Fire Prevention for Insulating Core (Sandwich) Panel Structures for Inside Use

Guidelines For Selection, Installation And Use

Contents

1 Generalities 1
  1.1 Objective and Scope 1
  1.2 Specific Fire Hazards 1

2 Materials Selection 2
  2.1 Fire Reaction of the Panel Components 2
  2.2 Location of the Structure and its Surroundings 2
  2.3 Restrictions Related to the Storage of Dangerous Materials and Processes 3
  2.4 Housekeeping and Maintenance 4

3 Design and Construction 4
  3.1 Structural Fire Resistance (Avoidance of Collapse) 4
  3.2 Compartment Partitioning Fire Resistance (Fire Proof Walls, Flooring) 5
  3.3 Facing Sheathing Continuity 5

4 Service Equipment 5
  4.1 Fire Detection and Evacuation Alarm 5
  4.2 Electric Equipment 6
  4.3 Flammable Gas Equipment 6

5 Transitory Rules for Already Existing Structures 6

Reference Documents 8

Glossary 9

Annex 1 10
Criteria for Equivalence between Fire Reaction Classes of Different Counties
1 Generalities

1.1 Objective and Scope

The Objective of this Safety Note is twofold:

– Since some of the material used for insulating core (sandwich) panels is not intrinsically safe and does not fulfil the requirements of CERN Safety Instruction IS41, additional restrictions and conditions for their design and installation are required.

– As sandwich panel structures – from now on called ‘structures’ – can reach significant elevation and weight, they may present a mechanical stability hazard.

When closed structures (barracks) are built with sandwich panels, CERN Safety Note NS3 must also be applied.

Though many criteria in this Safety Note are still valid for the realization of outside structures, SC must be contacted for advice on buildings that have more than one level.

All the relevant requirements are summarized and detailed in this Safety Note.

Engineering details for insulated core panel structures are presented in the document ‘Insulated Core Panels Structural Fire Safety Guideline’ (see References).

1.2 Specific Fire Hazards

From the fire safety point of view, the main distinction is made between incombustible and combustible core panels.

– Incombustible cores have a lower toxicity potential and are safer against fire, but they are significantly heavier and often require supplementary reinforced structures with consequent cost increases.

– Combustible cores, on the other hand, are usually lighter and cheaper but are (generally) less safe against fire, as they tend to produce a large amount of toxic smoke when exposed to flames or conducted heat, and give a rapid fire spread and flashover.

All kind of panels – irrespective of the core type – tend to lose a large amount of their mechanical stability by de-lamination when they are exposed to high temperatures (130–150°C), thus creating the risk of an early collapse. Another critical aspect is the possibility of the fire spreading behind or along the panels (through the fillings and joints) and propagating outside the structure. This is often in a difficult position for the Fire Brigade to reach or is out of sight.
2 Materials Selection

The designers and users shall take the following criteria into account when selecting materials:

– fire reaction of the panel components (chapter 2.1),
– location of the structure and its surroundings (chapter 2.2),
– restrictions related to the storage of dangerous materials and processes in the vicinity of the structure (chapter 2.3).

The user is responsible for ensuring that the conditions of use are respected (chapters 2.3 & 2.4).

2.1 Fire Reaction of the Panel Components

Currently, there is no internationally agreed real scale testing and qualification procedure for the fire reaction of the whole panel. Therefore each component must be considered separately.

The facing sheets shall be made of metal.

For the facing sheet finishing or painting, only the following classes (or equivalent\(^1\)) of fire-resistant products are acceptable: French classes M0 and M1, or Swiss classes VI and V.

The core material (see chapter 2.2 for acceptable core types) shall be certified by a third party laboratory and shall not be inferior to the French Class M2 or the Swiss Class V. The test shall be conducted on raw samples of the core material, with the surfaces directly exposed to air.

2.2 Location of the Structure and its Surroundings

Panels must not be placed in surroundings where dangers from combustible products cannot be alleviated, and must not be placed in areas that can be densely occupied or are accessible by the public. A non-exhaustive list of selection criteria follows.

