Northern Ireland
Fire & Rescue Service

STANDARD OPERATING PROCEDURE NO 25

Fires Involving Sandwich Panels

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VERSION CONTROL

Version No	Page No	Issued (Date)	Amendment	Initiated By	Reason for Change
1	All	06/12/06	Initial issue of Standard Operating Procedure (SOP) No 25	Group Commander (GC) Synnott (Operations Policy Unit)	New SOP
2	Page 5 Page 29	17/07/12	Version Control inserted; Safety critical amendment regarding acoustic levels (page 29 – 2.10.1 – last bullet point)	GC Synnott (Emergency Response Department)	Circulation of Operational Bulletin No 2 from Warwickshire Fire & Rescue Service
3	All	12/09/12	Full review of SOP	GC Synnott (Emergency Response Department)	Full review of SOP

NORTHERN IRELAND FIRE & RESCUE SERVICE

STANDARD OPERATING PROCEDURE NO 25

Fires Involving Sandwich Panels

INTRODUCTION

Sandwich panel construction is an increasingly common feature of commercial and industrial sites, both in urban and rural settings. Initially used by the food processing industry, it can now be found in warehousing, pharmaceutical plants, laboratories, electronic plants, hospitals, prisons, and as part of many other building types.

Used both internally and externally as a building element, the sandwich panel has attributes in a fire situation which set it apart from more traditional construction components.

The behaviour of specific types of panel during a fire, particularly when used as part of the internal structure, can have catastrophic consequences for the building and anybody inside.

This SOP is intended to provide Northern Ireland Fire & Rescue Service (NIFRS) personnel with the most appropriate methods of minimising the risks associated with firefighting in these buildings, through awareness, operational intelligence and tactical planning.

Commonly referred to as "Large" Insulated Sandwich Panel (LISP) buildings, this document uses the reference term "sandwich panel buildings".

Picture 1 – An example of a commercial premises constructed using large insulated sandwich panels

SOP No 25 has been produced in the following format:

SECTION A

Safety-Critical Information

All personnel ***must*** have complete knowledge and understanding of this section to ensure maximum safety at incidents. Section A is designed to reflect the content in the relevant section of the Operational Aide-Mémoire.

SECTION B

Provides more detailed information on the topics covered in Section A

Personnel ***should*** have a good knowledge of information contained within this section.

SECTION C

Background and Reference Material

This section includes information which personnel ***could*** use for reference material.

It provides details of relevant legislation and reference material used during SOP development.

1 – SECTION A

1.1 OVERVIEW

- Sandwich panels are a composite product comprising an outer thin rigid metal sheet (usually coated steel or aluminium alloy) either side of a bonded core of insulating material. Panels are typically about one metre wide, but may be over 10 m in length, with cores varying from 50 mm to 200 mm in thickness. They can be used not only to form the outer envelope of a building, but also to create internal partitions and ceilings.

- Core materials fall into 2 categories:

  - organic plastic foam;

  - inorganic mineral fibre.

- Fires in sandwich panel buildings can give rise to major safety issues for NIFRS personnel, particularly where the panels have been extensively used in the internal fabrication. Plastic foam cored sandwich panels provide the most serious problem - primarily that of the speed of development and spread of the fire, coupled with the overall build-up of dangerous conditions. This is typified by:

  - hidden fire and smoke-spread within panels and through joints;

  - skin *de-lamination, leading to structural collapse;

  - the production of large quantities of black, toxic smoke;

  - rapid fire-spread, possibly leading to flashover.

    ***** "De-lamination" – the separation of a facing panel from the core material.

- Fires involving sandwich panels can progress and change at a much faster rate than fires in more traditional structures. This means that the Incident Commander (IC) must react more quickly, must be responsive to new information or evidence of changing conditions, must be prepared to call for more resources at an earlier stage of the incident, or even withdraw crews.

1.2 GENERAL CONSIDERATIONS

1.2.1 IDENTIFICATION OF SANDWICH PANEL CONSTRUCTION

- Fire incidents could occur in premises in which:
  - sandwich panels have been previously identified and a Site-Specific Action Plan formed;
  - the presence of sandwich panels might be deducted, eg, a food factory and a Generic Action Plan applied;
  - the presence of sandwich panels is established only whilst firefighting is in progress and a Dynamic Risk Assessment (DRA) dictates the action plan.
- Ideally operational intelligence should be available on the location of sandwich panel buildings or, in its absence, NIFRS personnel should be able to readily identify such construction and react accordingly.

1.2.2 FIRE SCENARIOS

- Fires in sandwich panel buildings generally fall within 2 scenarios:
  - a fire involving only the contents of the building and which has not impinged on the structure;
  - a fire which has spread from the contents into the structure of the building.
- As the safety of NIFRS personnel is paramount at such incidents, it is essential that the IC determines, at the earliest opportunity, whether the sandwich panel structure itself has become involved.

1.2.3 SITUATIONAL AWARENESS AND HAZARDS TO FIREFIGHTERS

- For all fires in sandwich panel buildings, the IC will ensure that all personnel are:
  - briefed on the risk of rapid fire development;
  - aware of the possibility of sudden structural collapse;
  - aware of evacuation procedures;
  - aware of the problems associated with working in dense smoke.

Refer to Section 2.10 – Hazards to Firefighters.

- The IC will appoint a Safety Officer(s) specifically to monitor any changes in fire behaviour or structural indications that:
  - there is fire or smoke-spread to other parts of the building;
  - there are signs of de-lamination or other structural collapse.
- Indicators are:
  - paint effects (blistering, flaking, discoloration) at high level;
  - signs of buckling;
  - noises of metal moving;
  - changes in smoke patterns.
- All other NIFRS personnel should be alert to such changes and ensure that, if they occur, the information is rapidly passed to the Safety Officer or IC.

1.3 ACTIONS

1.3.1 EN ROUTE

Assess any operational intelligence available on the premises, ie, operational risk cards.

1.3.2 ON ARRIVAL

Confirm or identify the presence of sandwich panels and whether they are involved in the fire.

1.3.3 FIRE INVOLVING CONTENTS ONLY

- Carry out a DRA:
  - Establish if all persons are accounted for.
  - Gather information on the location and extent of the fire.
- Use standard firefighting and rescue procedures.
- Consider any requirement for additional resources - personnel or vehicles.
- Use a Safety Officer(s) specifically to monitor any changes in fire behaviour or structural indications that the fire has spread beyond the contents.

- An Emergency Breathing Apparatus (BA) team will be kept suitably equipped and standing by when NIFRS personnel are committed.

