Copy of article submitted to Fire Safety Engineering for publication January/February 2009

"Metal faced sandwich panels with plastic foam cores - a challenge to fire safety"

by Gordon Cooke

Confusion, misleading terminology and classification

Some manufacturers of insulation boards and sandwich panels use ill-defined terms implying fire safety to their products for marketing purposes – terms such as inflammable, fireproof, self extinguishing, equivalent to non-combustible, and recently firesafe. To the unwary specifier a term like Firesafe might suggest that the product is inorganic or non-combustible or will not contribute heat or smoke to a developing fire. PIR and phenolic foams may have better fire properties than PUR foam or polystyrene foam (expanded or extruded). However, both PIR and phenolic foams, like all plastics, are derivatives of the petrochemical industry and so it is not surprising that these materials can, in the event of a fire, contribute to fire. If materials become involved in 'flashover' they can contribute significant amounts of heat, together with toxic smoke;

The recently approved product standard for metal faced sandwich panels EN 14509 [1] does not make the distinction between the fire properties of panels any easier. Despite criticism and a failed first formal vote the standard still refers to the SBI test [2] for the reaction to fire testing of metal faced sandwich panels. The problem with using the SBI test for metal faced sandwich panels is that it does not distinguish between panels which cause flashover in the reference scenario from those that do not [3, 4]. It also is not possible to distinguish between panels with different types of combustible cores despite the well-known fact that some plastic foams have better fire properties than others. Eumeps (European manufacturers of EPS) writes in one of their reports [5] that: "Extensive research has been carried out on the reaction to fire classification for steel sandwich panels. This clarifies that it is not the core materials which determine the classification but the coating that is applied on the outsides of the steel."

All published test results of metal faced sandwich panels tested in the SBI test confirms the statement from Eumeps as all plastic foam cored panels obtained a Euroclass B classification [3,4,6].

So why is it a problem that all plastic foam cored metal faced sandwich panels obtain a Euroclass B? The answer is: because Euroclass B is the class reserved for combustible products which will not cause flashover when tested in the large scale reference test ISO 9705 [7]. Unfortunately most plastic foam cored metal faced sandwich panels will cause flashover when tested in the large scale reference test ISO 9705 or the similar free standing test ISO 13784-1 [8].

Importance of flashover

Flashover is internationally accepted as a major life threat condition not only to the normal building occupants but also, critically, to fire fighters, and it is also a threat to property and must be avoided if possible. Flashover is the condition in a growing fire within an enclosure (room or compartment) when all the materials (room contents and

at least the room's upper surface linings) suddenly all become involved in flame, Figure 1.

Typical example of flashover in the ISO 9705 reference room test (flames emerge from doorway, upper surfaces of specimen involved in fire)

Flashover should not be confused with backdraft which is an explosion occurring from the sudden introduction of air into a confined space containing oxygen-deficient superheated products of incomplete combustion. Flashover is internationally accepted as a failure criterion in the ISO 9705 reference room test and typically takes place when the combustion gases under the ceiling reach a temperature of around 600degC. At flashover there is a sudden and large increase in feedback of thermal radiation from the hot gas layer to the room contents below, and the effect of the radiation is to greatly increase the rate of flammable volatiles given off by the fuel (the room contents and room linings). This is reflected in a dramatic increase of burning rate and, consequently, an increase in the rates of heat release and smoke production. Combustion gas temperatures after flashover can range from 600degC to over 1300degC in real compartment fires.