For areas not included in this list, SC must be contacted for agreement on selecting the most similar category.

Incombustible cores

Mineral fibre (Rock wool) is usually preferred and has no additional placing or layout restrictions.

---

\(^1\) For Classes of other countries, refer to fire reaction equivalence table in Annex 1.
**Combustible cores**

Due to the poor flame-retardant quality and the possibility of highly toxic smoke, the following combustible cores have been judged **unacceptable** and shall not be installed anywhere at CERN: Polyurethane (PUR), if not properly modified by fire retarding agents, Extruded Polystyrene, and Expanded Polystyrene (EPS).

Phenolic foam, Polyisocyanurate foam (PIR), Modified (fire retarded) Polyurethane, are subjected to restrictions in their use, as all of them emit toxic and corrosive smoke fumes when submitted to high temperatures, and after a more or less prolonged latency, ignite and participate in the fire.

**Their use is forbidden in the following cases:**

1) in underground areas (see chapter 5 for existing installations);
2) in multi-storey buildings (buildings with more than one level);
3) if there is only one direct exit from the hosting hall to the outside;
4) in staircases, corridors and interconnecting rooms that are part of the evacuation path for a building (protected exits);
5) in halls which are under 4 m in height;
6) in buildings receiving public visitors (i.e. members of the public who have not followed a CERN safety course);
7) if the project shows evidence that points 2.3 and/or 2.4 cannot be respected;
8) if the building does not have an efficient smoke evacuation system;
9) if the ventilation system could spread smoke into other rooms;
10) for the construction of multi-storey structures;
11) for the construction of structures whose main function is to house electric equipment (especially if high currents or tensions, or if combustibles, such as dielectric oil, are present).

All other materials must comply with the CERN Safety Instruction IS 41.

### 2.3 Restrictions Related to the Storage of Dangerous Materials and Processes

Combustible sandwich panels, even if they are fire-resistant, will sooner or later actively participate in the fire. Furthermore, they make a significant addition to the amount of combustible materials in the area.

To compensate this weakness, the amount of combustibles must be limited and common sources of ignition must be carefully avoided.

Therefore, the owner (in the design stage of the project) and the user (during exploitation) shall ensure that:
Combustible cores

1) the amount of combustible material allowed inside the structure shall not exceed a maximum of 5 kg per square meter of floor surface – this includes under the floor, above the ceiling and within 2 m from the perimeter walls. For larger amounts of combustibles, the user must request a specific preliminary analysis of the layout by SC at the project stage.

2) that in the surrounding area:
   - no industrial or experimental processes are carried out that involve hot thermal sources (including lasers capable of reaching spot temperatures above ~200°C) or naked flames;
   - no flammable or combustible liquids are stored;
   - no chemicals capable of strong exothermal reactions are stored or used;
   - no flammable gases are stored or used;
   - there are no rubbish bins in the surrounding area.

2.4 Housekeeping and Maintenance

All kind of cores:

The user shall ensure a good and regular house keeping, in order to avoid undue or disordered accumulation of trash or other combustible substances.

Further prescriptions for combustible cores:

The user must immediately report any damage to the continuity of the sheathing facing sheets of the panels to the TSO, and a maintenance intervention must be accordingly performed.

3 Design and Construction

3.1 Structural Fire Resistance (Avoidance of Collapse)

All kind of cores:

Structures shall be designed, realized and assembled in compliance with the relevant codes, rules and manufacturer’s instructions, under the responsibility and supervision of a qualified professional.

Fire can quickly affect the mechanical stability of a non fire-rated structure.

A safety frame capable of supporting the structure is necessary if its dimensions don't allow fast evacuation and fire extinction from outside.
The supporting frame, and its joints with the panels, must be protected to direct exposition to the flame of a fire and be capable to withstand the service loads plus the accidental loads generated by the fire.

In general practice, for areas covered with sandwich panels not exceeding a surface of 20 m\(^2\), a supporting frame is not necessary (exception made for other structural reasons related to the own weight and the loads).