- Consider the use of specialist equipment, such as thermal imaging cameras (TICs). These can be used to check for fire-spread to the sandwich panels.

1.3.4 FIRE IN A SANDWICH PANEL STRUCTURE

- If all persons **<u>are</u>** accounted for, the IC should risk-assess the need for NIFRS personnel to be committed to the building at all. Consideration should be given to fighting the fire from a position of relative safety, even if this is in Defensive mode outside the building.

- If all persons **<u>are not</u>** accounted for, in making the decision to commit NIFRS personnel, the IC must balance the risk to crews against the chances of a successful rescue, taking into consideration factors such as:

  - knowing the exact location of the casualty (or casualties), thus minimising the amount of time crews spend inside the building;

  - being able to maintain safe evacuation routes for crews in the event of the situation suddenly deteriorating.

- The number of BA teams committed will be kept to a minimum.

- Any BA team committed for rescue will be supported by a **<u>further</u>** Safety team similarly equipped. This team will protect the means of egress and maintain continuous contact with BA Entry Control to advise them of any fire or structural changes that might affect rescue operations.

- **<u>In addition</u>**, an Emergency BA team will be kept suitably equipped and standing by.

- Use a Safety Officer(s) specifically to monitor any changes in the fire or structural behaviour.

- If committed, Offensive firefighting tactics will be employed by the crews:

  - standard hose for maximum firefighting capability;

  - jets to attack the fire;

  - provision of covering jets to protect evacuation routes for firefighting teams;

- sprays to cool and dilute the atmosphere;
- early ventilation at high level should be carried out, if possible.

- Consider any requirement for additional resources:
  - personnel;
  - aerial appliances for high level attack/ventilation;
  - TICs.
- Consider cutting through the external panels to:
  - improve access to the seat of fire;
  - create alternate escape routes for crews.
- The volume, density and toxicity of the smoke may necessitate the wearing of BA outside the building.

The IC will act at all times within the risk assessment philosophy:

"We may risk our lives a lot, in a highly calculated manner, to protect saveable lives.

We may risk our lives a little, in a highly calculated manner, to protect saveable property.

We will not risk our lives at all for lives or property that are already lost."

2 – SECTION B

2.1 BACKGROUND

- Research has shown that buildings of sandwich panel construction do not generally present a particularly high risk to the lives of their occupiers - that is in comparison to the risk posed by other combustibles on the premises. However, there is a clear risk to Firefighters who may have to enter such buildings in a fire situation.

- Should fire break out in these buildings it is possible that, within a short period of time, the sandwich panel structure itself may become involved, leading to panel de-lamination, weakening and early collapse of load bearing beams and fixings and uncontrolled escalation of the incident. Such a situation has major implications for crews and it is essential that ICs are aware of the potential operational difficulties. Indeed, there have been a number of serious fires in sandwich panel buildings which have resulted in the injury or death of Firefighters.

2.2 WHAT ARE SANDWICH PANELS?

"Sandwich panel" is the generic term used to describe any metal faced insulated panel used as a building element. Because of their size and composition, they offer fast-track construction and are very cost-effective in producing a relatively inexpensive and energy efficient building envelope. They are available with an array of aesthetically pleasing profiles, shapes and finishes, which has made them popular as both an internal and external building specification.

2.3 WHERE ARE THEY FOUND?

- Sandwich panel use is normally associated with the food industry, where the type of construction is determined by the need to provide a low cost, highly insulated, hygienic, temperature-controlled environment. They are used extensively in premises involving food processing, storage and distribution, supermarket food production areas, abattoirs and cold stores.

- The surface qualities of the panels make them suitable for other applications, particularly where the maintenance of a hygienic process is essential, so they can be found in laboratories, pharmaceutical plants and electronics factories.

- However, it must be noted that sandwich panels can now be encountered in an ever increasing number of building scenarios, including retail parks, hospitals, prisons and schools.

- Anecdotal evidence suggests that there is an expanding market in second-hand panels and consequently they may be found being used in varied and unexpected applications. In areas known for vegetable production, many find their way into agricultural buildings where cool storage is required.

2.4 INTERNAL AND EXTERNAL USE

- Sandwich panels are used to create the interior layout of buildings, particularly in the food processing industry, where internal partitions, ceilings and linings can produce a **"building within a building"**. The partition ceilings formed by the use of these panels may create large, undivided roof voids, which frequently house machinery, services and ducting.

- Panels are also used as cladding in the external envelope of a building. When used as a facing material they are often seen as forming the profiled surface, commonly giving walls and roofs a corrugated effect. They can also appear in the form of a completely smooth surface, with only the joints between the panels outlining their shape and position in the building.

- Interior wall and ceiling sandwich panels are usually attached to the building structure by lightweight fixings and hangers. These, along with panels used as free-standing internal walls, pose serious problems in a fire situation. Panel facings can become detached early in a fire, creating a falling object or "missile" hazard, unless they are specifically designed to remain fixed. Once de-lamination starts, the core material will add to the fire-loading, with the possibility of catastrophic structural collapse.

- Instability of cladding sandwich panels in well designed external wall and roof constructions is less of a problem to Firefighters, because they are normally held in position by mechanical fasteners fixed to the frame structure of the building. Providing both skins of a panel are fixed through to the support structure, panel facings are less likely to detach or expose their core to the fire. Statistics confirm that the origin and spread of fire via the external envelope is not as common as that occurring in internal panels. However, this does not exclude external cladding from making a significant contribution to the fire-load after the contents of the building, including interior panels, have become fully involved in the fire.

2.5 PANEL CONSTRUCTION

- A sandwich panel is a composite construction of layered materials. The external facings are galvanised steel or aluminium sheets, usually around 0.6 mm gauge and can be profiled or smooth in appearance. These facings are typically coated with an epoxy polyester layer which is fused to the surface by heat treatment (see Figure 1).

- The facings are adhesive bonded to the central core of insulating material, which may vary in thickness from 50 mm to 200 mm. There is no standard size of panel, but because of the inherent strength of construction, they can achieve large span to weight ratios and may be over 10 m in length.

