

Fire Testing Requirements for Railway Interiors : Fire Safety Engineering



This edition breaks down how to evaluate a fire testing lab beyond the obvious — focusing on the factors that truly influence safety, performance, and reliability.

FIRE SAFETY
INSIGHTS 2026
RAILWAY &
INFRASTRUCTURE
SPECIAL

TECHNICAL
EDITION

WWW.PROSPECTESTINGLAB.IN

Featured Story

Prospect Test Hub Pvt. Ltd

Your Trusted Fire Testing & Compliance Partner

CAUTION
RISK OF FIRE

CARE@PROSPECTESTINGLAB.IN

+91-9873001516 / 9873737181

WWW.PROSPECTESTINGLAB.IN



WHY RAILWAY FIRE TESTING CANNOT WAIT

A fire inside a train carriage is not an ordinary building fire. Passengers are confined at speed, often deep in tunnels, with evacuation windows measured in minutes. The physics are unforgiving: flashover can occur within two to five minutes of ignition, and smoke laden with hydrogen cyanide incapacitates long before flames become lethal.

This editorial examines the science, standards, and practical realities of fire testing for railway interiors — from the cone calorimeter on the bench to full-scale rail car tests, and from EN 45545 hazard levels to the emerging challenges of battery-electric propulsion.

Prospec Labs brings more than 20 years and professional years of accredited testing experience to precisely this domain.



In this Edition

- 01 The Physics of Rail Fire
- 02 Global Standards Landscape
- 03 EN 45545-2 In Depth
- 04 Test Methods Explained
- 05 Material Strategies & Case Studies
- 06 Future Outlook



KEY INSIGHT
Compliant fire-safe materials can extend safe evacuation time by 3–6 minutes — often the critical margin between life and death in a tunnel scenario.

FIRE SAFETY AT A GLANCE

RISK AND SCALE

The Mission: Zero Tolerance for Untested Materials

Railway fire safety operates on a simple but uncompromising principle: every material installed inside a passenger vehicle must be independently tested and certified before it enters service. This is not because fire is inevitable — rail fire incidents are statistically rare. It is because when fire does occur inside a tunnel or underground station, the margin between a safe evacuation and a catastrophe is measured in minutes.

Prospec Labs operates as an accredited testing laboratory under ISO/IEC 17025, providing EN 45545-2 cone calorimetry, smoke density, toxic gas analysis, and flame spread testing for rail OEMs, tier-1 suppliers, and rolling stock operators across India and globally. Our Certifier-recognised reports are accepted by notified bodies across Europe

2–5
MIN

FLASHOVER TIME

The window before all interior surfaces ignite simultaneously in an untested rail car

3–6
MIN

EVACUATION GAIN

Additional safe egress time delivered by fire-compliant interior materials

26
R-SETS

EN 45545-2
COMPONENTS

Distinct requirement sets covering every interior element from seats to cables

20+
YEARS

YEARS — PROSPEC

Three decades of accredited fire testing experience with 1,000+ tests conducted

WHAT PROSPEC TESTS FOR RAIL

- Heat Release Rate & FIGRA (ISO 5660-1 Cone Calorimeter)
- Smoke Optical Density / VOF4 (ISO 5659-2)
- Toxic Gas Emissions — CITg via FTIR Analysis
- Lateral Flame Spread (ISO 5658-2) for Floor Coverings
- Sub-assembly & cable fire performance testing
- IS 15614 & EN 45545-2 compliance reporting

PRECISION

EN 45545: The Standard That Reengineered Rail Interior Materials

The publication of EN 45545 in 2016 marked a watershed moment for the European railway industry. It replaced a patchwork of national standards — Britain's BS 6853, France's NF F 16-101/102, Germany's DIN 5510 — with a unified, evidence-based framework that treats fire safety holistically across the entire vehicle lifecycle. At its core is EN 45545-2, the document that materials engineers, procurement professionals, and rolling stock designers must understand before specifying a single component. The standard organises its requirements into 26 Requirement Sets (R1 through R26), each mapping to a specific component category: R1 for seats, R4 for floor coverings, R6 for wall panels, R17 for electrical cables. Within each R-set, the standard specifies which test methods apply and sets performance thresholds at three Hazard Levels. HL1 applies to open-air surface routes with rapid emergency response. HL3 — the most stringent tier — governs vehicles operating in tunnels or underground systems, where evacuation may take 30 minutes or more.