For areas covered with sandwich panels exceeding the surface of 20 m\(^2\), a supporting frame may be necessary, and its need shall be evaluated following the criteria stated in the chapter 1 of the document ‘Insulated Core Panels Structural Fire Safety Guideline’.

3.2 **Compartment Partitioning Fire Resistance (Fire Proof Walls, Flooring)**

The fire resistance of sandwich panels is generally poor; for this reason, if a project requires a fire resistant barrier (wall or floor), the choice must be made from specific products (usually rock wool panels), whose characteristic of fire resistance have been tested and certified following an official standard by a third part recognized laboratory.

Openings (doors, windows) and technical feed-through (for cables, pipes, ducts, etc.) must be made using specific accessories granting the same level of protection (fire resistant dampers, collars, sealing bags, etc.) as the whole assembled structure.

3.3 **Facing Sheathing Continuity**

Sandwich cores exposed to air are a weakness for fire safety; assembling of the structure must avoid gaps or uncovered holes. Feed-through shall be made only if in case of absolute necessity (chapter 2 of ‘Insulated Core Panels Structural Fire Safety Guideline’).

4 **Service Equipment**

In this chapter recommendations are given for the posing of service and emergency plants, in order to avoid lack of fire reaction performance and to reduce the probability of ignition.

4.1 **Fire Detection and Evacuation Alarm**

The installation of fire detection and alarm system shall cover the additional risk introduced by the combustible core sandwich panel.

General prescriptions for barracks shall be applied (CERN Fire Code E, CERN Safety Note NS3).
Further prescriptions for combustible cores:

The installation of a fire detection and evacuation system is recommended whenever a fire may involve the sandwich panels, generate a risk for evacuation of personnel, or suggested by the owning group whenever valuable properties are exposed to fire risk.

Furthermore, fire detection and evacuation alarm shall be installed for already existing structures in underground areas, multi-floor buildings and buildings receiving public.

4.2 Electric Equipment

Safety of electrical installation and equipment must be compliant to the CERN Electric Safety Code C1; additional prescriptions related to the specific fire risk of the panels are given in chapter 3 of the document ‘Insulated Core Panels Structural Fire Safety Guideline’.

4.3 Flammable Gas Equipment

Safety of flammable gases must be compliant to the CERN Flammable Gas Safety Code G. Flammable gas piping shall not either pass through panels or inside closed structures made with sandwich panels.

Further Prescription for combustible cores:

Flammable gas equipment shall not be installed inside structures made of combustible core sandwich panels.

5 Transitory Rules for Already Existing Structures

General requirements valid for combustible cores:

The structure must not be in a stair cage, corridor, or in a point being part of a protected egress path;

A protected egress path, or the outside, must be reachable in less than 40 m;

The hall hosting the structure must have a ceiling not lower than 4 m;

A smoke removal system must exist;

The finishing or facing sheets must be conforming to fire reaction classes stated in chapter 2.1;

Fire reaction of the sandwich must be not worse than French class M3, Swiss Class IV;

Restriction in the use must be conforming to chapter 2.3;
Housekeeping and maintenance must respect chapter 2.4;
Feed through shall be protected in conformity to chapter 3.2;
Inner core shall never be directly exposed to air, in conformity to chapter 3.3;
Cables must respect chapter 3.1 of the document ‘Insulated Core Panels Structural Fire Safety Guideline’;
Fire detection must be conforming to chapter 4.1;
Incandescent lights must respect safety distance stated in chapter 3.3 of the document ‘Insulated Core Panels Structural Fire Safety Guideline’;
Heating equipment must respect chapter 4 of the document ‘Insulated Core Panels Structural Fire Safety Guideline’;
Flammable gases must respect chapter 4.3;
If these minimal conditions are not respected, substitution with other materials or case-by-case specific compensatory measures must be evaluated and applied by initiative of the TSO, in collaboration with SC.
Reference Documents