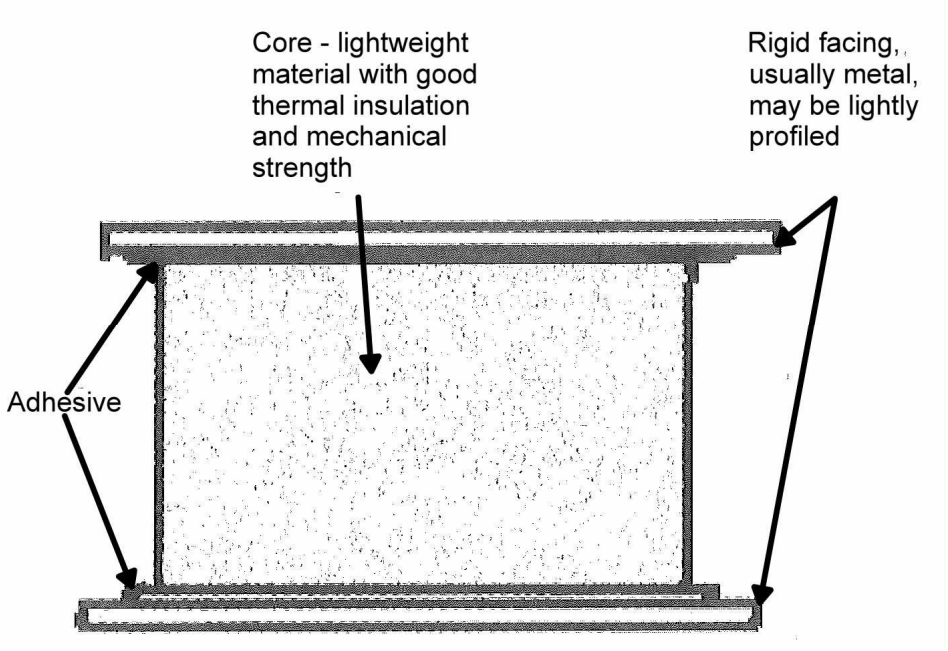


Figure 1 – Panel Construction

- The strength of the panel is achieved by the combined structural action of the rigid facings and the core material. One of the facings is in tension (ie, being stretched), the other is in compression, while the core material holds the facings together and transmits the load between the 2 facings. If one facing comes away from the core, eg, because of a one-sided fire attack, the flexural strength is lost and the panel will collapse.

- A well constructed panel will have the edges of the metal facings turned over to form a box completely enclosing the core (known as a closed cell) however, more commonly, only a short rebate is turned over (see Figure 2), leaving the core exposed where one panel butt or rebate joins against another.

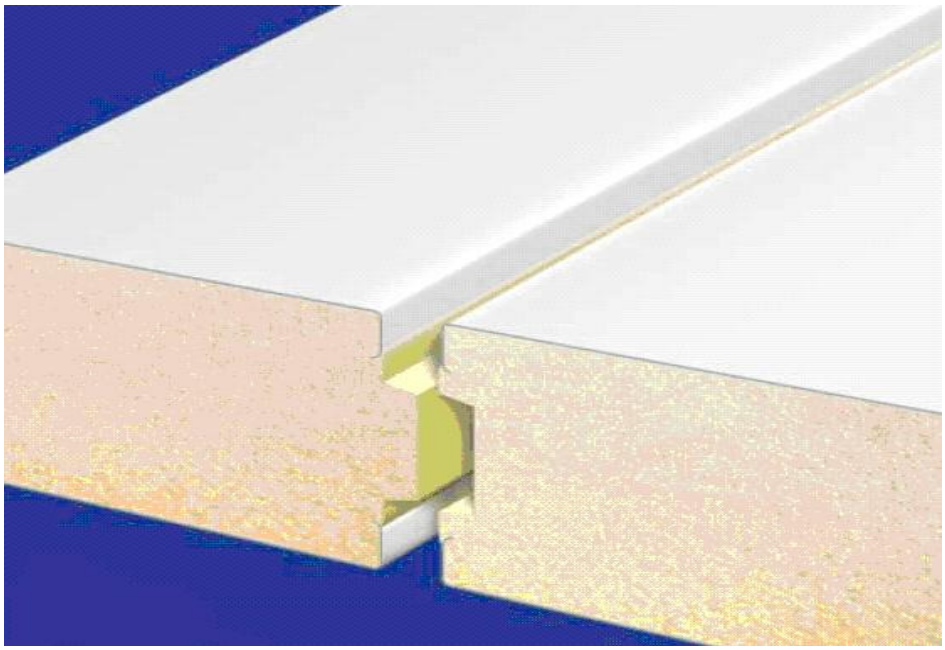


Figure 2 – Rebate Joint

- This type of joint is often found in a low temperature environment, because it retains consistent thermal qualities as there is minimal metal-to-metal contact between the facings. However, if the panels are installed without a thermal barrier between the adjoining cores, fire can readily spread from one panel to another.

- Panels used as part of the internal structure, particularly where insulation qualities are important, commonly have much thicker cores than those used as external cladding. In being thinner, and therefore lighter, external cladding may pose less of a problem in a fire situation but is none-the-less labour-intensive to tackle.

2.6 CORE INSULATING MATERIALS

Core materials fall mainly into 2 categories:

2.6.1 NON-COMBUSTIBLE – INORGANIC MINERAL FIBRE (MRF)

Mineral or Stone Wool

This is created in a spinning process, producing fibres in a variety of densities. Fibre direction can be selected to optimise its strength properties suitable to its structural application.

This insulating core is less frequently used in buildings for a number of reasons:

- it is more expensive than other core types;

- thermal bridging can occur through the material;

- the presence of fibres and possibly bacteria in the material.

As it is non-combustible, this panel core is less of a concern to NIFRS personnel but it is important to note that the facings will still de-laminate in a fire situation, creating a missile hazard.

2.6.2 COMBUSTIBLE – ORGANIC PLASTIC FOAM

Expanded Polystyrene Foam (EPS)

This is a thermoplastic material, usually white in colour, and accounts for a major proportion of all internal use panels manufactured in the United Kingdom.

Extruded Polystyrene Foam (XPS)

This is a thermoplastic material, usually blue in colour. When exposed to a small flame, both polystyrene foams, EPS and XPS, will soften, melt and shrink away from the heat source. A larger heat source will produce ignition, flaming molten droplets and rapid emission of dense black smoke and soot.

Polyurethane Foam (PUR)

This is a thermosetting material, typically yellow/brown/pink in colour, that will char when exposed to a small heat source. However, if sufficiently heated by a larger source, ignition and fire-spread can occur with abundant smoke and toxic decomposition, giving off Hydrogen Cyanide and Carbon Monoxide. PUR is a very common external cladding core.

Polyisocyanurate Foam (PIR)

- A thermosetting foam with similar fire and decomposition properties to PUR. However, at an advanced fire stage it may produce jets of flame, or a build-up of gas, with enough force to separate the metal facing from the core.

- It is the behaviour of these combustible cored sandwich panels in a fire situation which present the greatest hazard to NIFRS personnel.