"Smoke toxicity is as critical as ignitability. At HL3, CITg limits are halved compared to HL2 — and halogen-free materials are not optional, they are mandatory."

The three parameters that dominate EN 45545-2 compliance decisions are FIGRA (fire growth rate index, W/s), THR600s (total heat released in the first 600 seconds, MJ), and VOF4 (integrated smoke optical density over four minutes). These are derived from modelling of real fire scenarios in tunnel environments, calibrated to protect occupants at specific evacuation time assumptions. Prospec's cone calorimeter laboratory runs tests at 25 kW/m² for surface materials and 50 kW/m² for engineered components, producing full datasets including time-to-ignition, peak HRR, FIGRA, THR600s, VOF4, and CO/CO₂ ratios — everything a notified body requires.

EN 45545-2 · HL2 VS HL3 LIMITS			STANDARDS AT GLANCE	
PARAMETER	HL2	HL3	EN 45545	European Union
FIGRA	≤ 750 W/s	≤ 300 W/s	NFPA 130	United States
THR600s	≤ 15 MJ	≤ 10 MJ	UIC 564	International
VOF4	≤ 300	≤ 150	IS 15614	India
CITg	≤ 1.5	≤ 0.75	GB/T 31247	China
HCN	≤ 100 ppm	≤ 30 ppm	AS 7507	Australia

Values representative; refer to EN 45545-2 Annex C for R-set specifics

ASSEMBLY RULE

Individual material compliance does not guarantee assembly compliance. Fire interactions between components during combustion can produce performance significantly different from the sum of parts. EN 45545-2 mandates testing of the final configuration for seat assemblies and other complex R-sets.

TEST METHODS EXPLAINED

METHOD

The Instruments Behind the Numbers: How Prospec Tests Rail Materials

Fire testing is a hierarchy. At the base sit small-scale bench instruments that characterise individual material properties with precision and repeatability. At the apex sit full-scale rail car tests that validate system-level performance. Prospec's accredited laboratory operates at the critical bench level, delivering the data that feeds every subsequent stage of the compliance process. The Cone Calorimeter (ISO 5660-1) Named for its truncated-cone electrical heater — is the primary workhorse. A 100 mm × 100 mm specimen is exposed to a defined irradiance (25 or 50 kW/m²), and oxygen consumption in the exhaust stream is used to calculate heat release rate in real time. Simultaneously, a photometer measures smoke optical density. A minimum 600-second test produces the complete FIGRA, THR600s, VOF4, and CO/CO₂ dataset required by EN 45545-2. The Smoke Density Chamber (ISO 5659-2) Exposes a 75 mm × 75 mm specimen in a 0.51 m³ sealed chamber. It is particularly revealing for materials that smoulder before flaming — a behaviour that conventional ignition tests can miss but that represents a critical early-fire scenario in real railway incidents. FTIR Toxicity Analysis Couples to the cone calorimeter to provide real-time quantification of CO, HCN, HCl, HF, SO₂, NO_x, and acrolein — the principal N-gas toxicants. From these concentrations, the fractional effective dose (FED) and CITg are calculated. At HL3, CITg must not exceed 0.75 — demanding halogen-free material specification throughout. Lateral Flame Spread Test (ISO 5658-2) For floor coverings (R4), this measures how quickly a flame front travels under a radiant heat flux gradient. EN 45545-2 sets minimum Critical Flux at Extinguishment (CFE) values that become progressively more demanding from HL1 to HL3.

