Fire protection standards for railway applications

The new European standard **EN 45545** governing fire protection on railway vehicles was published in 2013. In Italy, the various parts are:
● **UNI CEI EN 45545-1**:2013-05 Railway Applications – Fire protection on railway vehicles – Part 1: General;
● **UNI CEI EN 45545-2**:2013-05 Railway Applications – Fire protection on railway vehicles – Part 2: Requirements for fire behaviour of materials and components;
● **UNI CEI EN 45545-3**:2013-05 Railway Applications – Fire protection on railway vehicles – Part 3: Fire resistance requirements for fire barriers;
● **UNI CEI EN 45545-7**:2013-05 Railway Applications – Fire protection on railway vehicles – Part 7: Fire safety requirements
for flammable liquid and flammable gas installations.

The standard replaces the previous voluntary Technical Specification
CEN/TS 45545:2009 and has formalised the withdrawal of all conflicting national standards as of 1st April 2016, the date on which
the following parallel standards cease to be effective: in Italy **UNI CEI**

● **UNI CEI EN 45545-4**:2013-05 Railway Applications – Fire protection on railway vehicles – Part 4: Fire safety requirements for rolling stock design;
● **UNI CEI EN 45545-5**:2013-05 Railway Applications – Fire protection on railway vehicles – Part 5: Fire safety requirements for electrical equipment, including that of trolley buses, track guided buses and magnetic levitation vehicles;
● **UNI CEI EN 45545-6**:2013-05 Railway Applications – Fire protection on railway vehicles – Part 6: Fire control and management systems;

11170-1:2005, **UNI CEI 11170-2**:2005 and **UNI CEI 11170-3**:2005,
in France, **NF F 16-101**:1988 and **NF F 16-102**:1992, in Germany, **DIN 5510-2**:2009, in Great Britain, **BS 6853**:1999. These, however, will remain applicable until 31st march 2016. All certificates covering materials issued in line with national standards will remain valid in Europe up until this date. As of 1st April 2016, the only reference standard will be EN 45545:2013.
EN 45545-2 specifies the requirements for the fire behaviour of materials and components of railway vehicles according to the different hazard levels defined by EN 45545-1:2013 (HL = Hazard Level). See Table 1 - Classification of hazard levels (EN 45545-2:2013).

Each hazard level provides for its own specific test procedures, test
conditions, fire-fighting requirements and severity (min or max
threshold), ranging from **R1** to **R26**. Small electrical and earthing
components, such as electrical connectors, must have a nominal fire behaviour rating (self-extinguishing).

are available. In this case, the requirements depend on the so-called grouping rules.

The connectors are products not listed in Table 2 of EN 45545-2:2013.
As non-listed products, they must satisfy the requirements of Table 3,and as their exposed surface area is ≤ 0.2 m2, the requirement set for interior installation in railway vehicles is **R22** while for exterior installation it is **R23** (Table 5 of EN 45545-2:2013).
The materials making up the connectors constitute the maximum applicable requirement sets.
These sets specify parameters, procedures and limit thresholds (minor max) for the tests. In particular, R22 and R23 specify tests and limit values for oxygen content (oxygen index OI), smoke density (Ds max)and toxicity (conventional toxicity index CIT_{NLP}). The polycarbonate

94V-0 (standard UL 94)
The thermoplastic insulating material used in ILME connectors complies with the requirements of UL 94V-0. There are no requirements applicable to products with a combustible mass < 10 g not in contact with other unclassified products, if they are installed
adjacent to components for which no certificates
used by ILME in its connectors satisfies the limit values specified in EN45545-2.
See Table 2 - Requirements for unlisted products (including electricalconnectors) - at following page.
Up until the publication of the previously mentioned new European standard, the most advanced fire safety standards for the railway industry were French:
– **NF F 16-101** Materiel roulant ferroviaire – Comportement au feu –Choix des materiaux;
– **NF F 16-102** Materiel roulant ferroviaire – Comportement au feu –Choix des equipements electriques;
which in turn referred to the test methods described in standards:
– **NF X 70 100** Analyse de gaz de pyrolyse et de combustion;
– **NF X 10 702** Determination de l'opacite des fumees en atmosphere non renouvelee.