2.7 RECOGNITION

- In an ideal situation, operational intelligence will be gathered, as part of the SOP No 12 process, identifying sandwich panel construction buildings for crews responding to incidents. Where a Site-Specific Plan has been produced, the type of panels and their position in the structure should be pinpointed to allow the IC to make the correct safety-critical decisions as an incident progresses. SOP No 12 data may include information on the use of panel signs.

- In 1999 a Panel Labelling Scheme was proposed by the International Association for Cold Storage Construction (IACSC) (see Figures 3, 4 and 5). Although not compulsory under the Building Regulations, it is being cited as good practice, by the likes of insurance companies, for building owners/occupiers to have these signs displayed where appropriate.

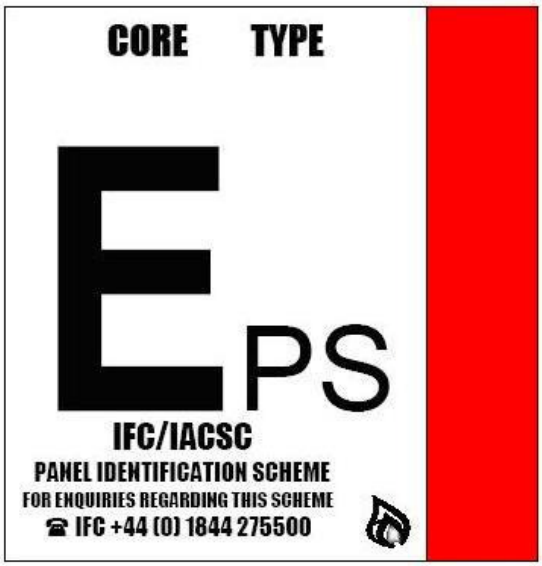


Figure 3 – Expanded Polystyrene Foam Sign

Figure 4 – Polyisocyanurate Foam Sign

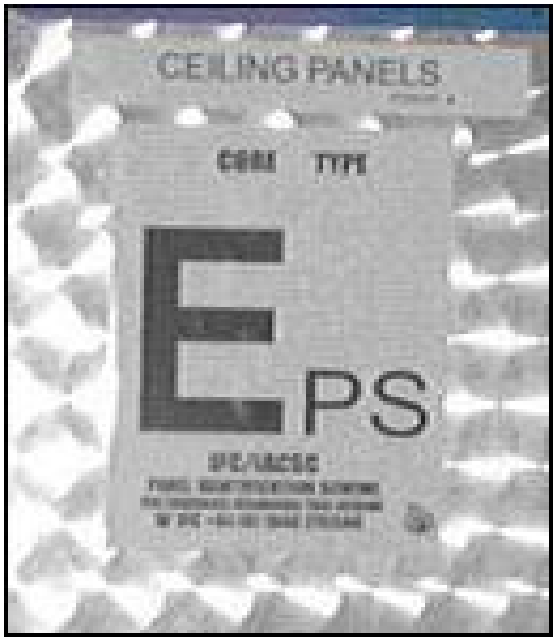


Figure 5 – Sign in use for Ceiling Panels

- The main body of the sign identifies the core type and the side flashes indicate compliance with fire performance standards:

  - If fire stability criteria are met, the panel will carry a green and white striped flash.

  - If the panel has fire resistance in addition to fire stability, ie, complies with BS476, Part 22, 1987 or LPS (Loss Prevention Standard) 1208, then the side flash will be solid green.

  - If the panel complies with LPS 1181 performance and installation criteria, then the side flash will be solid red.

- Given that the labelling scheme originated from a cold storage association and that it is not mandatory, it is not clear how extensively such signage is employed amongst other sandwich panel users. It is therefore more likely that they will be found in food processing industry premises, particularly on internal structures and partitions. It is not clear to what extent, if any, they are utilised on external panels. Signs will be found in new and more recently constructed sandwich panel buildings but they might not appear at all in older buildings.

- However, as stated before, crews could be confronted with a fire in premises containing previously unidentified sandwich panels or encounter them in a completely unexpected location. In the absence of labelling signs, there are general features that should alert crews to the possible presence of sandwich panels in a building.

2.7.1 GENERAL FEATURES – INTERNAL PANEL FINISHES

- Internal walls and ceilings constructed with sandwich panels generally resemble a smooth metal surface that has been treated with a high quality paint or a thin plastic coating. Frequently, the panels are white/grey/neutral in colour. Joints will usually be seen where the panels are fixed together and this will show both their size and their orientation within the structure (see Figure 6).

- The finish of these panels may make them difficult to recognise, therefore, where the use of a building indicates the need for insulation, the IC should assume sandwich panels are present.

Figure 6 – Internal Panel Finish

2.7.2 GENERAL FEATURES – EXTERNAL PANEL FINISHES

- Panels for use as external cladding are available in a number of surface finishes and profiles. One of the most commonly used is the corrugated panel and this can now be seen at almost all industrial/commercial/retail sites. Figure 7 shows corrugated panels as external wall cladding, but panels of similar design can just as frequently be found as part of the roof structure.

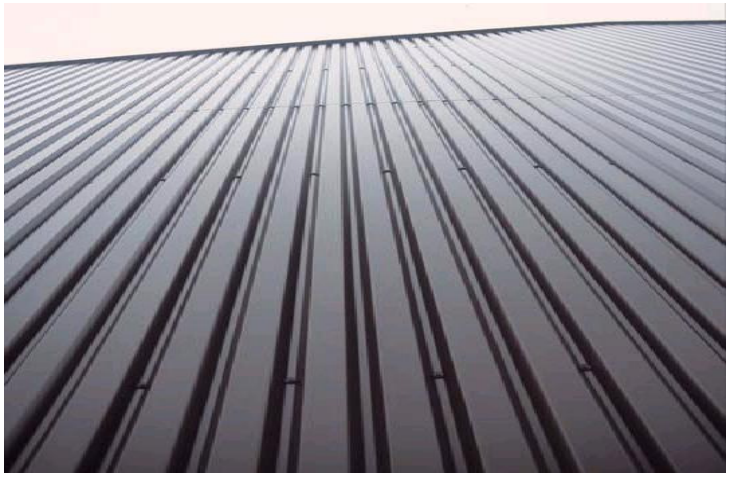


Figure 7 – Typical Corrugated Finish

- The actual profile of corrugated cladding panels will differ amongst manufacturers (Figure 8 shows an example of what may be found at many premises). The panel has been taken from a building under demolition. It shows:

  - the profile of the external skin, partly separated from the core;

  - a polyurethane foam core (PUR).

Figure 8 – Corrugated Construction

- The other profile in widespread external use is the smooth panel finish (see Figure 9). Here the joints indicate the outlines of the panels and also where they are attached to the support structure of the building. The panels come in varied colours and the most modern panel designs frequently have a "metallic" looking finish.

