walls of reinforced concrete could allow BLADE to be used. Note though that it starts to deteriorate and break down explosively between 1000°C and 1500°C.

Alternatives discussed included liquid nitrogen - but there is ammonia in many of these buildings which can react unpleasantly with the nitrogen.

This led to discussion regarding cutting measures, water at high pressure as a water cutting charge with a low explosive equivalent to shot gun cartridges fires electrically, the 'pig stick'. The Bucks Fire Brigade snozzle was described as being equivalent to the 'pig stick' approach. However trained personnel only could use it. The method is quite straight forward involving a frame, cartridge and a pair of wires and a way to set it off. One major part of the system is the training required because it can only be used under license. This is not really an option for retained crews who only get 2 h a week for training and this technique involves a minimum of two days.

Capt. Moore then suggested an abrasive cutting tool which uses water and sand on a circular frame. They use it to cut the casings off bombs which can be 4mm to 20mm and takes some 20 min to get through the shell of a 500 lb bomb. A food process building would be less sensitive to disturbance and so could be cut more rapidly. We understand that the system that bomb disposal use is a prototype from DERA. The equipment involves a small generator and pump plus some sand or other abrasive. The safety distance is 5 - 10 m. Training is by the manufacturer. FRS raised the possibility of this technique having a multiple use, for example at road traffic accidents, for fine cutting of the injured from damaged vehicles particularly if they are armoured.