Table 1 – Classification of hazard levels (EN 45545-2:2013)

	Design Category			
Operation-category #)	A: Vehicles forming part of an automatic train having no emergency trained staff on board	D: Double decked vehicle	S: Sleeping and couchette vehicles	N: All other vehicles (standard vehicles)
OC 1	HL	HL	HL	HL1
OC 2	HL	HL	HL	HL2
OC 3	HL	HL	HL	HL2
OC 4	HL	HL	HL	HL3

#) Relationship between service, infrastructure and evacuation conditions for passengers and staff

Requirements for unlisted products (including electrical connectors)

Table 2 - Requirements for unlisted products (including electrical connectors)

Test method	Standard	Parameter	Unit	Interior	Exterior	Threshold R22 (more severe than R23)	ILME (polycarbonate)
Oxygen index	EN ISO 4589-2	OI (min)	%	R22	R23	HL1: 28 HL2: 28 HL3: 32	better than R22-HL3
Smoke density	EN ISO 5659-2	D_s max [1)]	---	R22	R23	HL1: 600 HL2: 300 HL3: 150	better than R22-HL3
Smoke toxicity	NF X70-100-1	CIT_{NLP} (max) [2)]	---	R22	R23	HL1: 1,2 HL2: 0,9 HL3: 0,75	better than R22-HL3
	NF X70-100-2						

1) Ds max = specific optical density of smoke

2) CIT_{NLP} (max) = maximum conventional toxicity index of smoke

These latter were somewhat similar, in terms of methods, to the American standards:
– **ASTM E 662** Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials;
– **ASTM E 162** Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

Test methods referred to in the American reference standard specifying the performance criteria:
– **NFPA 130** Standard for Fixed Guideway Transit and Passenger Rail Systems.
Also widely used are the Bombardier Transportation smoke toxicity specifications:
– **SMP 800-C** Toxic Gas Generation.

In Italy, from 2006 to 31st March 2016, for installation on board railway vehicles, a certificate of conformity to the following Italian railway standards is required:

– **UNI CEI 11170-1:2005** Trains and trams – Fire safety guidelines for trains, trams and track guided vehicles – General principles;

– **UNI CEI 11170-2:2005** Trains and trams – Fire safety guidelines for trains, trams and track guided vehicles – Design recommendations – Fire containment measures – Indication, monitoring and evacuation systems;

– **UNI CEI 11170-3:2005** Trains and trams – Fire safety guidelines for trains, trams and track guided vehicles – Material fire behaviour assessment – Acceptance limits;

published jointly by UNI and CEI on 30/11/2005 with parallel effectiveness until 31st March 2016. In these standards, the requirements for materials relating to electrical connectors are contained in the 2nd schedule “Acceptability criteria for electrical and electronic materials and components” at the application “All other applications including flammable materials” (all applications other than electric cables). For these applications, four material tests are required:
– Exposure to a small flame according to EN ISO 11925-2 with, depending on the level of risk, a resistance to fire of the material of 15 s for LR1 and LR2 and a resistance of 30 s for LR3 and LR4.
– Smokiness in compliance with French standard NF F 16-101 with IF better or equal to F2 for all risk levels. The material we use is classified as F1 (better than F2) according to the tests carried out.

– Smoke optical density measurement, in compliance with French standard NF X 10-702 (from NF F 16-101) with values ≤ 100 for all risk levels LR1…4.
– Toxicity measurement, in compliance with Italian standard CEI 20-37/7, with T ≤ 2 for all risk levels LR1…4.

Tests

EU - The material tested in accordance with the European Norm **EN 45545-2**:2013 – showed an oxygen index (OI) of 40,4%, a Ds max (flaming) = 95 and a smoke toxicity index CITNLP = 0,28, **compliant with the requirements of EN 45545-2:2013 for all risk levels: HL1 – HL2 – HL3** and, consequently, for all the design categories (A, D, S, N) and operation categories (1, 2, 3, 4) defined in EN 45545-1:2013.

France - The material used in our connectors is certified by an accredited laboratory CERTIFER, according to the previously mentioned French standards **NF F 16-101** and **NF F 16-102,** and has a **classification F1** (Index Fumee I.F. = 18) and a smoke toxicity index (Index Toxicite Fumee) **I.T.C. = 18.**
Both values meet the requirements set out by the French standards and by the Italian standard UNI CEI 11170-3 schedule 2, which relates to electrical connectors.

Germany - The material used in our connectors also complies with the German standard **DIN 5510-2**:2009 with a **flammability class = S3, smoke spreading class = SR2** and **drip class = ST2**.

UK - The material was also tested according to British Standard **BS 6853**:1999, with an **R (max) index = 0.6**, consequently within the limits of Tables 7 and 8 of the standard for vehicle categories Ia, Ib and II.

USA - Tests compliant with American standards have also been carried out at a qualified North American laboratory, confirming compliance with the requirements set out by the US Federal Transit Administration “Recommended Fire Safety Practices for Rail Transit Material Selection” for methods ASTM E 662 (NFPA 258) (specific optical smoke density), ASTM E 162 (ASTM D3635) (surface flammability⇒ flame propagation index) and Bombardier Transportation SMP 800-C (smoke and gas toxicity).

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