Figure 9 – Smooth Panel Finish

2.8 INSTALLATION

2.8.1 INTERNAL INSTALLATION

- In the food processing industry the panels are often installed in a premises, forming a "building within a building". This can contain the process principle to the factory's operation, eg, a food production line or a cold storage room. In this arrangement the panels may be fixed in both horizontal and vertical positions (see Figure 10). Fixing methods will vary from a tongue and groove assembly to simple butt joints, adhesive fixings or aluminium rails with spring clips. They will form the walls and ceiling of the process area and may conceal voids, both beside and above them. Ceiling panels may rest on lightweight wire hangers and support rails which are attached to the building structure.

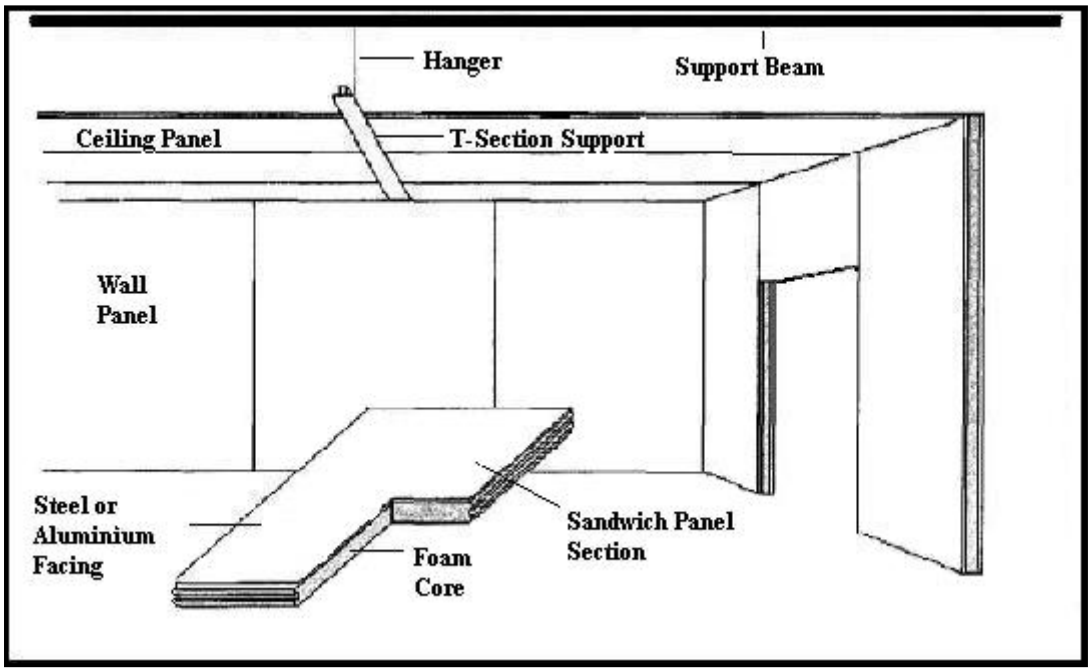


Figure 10 – Sandwich Panel

- Essentially, such an assembly can be considered as free standing, as the only structural attachment is through the ceiling hanger to the frame of the building. In this form, much of the stability of the structure is dependent upon the inherent strength and rigidity of the sandwich panels themselves and the properties of the system that fixes the panels together.

- Figure 11 shows a completely freestanding design for a "modular" cold room with similar thickness panels forming both the walls and ceiling. In this case the structure is of limited dimensions.

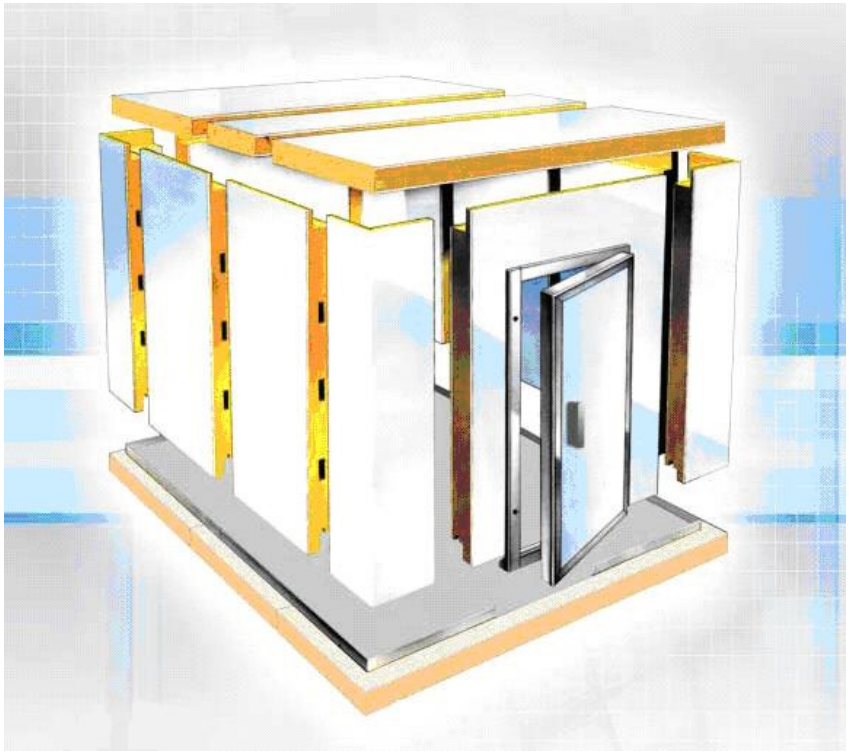


Figure 11 – Modular Design

- However, Figure 12 illustrates a substantial "building within a building", in this case also a cold storage facility and shows the size of the internal structures that can be faced by Firefighters at an operational incident.

Figure 12 – "Building within a Building"

2.8.2 EXTERNAL INSTALLATION

- Panels used as external cladding are usually mechanically fixed to the steel skeleton of a building and will be supported on an intermediate framework between the main spans (see Figure 13). Providing that panels are fixed to the frame through both interior and exterior panel surfaces, then the chances of them falling away during a fire situation are reduced. However, as noted in Approved Document B – *"Fire Safety, Building Regulations 2000"*, if the panels are mounted on light-gauge steel members, these supports may be compromised early in a fire. Document B suggests that they should be mounted on heavier gauge fire-protected steelwork.

Figure 13 – Panel Support Frame

- Figure 14 shows a typical fixing detail, on a corrugated panel, where through-bolts fasten both panel faces to the internal H-beam structure of the building.