- CERN Safety Instruction IS23 – Criteria for the selection of electrical cables and equipment with respect to fire safety and radiation resistance
- CERN Safety Instruction IS41 – The use of plastic and other non-metallic materials at CERN with respect to fire safety and radiation resistance
- CERN Safety Note NS3 – Safety requirements for barracks in experimental areas
- Règle CNPP\textsuperscript{2)} D14 A – Panneaux sandwich – Comportement au feu – Spécifications et méthodes d’essais
- Règle CNPP T14 A – Panneaux sandwich – Guide pour la mise en œuvre
- Factory Mutual\textsuperscript{3)} Approval Standard n.4880 – Class 1 Approval requirements for wall roof ceiling panels
- ISO Draft 13784-2 Reaction to fire tests for industrial sandwich panels-Intermediate scale tests
- Department of Environment, Transport and Regions, UK – Building Regulation approved Document B (Year 2000), Appendix F.

\textsuperscript{2} Centre National de Prévention et de Protection, CNPP-VERNON, CD 64, Route de la Chapelle Réanville, Saint Just, F-27950 Saint-Marcel

\textsuperscript{3} FM Insurance Company, Ltd., Tour Europlaza, Défense 4, F-92927 Paris La Défense, Cedex, France
Glossary

Building receiving public

At CERN these are the kindergarten, the main building with the amphitheatre, and the MICROCOSM exhibition.

Fire resistance

Ability to contain fire, heat and smoke into a compartment and to maintain mechanical stability.

Insulating core (sandwich) panel

Composite panel, realized by means of a lightweight inner core sandwiched between and bonded to facing sheets, e.g. galvanized steel. Insulating core (sandwich) panels are often used for the construction of internal structures inside industrial buildings. Their main use is in providing enclosures that allow control of temperature, humidity, noise, dust particles, etc.

Protected egress path

Portion of building (corridors, stairs, rooms) used to evacuate a compartment in fire, protected from smoke by means of walls and doors, and kept free from combustibles.

Sandwich panel structures

The whole assembly consisting of the sandwich panels, supporting frames and fixing devices.
## Annex 1

### Criteria for Equivalence between Fire Reaction Classes of Different Counties

#### Fire Reaction Equivalence Table

(Taken from the ‘International Plastics Flammability Handbook’ J. Troitzsch, Hanser Publishers – Munich, 1990)

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>A</th>
<th>CH</th>
<th>D</th>
<th>DK</th>
<th>F</th>
<th>GB</th>
<th>I</th>
<th>N</th>
<th>NL</th>
<th>S</th>
<th>USA</th>
<th>B</th>
<th>CZ</th>
<th>E</th>
<th>H</th>
<th>SF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ignition contribution of building material</td>
<td>A</td>
<td>VI</td>
<td>VI</td>
<td>A1</td>
<td>A2</td>
<td>MO</td>
<td>O</td>
<td>O</td>
<td>nc*</td>
<td>nc*</td>
<td>nc*</td>
<td>AO</td>
<td>A</td>
<td>MO</td>
<td>nc*</td>
<td>nc*</td>
</tr>
<tr>
<td>Minimal</td>
<td>B1</td>
<td>V</td>
<td>B1</td>
<td>A(1)</td>
<td>M1</td>
<td>M2</td>
<td>1</td>
<td>1</td>
<td>A20</td>
<td>1</td>
<td>1</td>
<td>A(I)</td>
<td>A1</td>
<td>A2</td>
<td>B</td>
<td>M1</td>
</tr>
<tr>
<td>Normal</td>
<td>B3</td>
<td>III</td>
<td>B3</td>
<td>B3</td>
<td>M4</td>
<td>M5</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>A4</td>
<td>C3</td>
<td>M4</td>
<td>hc*</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>B3</td>
<td>III</td>
<td>B3</td>
<td>B3</td>
<td>M4</td>
<td>M5</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>A4</td>
<td>C3</td>
<td>M4</td>
<td>hc*</td>
<td></td>
</tr>
</tbody>
</table>

1) Classes 1, 2 for linings

2) Classes A, B, C or I, II, III for linings depending on Model Building Code

nc = non combustible, lc = low combustibility, mc = moderately combustible, hc = highly combustible, the words used in the codes.