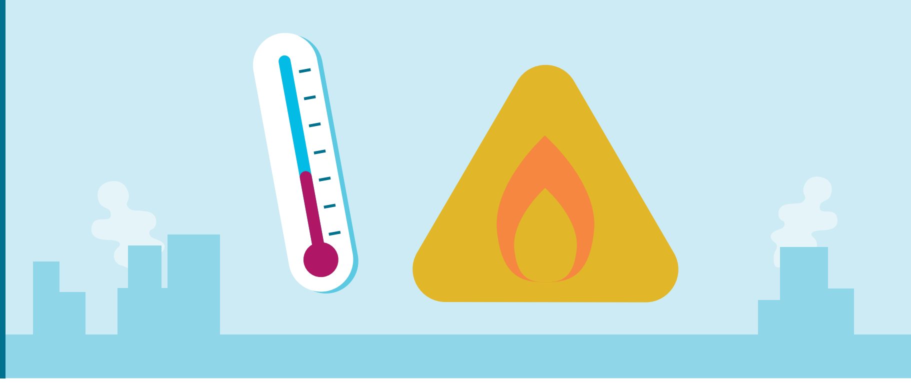
Technical Newsletter

#30 - December 2015



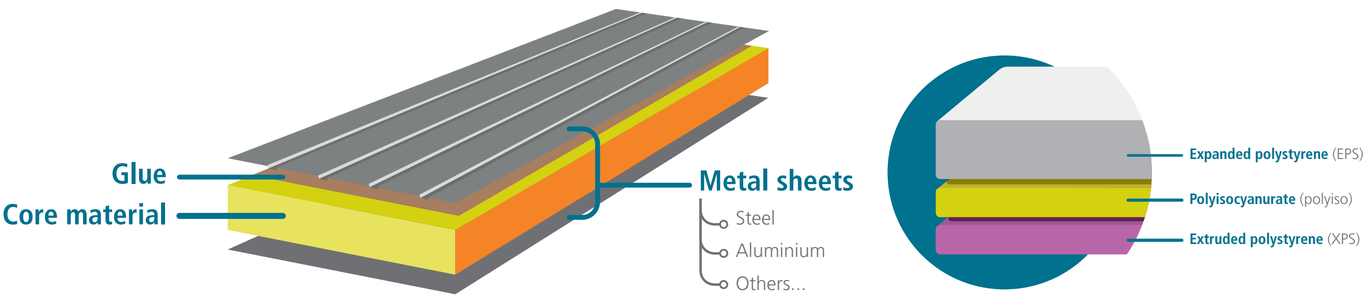
# COMPOSITE INSULATED PANELS (CIPS) OR INSULATED SANDWICH PANELS

### The System, Fire Hazards & Loss Mitigation

## Scope

Over the last decades there have been significant fire losses (Property Damage/Business Interruption) associated with the use of insulated sandwich panels. As the frequency and severity of losses has been increasing, it has become necessary to mitigate the risks for building occupants and fire fighters, and to reduce property losses related to the use of insulated sandwich panels.

## Type & Use of Sandwich Panels




Sandwich panels consist of a core material of varying thickness, held between metal or plastic facings. They are used in a wide range of occupancies including cold storage, warehousing, the food industry, hotels, exhibition halls and clean room environments where temperature control is desirable to minimise energy loss.

Common types of core material are Mineral Wool (MW), Polyisocyanurate Foam (PIR), Polyurethane Foam (PUR) & Expanded/Extruded Polystyrene (EPS/EXPS). All the above, except for MW, are combustible type (cellular plastic with density of ≤ 320 $kg/m^3$ formed by a foaming agent, heat rate of 8141 kJ/kg or more & flame spread index of 25-50) and are commonly known as Foam Insulated Sandwich Panels (FISP).

**Their widely accepted use is mainly due to:**

- Good thermal insulating properties reducing heat & cold transmission (50 mm PUR = 1720 mm thick solid brickwork)
- Acoustic properties reducing sound transmission
- Lightweight (PUR: 35 - 48 $kg/m^3$ against MW: 80 - 160 $kg/m^3$)
- Ease and speed of construction
- Ease of wash down - essential in certain industries
- Relative low cost compared to some other forms of construction (30%-50% less)