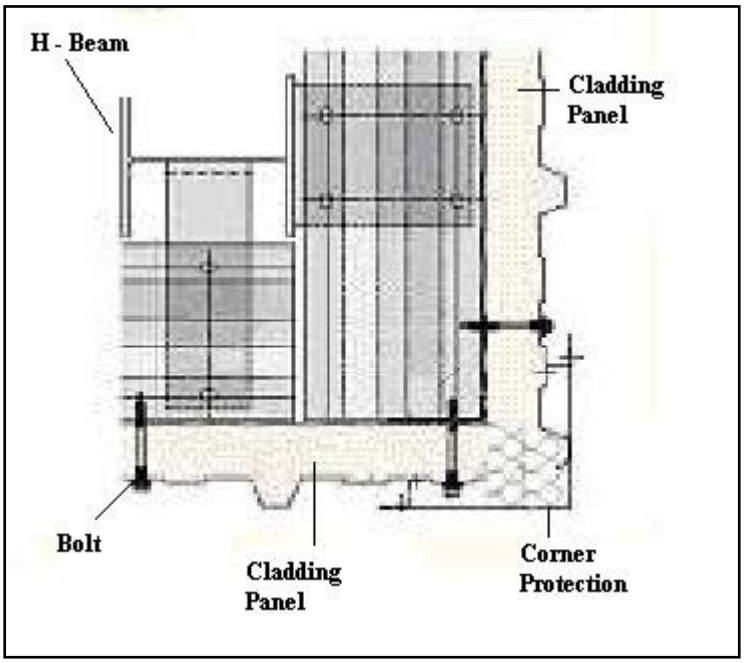


Figure 14 – Through-Bolt Fixing

- Problems arise for crews when panels are not fixed through both surfaces, or light-weight fixing materials are used, leading to de-lamination and full-scale collapse in a fire.

2.9 BEHAVIOUR OF SANDWICH PANELS IN A FIRE SITUATION

- The reaction of ceiling and wall panels to fire will depend on the type of core, the quality of workmanship during construction and the method of fitting the panels into the building. Typically, as the internal temperature of the building rises with the spread of fire, the metal facings of the panels will start to expand. The expansion of the exposed skin may be around 20 mm, with the unexposed skin remaining relatively cool and not expanding. At 100^{o}C aluminium supports will begin to lose their strength.

- As the temperature of the core increases, partial pyrolysis of the foam core will take place releasing flammable vapours. At this point, panel integrity and strength start to fail. The combination of expansion and loss of structural strength will lead to panel de-lamination.

- By the time the core of the panels ignite at around 400^{o} C, the aluminium supports may have either collapsed or be so badly affected that they offer little or no support to the facing panels containing the already heated foam core; flaming, molten droplets will appear.

The expansion of the panels will cause buckling and bowing to occur; joints will become exposed and increasing numbers of panels will become involved. When the supports give way, collapsing panels will expose even more pre-heated foam core to the fire; at this point a flashover may occur.

- As supports fail, any machinery or trunking situated above a ceiling is likely to fall through. During collapse, the heat softened metal sheets will fall through the heat barrier and reset themselves at floor level. This can create steel protected pockets of fire that are difficult to attack and a barrier of metal which will be hazardous for crews to travel through. The fire by this time may be creating so much heat that the main structure of the building will be seriously weakened and in danger of collapse.

2.9.1 WALL PANELS

- Where panels are not fixed to a supporting structure, or use lightweight aluminium or plastic fixings, the facings can de-laminate and fall away from the core in fire temperatures as low as 270^{o} C. This is even when the core has not become involved in the fire. Figure 15 illustrates how failure of the adhesive bond of a non-fixed internal wall panel subsequently leads to the complete collapse of the structure.

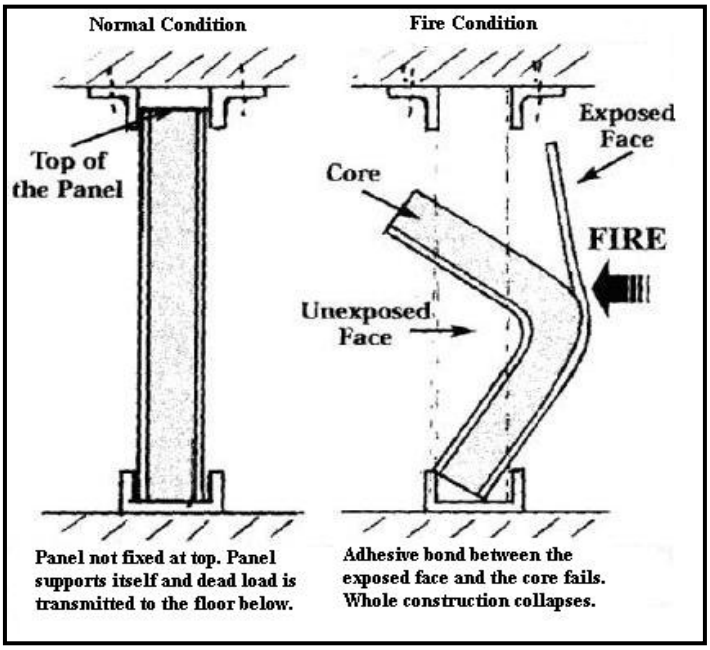


Figure 15 – Wall Panel Collapse

- Again, where external cladding panels are not fixed through both surfaces to a supporting structure, or use lightweight fixings, the facings can de-laminate and fall away from the core in much the same manner.

2.9.2 CEILING PANELS

Where ceiling panels rest on and are not fixed to their structural support, fire directed from below will cause the lower facing adhesive bond to fail, followed by panel collapse (see Figure 16). The same thing will happen if there is a fire above the ceiling, except it is the upper facing adhesive bond that fails.

