White Paper

New EN45545 Fire Safety Standards: Implications and Options for Rail Component Manufacturers.

Until now, fire safety regulations for rail interiors varied across Europe. Manufacturers had to contend with a range of requirements from one nation to the next. However, the new Interoperability of the Trans-European High-Speed Rail System Directive 2008/57/EC aims to harmonize rail systems throughout the European Union.

What does this push toward a universal European rail system mean for manufacturers? Rail component manufacturers will have to determine the most practical way to meet rail safety standard EN 45545's new fire safety parameters.

Technical specifications narrow the field of options.

The fire safety requirements for rolling stock are laid down in the forthcoming Fire Safety Standard EN45545. This directive regulates material selection for trains and their interiors, depending upon the type of train and the type of track on which it operates. Materials are generally specified such that they resist burning long enough for passengers to escape.

To establish the stringency of materials required for a particular train on a particular route, the train is assigned a Hazard Level. A higher HL suggests passengers will take longer to reach safety on that train, so the materials there need to be extra fire safe. A train's hazard level is determined by two parameters: its design category, and the route's operational category.

Design categories are A, D, S and N. A means an automatic train with no emergency staff on board. D is for double deckers, S is for sleeping cars, and N is for regular trains.

Operational categories 1-4 are assigned depending upon whether the train routinely operates in tunnels, as opposed to above ground, and how far away the nearest emergency station is likely to be should the train have to stop below ground. An operational category of 1 is for trains that would be easiest to escape from in an emergency, ranging up to category 4 for the hardest.

By combining these categories, EN45545 defines the hazard levels according to table 1:

Table 1.

EN 45545 defined hazard levels				
Design Category	**N**	**A**	**D**	**S**
Operation Category				
1	HL1	HL1	HL1	HL2
2	HL2	HL2	HL2	HL2
3	HL2	HL2	HL2	HL3
4	HL3	HL3	HL3	HL3

Each hazard level has its own criteria for usable materials. The vast majority of trains in operation are classified as HL2.

What materials qualify?

Part of regulation EN45545 specifies a series of tests for evaluating materials for use in trains. These fire tests check a substance's performance along the axes of fire/flame spread, and the toxicity of fumes and opacity of smoke produced. The fire behavior of a material in the various fire tests determines which hazard level(s) it qualifies for.

Probably the most telling test is a material's heat release, as measured by cone calorimeter according to ISO standard 5660-1. This test shows how ignitable a substance is and determines its likely contribution to the spread of a fire.

In this test, the material in question is first exposed to a radiant heat source (e.g. with 50 kW/m^2) that ignites it. The heat produced during burning is recorded as an average rate of heat emission (AHRE) and a maximum average rate of heat emission (MAHRE). Threshold MAHRE values are used to decide which materials are allowable for each Hazard Level.

For example, the threshold MAHRE values for walls and ceilings are:

Table 2.

	HL 1	**HL 2**	**HL 3**
ISO 5560-1	MAHRE < NA	MAHRE < 90	MAHRE < 60

What are your options?

There are three common ways in which manufacturers can address the issue of EN45545's higher FST requirments today.

1. Using intumescent gelcoats and polyester resins with flame retardant fillers. These coatings char on exposure to flame and retard flame spread. However, such intumescent gelcoats are twice as expensive as normal gelcoats, and a thicker layer is required to achieve required fire safety performance.
2. Polyester resins filled with flame retardents are also an option, but filled resins are difficult to handle in automated manufacturing processes due to sedimentation, uneven filler distribution and voids in the final part.
3. Using phenolic resins for composite materials is also a direction you can take. Known for decades as the highest performing option for fire safety not only in ground transportation, but also in aerospace, phenolics reliably yield materials that are resistant to ignition, have extremely low flame spread, and produce minimal levels of smoke and toxic emissions.

It is no wonder, then, that over the years, a phenolic resin system – namely, Hexion Inc.'s (Hexion) Phenolic Cellobond™ FRP resin – has been specified by global rail builders Ahlstrom, Bombardier, CAF and Siemens in important rail projects for the London and Hong Kong Undergrounds, the Gardemoen Airport Express, the Heathrow Express, the Eurostar (Le Shuttle), the Gautrain for the 2010 World Cup in South Africa, and many others around the world.

High-strength bonds formed within fully cured phenolic matrices are responsible for their exceptional level of fire and high temperature performance. Current testing, such as the critical ISO 5660-1, indicates that phenolics meet all the new safety standards. When looking at the chemistry, the compounds that perform best on these tests are aromatic—predominantly phenolic resins which perform well regardless of the type of process used to manufacture the component.

Preliminary tests for specimens manufactured with Hexion grade Cellobond™ J2027L resin using various processing techniques with a variety of composite materials show only minor differences in MAHRE values among samples. All values easily satisfy the highest levels of safety according to the forthcoming European Union Fire Safety Standard EN45545.*

Table 3.

Test Specimen Details	MAHRE
Surface Pasted / Hand Laminated plaque 38-40% glass	35
Surface Pasted / Vacuum Infused plaque 50% glass	31
Continuous Fibre Mat / RTM plaque 25% glass (resin rich)	45
Fine Weave Cloth / Vacuum Infusion plaque 70% glass	21

Where fire, smoke and toxicity performance is required, phenolic resins are the gold standard of choice for the fabrication of composite parts. Hexion Cellobond phenolics can achieve a fire safe FRP system without the need for added fire retardants or fillers. They meet current fire safety regulations and are highly likely to comply with the new European Standard EN45545 (HL2 and HL3) as well.

* ISO-5660-1 test conditions are not finalized. Testing was done based on the method promulgated in the draft regulation.

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