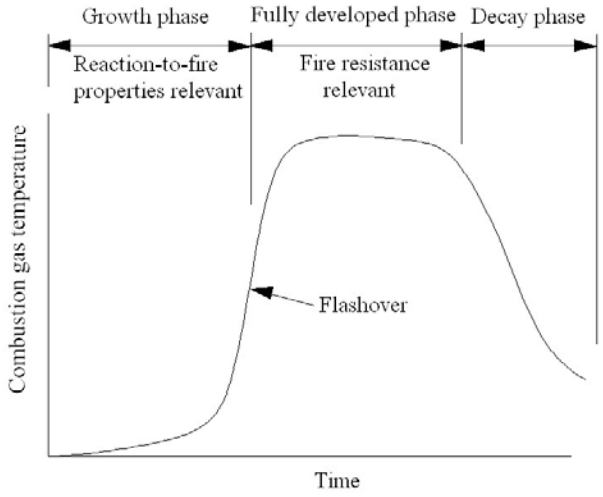

Figure 1. Flashover and the three phases of fire

The large scale reference test ISO 9705

The ISO 9705 test uses a standard room 3.6m x 2.4m x 2.4m high with a single ventilation opening in one of the narrow end walls to simulate an open doorway giving a well ventilated fire condition. The room is lined on three walls and the ceiling with the product. A small ignition source (matrix gas burner), located in contact with the two walls in a corner of the room away from the doorway, is set to give 100kW heat output in the first ten minutes followed by 300kW for the next ten minutes. Note that 100kW is roughly the peak heat release rate from a burning waste paper basket. The test room uses a 3m square hood next to the opening to collect all the combustion gases and has an instrumented duct capable of accurately measuring several exhaust gas parameters including rate of oxygen consumption (from which heat release rate is determined) and optical density of the smoke, Figure 2. If flashover occurs within the 20 minute test period the product is deemed to have failed the test. Flashover is deemed to occur when the sum of rate of heat release from the ignition source (100kW or 300kW) and the surface product reaches 1000kW and usually coincides with flames emerging from the door opening.

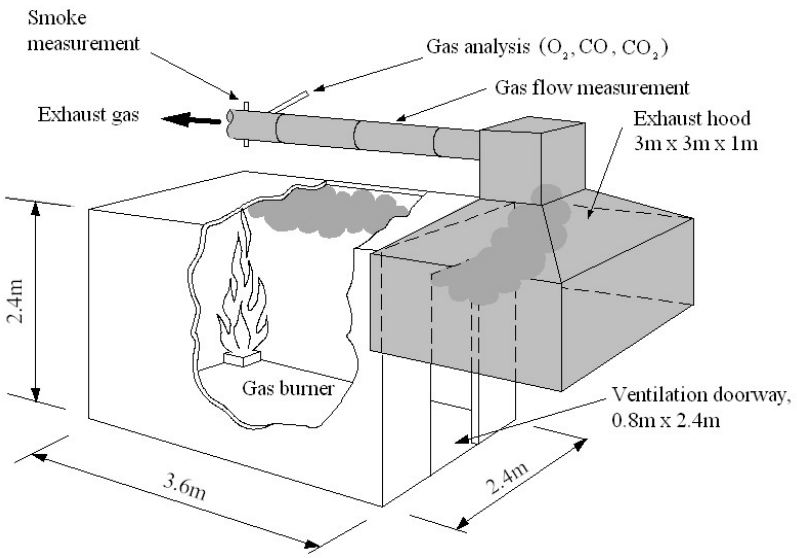

Figure 2. ISO 9705 Room reference test apparatus (copied by courtesy of SP).

ISO 13784-1 an alternative large scale test for sandwich panels

In addition to ISO 9705, ISO has developed a large scale test specifically for sandwich panels (ISO 13784-1) based upon the same scenario and philosophy as the ISO 9705 test. This test uses a test room of the same size as that described for ISO 9705 build up of the panels themselves. This allows for the panels to be mounted either completely free standing or fixed to either an internal or external frame. The test also measures heat release and smoke production as is done in ISO 9705. It should however be noted that the large-scale Room Corner Test ISO 9705 remains the official reference test within the European classification system for the reaction to fire performance of all construction products except floorings, including sandwich panels.

Life safety

So where do we look to get guidance relating to insulation boards and sandwich panels and life safety issues. We must turn to the Building Regulations 2000 (as amended). The relevant functional regulation is given in Part B of Schedule 1 to the regulations and is reproduced below

> 'Internal fire spread (linings)
> B2. (1)To inhibit the spread of fire within the building, the internal linings shall:
> (a) adequately resist the spread of flame over their surfaces; and (b) have, if ignited, a rate of heat release or a rate of fire growth, which is reasonable in the circumstances'

Note the requirement for a reasonable rate of heat release or rate of fire growth.

We know that Approved Document B 'Fire Safety' is the government's official (benchmark) guidance for deciding whether or not a building is safe from fire, in terms of life safety of building occupants and fire fighters, and if the building meets the fire regulations. What does ADB say about sandwich panels? The 2006 edition recognises the fire risk posed by some sandwich panels. Accordingly it includes Annex F 'Fire behaviour of insulating core panels used for internal structures'. This recommends that a fire risk assessment is made and it gives some pointers as to what matters to consider. While this raises awareness of the fire risk of some sandwich

panel constructions it does not, in my opinion, go far enough. ADB ought to be redrafted to make it clear that:

a) the Single Burning Item (SBI) test, Figure 3, which is one of four standard small scale fire tests used in deriving a European class (Euroclass) for a surface product, is unable to assess the fire behaviour of sandwich panels owing to the small size of specimen tested (maximum 'wing' size 1m by 1.5m high), and
b) any sandwich panel construction should be submitted to the large scale reference test ISO 9705, as this was specifically designed to assess the rate of heat release (a requirement of the functional regulation as we saw above) and smoke production, and decide whether or not a sandwich panel assembly will result in flashover.