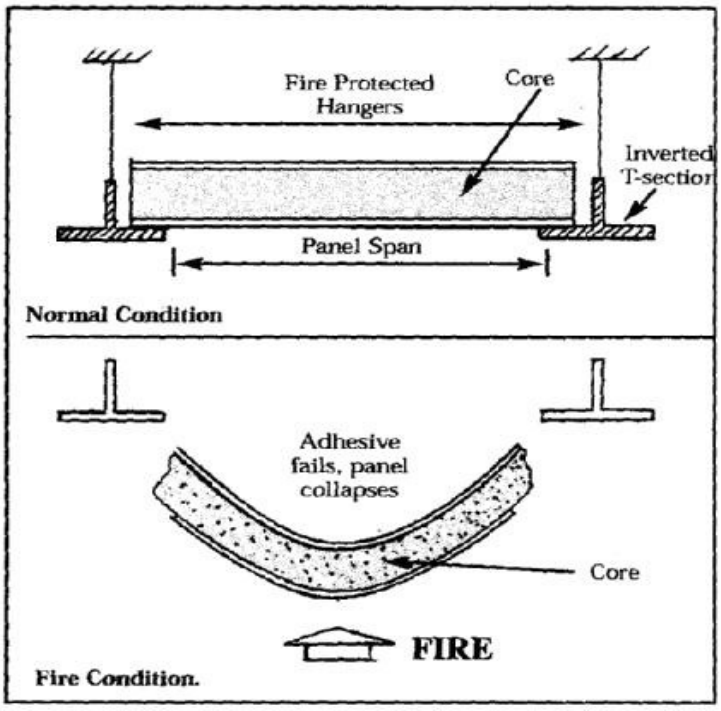


Figure 16 – Ceiling Panel Collapse

2.10 HAZARDS TO FIREFIGHTERS

2.10.1 SPEED OF FIRE-SPREAD

- A fire in a building containing sandwich panels can spread rapidly and grow due to:
  - the properties of the combustible material of the core, particularly foam;
  - the lack of cavity barriers preventing the fire from travelling along the core of one panel to another;
  - hidden fire travel inside panels leading to outbreaks in areas remote from the original source;
  - the sudden increase in fuel loading as panels de-laminate;

- the metal facing of the panel preventing the penetration of water to extinguish the burning core, both for in-situ and collapsed panels;

- large undivided voids above ceilings, behind partitions and in roof structures. Figure 17 shows sandwich panel construction within a portal frame building. This type of installation is particularly susceptible to fire-spread through voids if there is no compartmentation.

Figure 17 – Portal Frame Building

- Figure 18 graphically illustrates the problems Firefighters face when a portal frame building with an internal sandwich panel structure becomes involved in a fire. Unrestricted fire and smoke travel in the undivided ceiling void will quickly result in the whole building becoming involved.

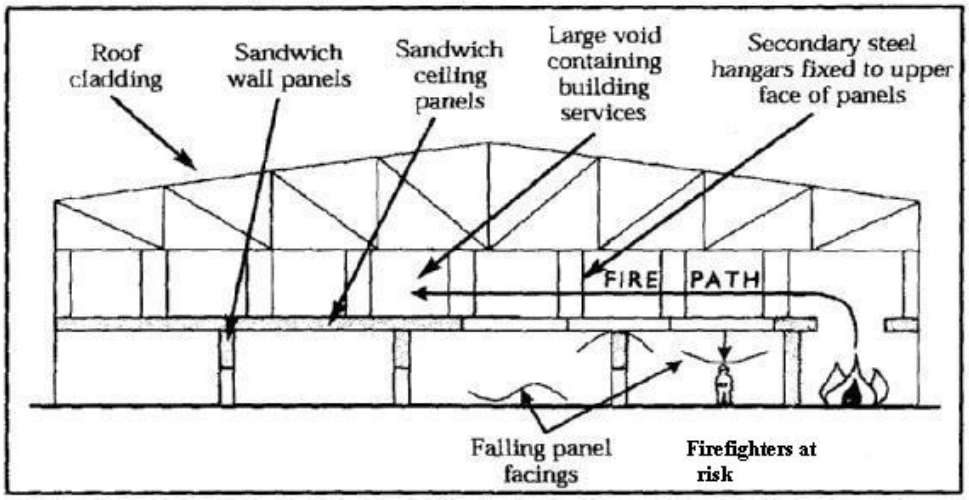


Figure 18 – Portal Frame Building

- This rapid spread of fire can change the circumstances in the building with such speed that Firefighters committed inside may be unaware of, or be unable to react effectively to, what is happening around them.

- Panels may have good acoustic insulation properties, meaning that the sound of a developing fire may be masked from personnel.

2.10.2 EARLY COLLAPSE OF INTERNAL STRUCTURES

- Many sandwich panel buildings are of large volume with high roofs that are difficult to ventilate. This may result in a speedy build-up of adverse conditions, particularly increasing temperature, which will affect the structural integrity of the sandwich panels.

- De-laminated panels may pose a missile hazard (see Figure18) or, as described previously, compromise access/egress and firefighting capability.

- Once internal elements are fully involved and support structures are exposed, complete building collapse may occur often, with little or no warning.

2.10.3 SMOKE GENERATION

- Foam-based core materials can generate unusually large quantities of acrid, toxic smoke, even if they have been treated with a fire retardant. This creates a hazard not only to Firefighters inside, or in close proximity to the building, but also to those much farther away who would normally be considered to be in safe locations. This may require the use of BA for greater numbers of personnel than would usually be expected.

- Hot, toxic smoke will exacerbate the problems associated with any internal firefighting procedures, in particular where crews are unable to ventilate because of the size of the building or the panel design.

2.11 FACTORS FOR CONSIDERATION BEFORE FIREFIGHTING OPERATIONS

2.11.1 DIFFICULTY IN REMOVING OR CUTTING THROUGH PANELS

Consider:

- adequacy of standard cutting equipment;

- creation of holes for access of jets;

- use of a JCB or bulldozer to create large firebreaks/escape routes.

2.11.2 DIFFICULTY OF VENTILATION

Consider:

- height/span of the building – access only by aerial appliance;
- volume of building – is positive pressure ventilation feasible?
- ability to cut through panels.

2.11.3 ADEQUACY OF WATER SUPPLIES

Consider:

- large amounts of water for firefighting/cooling;
- availability of additional sources.

2.11.4 LARGE UNCOMPARTMENTED ROOF/CEILING VOIDS

- Many sandwich panel buildings are single span with no compartmentation.
- Roof/ceiling/wall voids will allow passage of fire and smoke.
- Crews may be unable to effectively restrict progress of fire.

2.11.5 ABSENCE OF SPRINKLERS

- The majority of sandwich panel buildings will not be sprinklered.
- It is not cost-effective for companies to install sprinklers.
- Upon arrival crews can be faced with a well developed fire.

2.11.6 LIMITATIONS OF THERMAL IMAGING CAMERAS ((TICs)

TICs can be limited by the inherent insulation qualities of sandwich panels and can therefore make the tracking of fire in the panels and the scanning of open areas ineffective.

2.11.7 DECISION TO ADOPT DEFENSIVE FIREFIGHTING PROCEDURES

- In a fully developed fire, with no life risk, an IC must balance the judgement to use Offensive firefighting procedures against the safety requirements of NIFRS personnel committed to the incident.