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# Fire Properties of Sandwich Panels

| TYPE OF CORE MATERIAL | FIRE LOAD | EASE OF IGNITION | FIRE SPREAD | FIRE RESISTANCE | THERMAL INSULATION | SMOKE PRODUCTION |
|---|---|---|---|---|---|---|
| Expanded Polystyrene (EPS) | 5 | 5 | 5 | 5 | 2 | 5 |
| Polyurethane Foam (PUR) | 5 | 5 | 3 | 5 | 1 | 4 |
| Polyisocyanurate Foam (PIR) | 5 | 3 | 3 | 4 | 1 | 4 |
| Modified Phenolic Foam (PF) | 5 | 2 | 3 | 3 | _ | 3 |
| Glass Foam (GF) | 1 | 1 | 1 | 1 | _ | 1 |
| Mineral Wool (MW) | 1 | 1 | 1 | 1 | 3 | 1 |

(1 is the best performance, 5 is the worst)

### CHEMICAL COMPOUNDS OF INSULATING MATERIALS

**Organic (PUR/PIR/EPS/PF) Type:** organic material derived from a petrochemical process and whose molecules contain carbon

› PUR/PIR/EPS are organic synthetic or semi-synthetic compound parts of plastics.

› (Plastic) Phenolic foam or Phenolic formaldehyde resins (PF) are synthetic polymers obtained through the chemical reaction between phenol, or substituted phenol, and formaldehyde. The decomposing point of Phenolic resins is situated in the temperature zone of 220° C and above.

**Mineral (GF/MW) Type:** mineral material comprising inorganic substances occurring in nature

› Glass Foam can be manufactured fully out of waste glass, with only a minimum of virgin additives. The process consists of heating glass powder, which contains a certain amount of sulfur trioxide, with finely divided active carbon. Due to the reaction of the sulfur trioxide with the active carbon, gases are produced which generate a cellular structure in the glass which becomes viscous during the heating process. There is also some hydrogen sulphide within the foam glass cells. GF may release small amounts of hydrogen sulfide & carbon monoxide gas when involved in a fire but is not expected to contribute to the intensity of a fire.

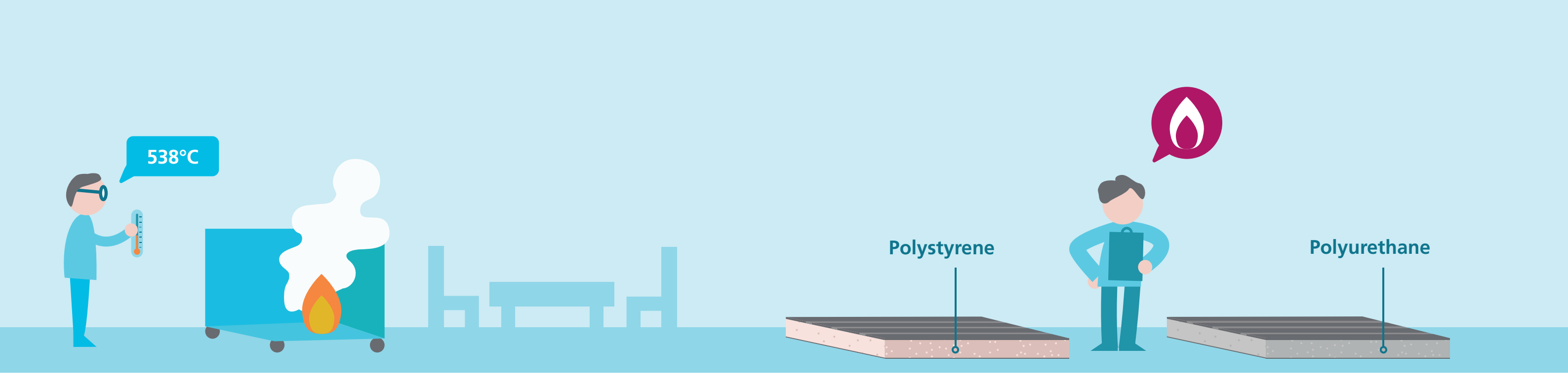
› Mineral Wool (MW), also known as mineral fibre, mineral cotton, mineral fibre, man-made mineral fibre (MMMF), and man-made vitreous fibre (MMVF), is a general name for fibre materials that are formed by spinning or drawing molten minerals. Specific mineral wool products are stone/rockwool and slag wool. In Europe there is also glass wool which like ceramic fibre, is completely man-made.

- Stone/rockwool is a furnace product of molten rock at a temperature of about 1600 °C, through which a stream of air or steam is blown.