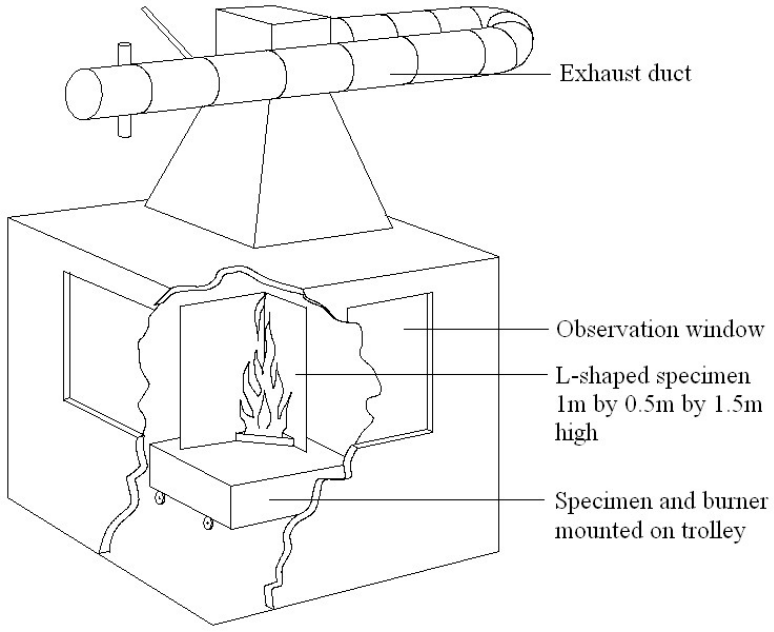

Figure 3. BS EN 13823: 2002 Single Burning Item test apparatus. (Note small size of specimen)

Conclusions.

- Metal faced sandwich panels with a plastic foam core should not be described in a way that implies a degree of fire safety that is not proven by tests and classification systems as discussed above, and their use in buildings should be critically considered in the knowledge that they are combustible.
- In some building configurations metal faced sandwich panels with a plastic foam core may be safe (e.g. when the panel is located well away from any ignition source or when the enclosure is very large), but assuming the initiating fire develops there will come a stage where the foam could contribute to the fire. Defining the scenarios in which the product will not contribute to flashover is very difficult.
- Specifiers should be aware that the LPS 1181-1 test, often cited in manufacturer's literature, may be inappropriate to the life safety scenario. BRE has confirmed this fact in a recent News release.
- The SBI test is inappropriate to test metal faced sandwich panels as it cannot distinguish between panels that will cause flashover in the reference scenario from those that will not.

- AD B should be amended to require the performance of sandwich panels containing combustible cores such as plastic foam to be determined in accordance with the ISO 9705 room reference test or ISO 13784-1.
- If in the absence of this large-scale test data the product specifier, having made a full fire risk assessment, remains in any doubt, it will be prudent to specify non-combustible materials - i.e. materials that have a Euroclass class of A1 or A2 when tested directly exposed to the test heat source.

References

[1] EN 14509: 2006, Self-supporting double skin metal faced insulating panels - Factory made products - Specifications
[2] BS EN 13823: 2002, Reaction to fire tests for building products — Building products excluding floorings exposed to the thermal attack by a single burning item
[3] Van Hees P, Johansson P. Development of a Test Procedure for Sandwich Panels using ISO 9705 Philosophy. Nordtest project nr 1432-99. SP Rapport 2000:26, SP Swedish National Testing and Research Institute, Fire Technology, Boras, 2001.
[4] Jesper Axelsson and Patrick Van Hees, New data for sandwich panels on the correlation between the SBI test method and the room corner reference scenario, Fire and Materials, 2004
[5] Eumeps, Fire safe constructions with EPS, http://www.eumeps.org/pdfs/firesafe.pdf
[6] BRE, Final Report for Sector Group C – Sandwich Panels, October 2003
[7] ISO 9705: 1993 Fire tests – Full scale room tests for surface products.
[8] ISO 13784-1: 2002, Reaction to fire tests for sandwich panel building systems – Part 1: Test method for small rooms

End of article