- For many companies it can be more cost-effective to demolish and rebuild a fire-affected sandwich panel building than to renovate.

2.12 ENVIRONMENTAL CONSIDERATIONS

- As described previously, if panel skins remain intact and in situ, it may prove difficult to direct water to the seat of the fire or to control further fire-spread within panels. Similarly, if there has been extensive panel collapse, the fire can be shielded. Both these situations may lead to an excessive use of water, with consequent run-off effects of contaminated waste reaching the water table or discharging into drains and sewers.

- A sandwich panel building fully involved in a fire will release large quantities of acrid, toxic smoke directly into the atmosphere, with plumes that may reach well beyond any restricted zone. Depending on the size of the incident, weather conditions, wind direction, etc, evacuation of populated areas might be required.

- The IC should involve, and take advice from, all relevant environmental and service agencies (environmental health, water, sewerage, etc) at an early stage.

2.13 ADVANCE PLANNING CONSIDERATIONS

Advance planning considerations are:

- general planning for sandwich panel fires;

- planning for a specific building – SOP No 12 procedure;

- pre-determined attendance composition – pumps and special appliances;

- type of building, type of installation;

- location of sandwich panels;

- layout of evacuation routes;

- compartmentation – number and size of compartments;

- presence and use of sprinklers;
- means of access;
- use of fire breaks;
- availability of resources – additional crews/appliances;
- water supplies;
- special equipment;
- sources of information;
- training;
- inter-agency communications
- environmental issues.

3 – SECTION C

3.1 EXTRACT FROM TECHNICAL BRIEFING - *FIRE PERFORMANCE OF SANDWICH PANEL SYSTEMS*: ASSOCIATION OF BRITISH INSURERS

SANDWICH PANELS USED INTERNALLY IN FOOD FACTORIES

- Fire statistics clearly show that it is unsuitable use and management of sandwich panel systems in food factories that is the principal reason for rapid fire-spread. The reasons for a fire starting vary, and some causes of ignition in food processing areas from cases which have been reported as ultimately involving the sandwich panels, are listed below:

  - debris in the base of an oven;
  - oil heated to above its flash point;
  - discarded smoking materials in a packaging store;
  - oil deposits on filters ignited from a spark from an oven;
  - badly maintained deep fat fryer;
  - oil ignited in a bund surrounding an oil tank;
  - sparks igniting tarry residue on pipe work;
  - arson;
  - inappropriate specification for conveyor belting;
  - badly maintained or used radio frequency defrosting ovens

- Much of the above can probably be identified as being due to inadequate levels of fire safety management. This is clearly an important issue to consider in addition to the fire performance of the construction products.

3.2 FIRE-LOAD ASSESSMENT OF CORE MATERIALS

- Fire severity is directly proportional to the fire-load, ie, the sum of the calorific energies which can be released by the complete combustion of all the combustible materials in an enclosure. In determining the fire-load, the heat [or Mega Joules (MJ)] released by a material must be considered, eg, the conversion from mass of timber to heat is such that one kilogram (kg) timber yields 19 MJ for complete combustion.

- The table below sets out the calorific values of some core materials with wood and rubber as a comparison.

Material	Mega Joules (MJ)/kg
Stone Wool	1
Wood (as comparison)	19
Rubber (as comparison)	32
Polystyrene Foam	40
Polyurethane Foam	26
Polyisocyuranate Foam	24

- The table below details examples of fire-load per unit area for different thicknesses of core material. This is expressed as MJ/m^2 of the material used.

Core Material	Fire-Load (MJ/m^2) - for Thickness of:		
	50 mm	100 mm	200 mm
Polyurethane Foam	58.5	117	234
Polystyrene Foam	46	86	166
Polyisocyuranate Foam	46	86	166
Stone Wool	11	16	26

NB - The final fire-load calculation also takes into account the density of a material. In this case, polyurethane foam is over twice as dense as polystyrene foam, so it ends up with a higher rating.

- The tables above are taken from Cooke: *"Sandwich Panels for External Cladding"*. The paper also states, "In enclosures utilising sandwich panels of enhanced thermal insulation, such as in the food processing industry, the ratio of fire-load of panels to fire-load of contents can rise to 150%".

3.3 REFERENCES

"Firefighting Options for Fires Involving Sandwich Panels" - Morgan & Shipp - FRDG Publication 3/99;

Technical Briefing - *"Fire Performance of Sandwich Panel Systems"* - Association of British Insurers - May 2003;

"Fire Safety of Sandwich Panels" - Harwood & Hume - FRDG Publication 76/97;

"Sandwich Panels for External Cladding" - Cooke, November 2000;

"Labelling of Insulating Panels" - International Association for Cold Storage Construction - Guidance Note 1 - June 2003;

Appendix "F", Approved Document B - *"Fire Safety, Building Regulations, 2000"*;

A Guide to Operational Risk Assessment, Volume 3 - Generic Risk Assessment 3.1 - *"Fighting Fires - in Buildings"*;

Operational Bulletin No 2 – *"Insulating Properties of Non-Combustible Sandwich Panels"* – Section 12–2012 – Warwickshire Fire & Rescue Service.

CONCLUSION

Sandwich panels serve an important role in the building industry because they are a fast-track, energy efficient and aesthetically attractive means of construction.

When specified with non-combustible cores, such as stone wool and properly secured metal sheet faces, their performance in fire can be excellent. Such panels can even achieve 2 hours' fire resistance and, being non-combustible, they release negligible amounts of heat or smoke.

However, as described in this document, the widespread use of sandwich panels with combustible foam cores can be a major risk to both life and property in a fire situation.

Firefighters face unusual hazards in tackling these fires, and manufacturers are now making available foam panel designs which meet varying Fire Resistance standards. However, the basic guidance contained in Appendix "F" - Approved Document B recommends that:

"Panel faces are adequately fixed to prevent de-lamination and facing collapse, and prevent the core materials from becoming exposed to the fire and contributing to the fire-load.

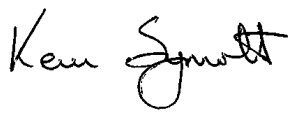
By example, combustible cores should not be used in some internal applications."

By applying this guidance, architects/builders/owners can contribute to providing a safer working environment for NIFRS personnel when they are involved in firefighting at a sandwich panel building.

By applying the guidance contained in this SOP, ICs and NIFRS personnel themselves can minimise the risks faced at such incidents.

This SOP is supported by:

- SOP No 1 and Operations Policy No 1 – Incident Command;
- SOP No 12 – Operational Intelligence;
- SOP No 6B – Pollution Emergencies.



Kevin Synnott
Group Commander (Emergency Response)

12 September 2012