- Glass wool is a furnace product consisting of a mixture of natural sand and recycled glass heated at 1450° C. The glass that is produced is converted into fibres. The cohesion and mechanical strength of the product is obtained by the presence of a binder that "cements" the fibres together. Ideally, a drop of bonder is placed at each fibre intersection. This fibre mat is then heated to around 200° C to polymerise the resin and is calendared to give it strength and stability.

## Reminder

| Heat Resistance of mineral wool | Temperature |
|---|---|
| Glass wool | 230 - 260° C |
| Stone wool | 700 - 850° C |
| Ceramic fibre wool | 1200° C |




# Fire Hazards of Sandwich Panels

**POTENTIAL RAPID FIRE SPREAD INSIDE THE PANEL**

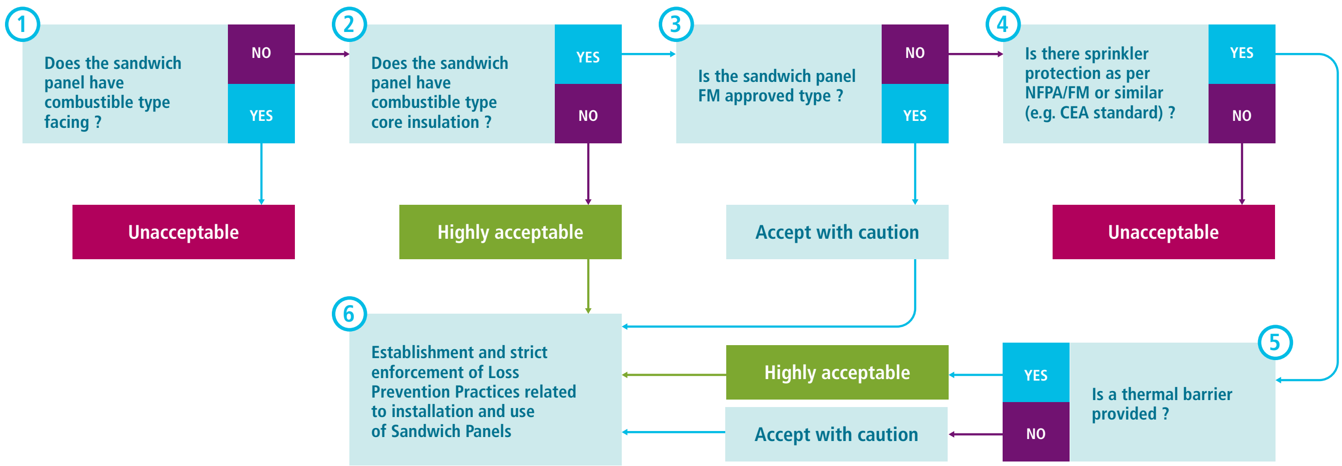
- Difficulty in fire-fighting when the concealed core is involved in fire
- Melting polystyrene core creating a spreading burning liquid fire
- Delamination of panels can expose the combustible core Exposing the core to direct fire impingement increases the rate of fire spread
- Dense, corrosive and toxic smoke

## Our position

In short, our position with regards to sandwich panels is: We strongly recommend the use of non-combustible type (facing & insulation – rock wool preferred) sandwich panels. Combustible type insulation approved by Factory Mutual (FM) or when the area is adequately protected by sprinkler and thermal barrier may be acceptable subject to product usage restriction and occupancy application. Please refer to the risk assessment flow chart below.

"IN ALL CASES, ADEQUATE LOSS PREVENTION PRACTICES SHOULD BE STRICTLY ENFORCED TO MANAGE THE RISK."

# Recommended Risk Assessment Flow Chart of Sandwich Panels



# The factors considered in flow chart above are further discussed below

## FACING & CORE MATERIAL

### Construction Material Classification

Fire resistance tests in various countries have led to certain classification codes for sandwich panels, ranking from "not easily flammable" to "highly flammable". Even if it is more difficult to ignite a fire retardant rated panel than a "non-rated panel", both will burn the same way under real conditions. Retardants often perform well in small scale tests however, when the retardant material is exposed to a more intense heat source, one radiating over a larger area, or one that persists for a longer time, intense burning may occur. In addition, fire retardant chemicals that are initially present in a material may sometimes be lost over a period of time because of leaching or volatilisation.

As building fire experiences have shown that available small scale tests do not realistically evaluate the in place behaviour of installed plastic building products, the Corner Test was developed. This test is intended as a method to evaluate fire propagation only.

No limits are placed on the amount of smoke produced. It is conducted in a structure 7.6 m high by 11.5 m wide and 15.2 m long. For non-combustible occupancies, a fire exposure of approximately 340 kg of wood is arranged as a 1.52 m high crib.

This is located in one corner of the structure, 34 cm from each wall. The exposure produces fire temperatures in excess of 538° C at the corner of the ceiling with flames impinging on the underside. The US Factory Mutual Research corporation (FMRC) corner tests have also used various combustible materials as the ignition source to determine whether combustible building panels require greater sprinkler protection than the occupancy itself.

### Listed or Approved Type of Materials

Sandwich panels with non-combustible materials are preferred in all cases. Where other materials are required, panels from approved or listed bodies such as Factory Mutual are recommended for all new construction and retrofit applications.

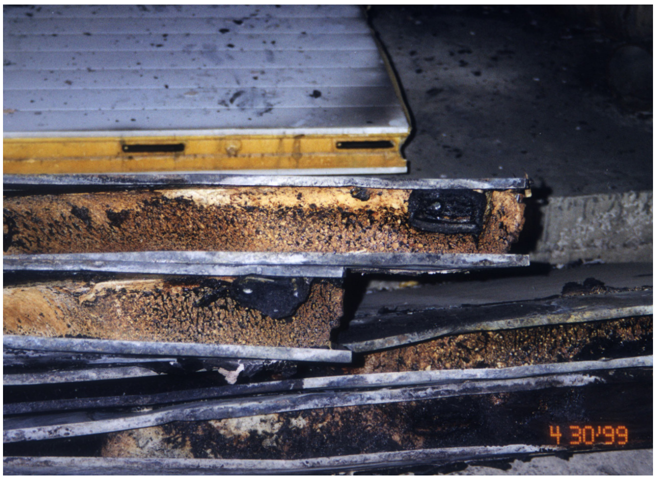
**Caution**

Some panels are approved for a maximum building height. This should be clearly indicated in the certificate.

**TOTAL LOSS OF A DAIRY PLANT CONSTRUCTED OF PU FOAM INSULATED SANDWICH PANELS**

### Handling Openings & Penetrations through Sandwich Panels

Approved panels were tested without such openings. Penetrations (such as cables and ducts) through any combustibe type sandwich panel should be limited and properly fire stopped with FM-approved and/or UL-listed fire-stopping material. Unprotected openings including those that have not been properly fire-stopped can therefore negate the approval listing. This should be seriously investigated during a visit to the site.



**DIFFERENT RATE OF COMBUSTION OF FOAM INSULATED SANDWICH PANELS**

**Fire Retardant Additives in Insulation Material**

Fire retardants may raise the ignition threshold, but they cannot meet the non-combustibility criteria.

> "LARGE SCALE CORNER TESTS HAVE SHOWN THAT THE PERFORMANCE OF PLASTIC FOAM UNDER ACTUAL FIRE CONDITIONS IS NOT SIGNIFICANTLY AFFECTED BY THE USE OF THESE FIRE-RETARDANT ADDITIVES."

When exposed to fire or sufficient heat, polyurethane decomposes at approximately 230° C and ignition occurs at 315° C to 370° C. Ignition results in the evolution of dense acrid smoke, and flames can flash rapidly across the surface of the material. Certain 'approved' polyurethane insulated sandwich panels allow the properly formulated foam core to char when exposed to an ignition source. This charring helps protect the remaining foam and limits fire propagation to acceptable limits.

## Thermal barriers delay ignition

### AUTOMATIC SPRINKLER PROTECTION

Sandwich panels containing plastic foam (PUR-EPS) present severe challenges for automatic sprinkler systems. Fire can spread readily & rapidly within panels with combustible type insulation material

Automatic sprinkler protection should be considered at roof level, at false ceiling level, in racks and should protect building walls and building structures.

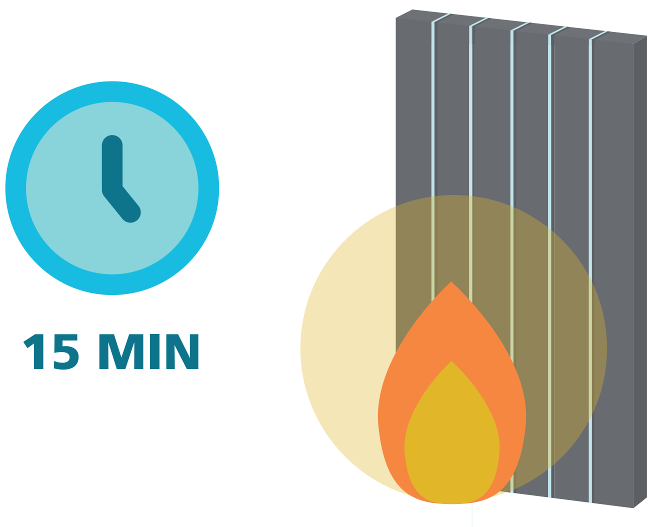
Polystyrene (EPS) is 1.5 times as combustible as polyurethane, forming a combustible liquid when it melts. EPS can be ignited by open flame and will burn in the presence of a flame generated by other fuels. It tends to shrink away from heat sources prior to ignition. To maintain burning, the heat source must either be sufficiently large to follow the shrinking material. This phenomenon allows EPS to obtain relatively low flame spread values in small scale tests. However, in a larger fire, such as one involving a small amount building contents, the heat source will be sufficient to sustain intense burning.

Automatic sprinklers may not confine the fire when EPS insulated sandwich panels are installed at ceiling level. In some cases, retrofitting or additional sprinklers should be installed, depending on the geometry of the room. As a result, automatic sprinkler protection alone should not be considered as a substitute for thermal barriers in the case of EPS installed at ceiling level.

### THERMAL BARRIER

The purpose of thermal barriers and/or metal sheathing in sprinklered applications is to delay ignition of the plastic for 10 to 15 minutes to allow sprinklers time to control the fire. It should be noted that fire-retardant paint coatings or metal panels do not provide adequate protection against rapid fire spread and should not be considered equal to a thermal barrier.

A thermal barrier is a cementitious covering for the exposed surface of foam insulation which can delay the ignition of foam for 10 to 15 minutes. Portland cement plaster, 13 mm thick, will provide an adequate thermal barrier for polyurethane – PUR – and especially for EPS. This should be done for most combustible type sandwich panel construction irrespective of whether the building is sprinklered or not. These thermal barriers should be listed or approved by certified companies conducting adequate tests. The 15-minute time frame should allow for sprinkler control, or if the building is unsprinklered, partially sprinklered, or if the sprinklers fail, it allows for Plant Emergency Organisation or Fire Department to respond accordingly.



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# Loss Prevention Practices Related to Installation and Use of Sandwich Panels

### THE INTEGRITY OF THE SANDWICH PANELS SHOULD BE CHECKED AS FOLLOWS

- There should be no exposed combustible insulation
- Panel walls should be covered with metal skins; aluminum foil as Facing is not considered as adequate protection from fire
- Each panel should be adequately joined to another one and suitably attached to building floors and roofs at the lower and upper ends
- There should be no other combustible type components (such as vapour barrier, glue, inner & outer coatings) other than the insulation

### PRECAUTIONS WHEN INSTALLING ELECTRICAL DEVICES AND EQUIPMENT

- All cable penetration through sanwich panels should include the provision of a non-combustible conduit to prevent the cable insulation from being damaged by the sharp edge of the metal panels. Cable and duct openings should be filled with approved non-combustible sealant
- Heat tracers: when installed in cold rooms with sub-freezing temperatures, these should be checked regularly. An alternative non-conductive system should be investigated for the new installation
- No electrical device should be installed against sandwich panels. A minimum of 10cm spacing should be provided. Lighting fixtures should not be installed against the panels and should be non-combustible type where unavoidable
- Good spacing, separation & fire protection should be considered between the refrigeration system/space heater and the rest of the facilities

### PRECAUTIONS WHEN CONDUCTING CUTTING AND WELDING OPERATIONS NEAR SANDWICH PANEL

- Hot works should not be allowed to be conducted near combustible type sandwich panels
- Adequate formalised hot work procedure should be established
- Only appropriate tools suitable for a given construction material should be used
- Adequate risk assessment should be ensured prior to the work being done, during the work, and after completion of the work.

"INSULATED SANDWICH PANELS MUST BE CONSIDERED AS SYSTEMS, NOT AS COMPONENTS. THEIR HAZARDS MUST BE EVALUATED ADEQUATELY & ADDRESSED APPROPRIATELY BEFORE INSTALLATION AND THEY MUST CONTINUE TO BE PROPERLY MANAGED THROUGHOUT THEIR USE."


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Editor: SCOR Global P&C Strategy & Development
ISSN: 1967-2136