"The King's Cross fire in 1987 showed what conventional bench tests could miss. Today's cone calorimeter methodology was built directly from those lessons — to replicate real fire dynamics, not just a standardised flame."

Material Compliance Strategy

- Inherently FR Polymers
- Halogen-Free Additives
- FR Seat Foam Technology
- Fire-Resistant Textiles



TRUST

PROSPEC — FIRE TESTING TODAY. SAFER TOMORROW

Case Study: Eurostar E320 — Engineering for the World's Toughest Tunnel

The Eurostar e320 (Siemens Velaro) operates through the Channel Tunnel — 50 km of enclosed environment with extremely limited evacuation options. Every interior material was specified to EN 45545 HL3.

Phenolic composite panels line the ceilings and walls. Intumescent coatings protect all steel structural elements. Seat foam incorporates graphite intercalation compounds, and upholstery was specified in inherently FR wool-polyamide blends.

The compliance case — assessed by a notified body and reviewed by the Channel Tunnel Safety Authority prior to service entry — represents the gold standard for how fire testing translates from the bench to the real world. Every material had a cone calorimeter report. Every assembly had been tested as a system. Every data point had been reviewed by an independent authority.

The Emerging Challenge: Battery & Hydrogen Fire Safety

As the railway sector transitions to battery-electric and hydrogen propulsion, fire testing faces new demands. Lithium-ion battery thermal runaway can exceed 800°C and release HF and hydrogen simultaneously. Hydrogen combustion creates high-velocity jet flames and detonation risks absent from conventional traction. EN 45545 is being actively extended to address these hazards — and Prospec is already engaged in developing the test methodologies that will underpin next-generation certification.

Fire safety will remain the non-negotiable baseline. The organisations that develop the deepest expertise now will be best positioned to design the safe railways of the next generation.

WHY TEST IN INDIA WITH PROSPEC?

- Certifier-recognised test reports accepted by European notified bodies — eliminating the cost and delay of overseas testing.
- Faster turnaround than sending specimens to European labs — critical for project timelines in metro and intercity rolling stock.
- 20+ years of accredited fire testing experience and several man-years of domain expertise across rail, defence, and building materials.
- Full EN 45545-2 suite: cone calorimeter, smoke density chamber, FTIR toxicity, lateral flame spread, and sub-assembly testing.
- IS 15614 capability for Indian Railway specification requirements alongside international standards .
- Early technical consultation — Prospec helps clients identify the right test matrix before procurement, avoiding costly reformulation

FUTURE OUTLOOK
Digital material passports and blockchain-based traceability are beginning to transform how compliance is managed across multi-supplier supply chains. CFD fire modelling (FDS/NIST) is increasingly used to validate evacuation strategies — but CFD must be anchored in physical test data. Prospec's reports provide exactly that anchor.

FUTURE OUTLOOK

LOOKING AHEAD

Compliance Is Not a Checkbox. It Is a Lifecycle Commitment.

The standards that govern fire testing for railway interiors — principally EN 45545 in Europe and NFPA 130 in North America — have been built over decades of research and, critically, from the hard lessons of real disasters. The 1987 King's Cross fire, the 1994 Channel Tunnel incident: each one reshaped the testing framework. The materials on trains today are safer because of those tragedies. But compliance is not a point-in-time event. Railway vehicles operate for 25–40 years, often undergoing multiple interior refurbishments. Each refurbishment introduces new materials that must be assessed against standards which may have evolved since the vehicle was first certified. Managing this across a complex, multi-supplier supply chain — without robust material traceability and re-qualification processes — creates exactly the kind of compliance gaps that fire incidents exploit. At Prospec, we work with rail OEMs, tier-1 suppliers, and procurement teams from the earliest specification stage. We help clients identify the right test matrix before materials are committed to purchase. We issue Certifier-recognised reports that are accepted by European notified bodies. And we bring 30+ years of accredited testing expertise to every project. The engineers and organisations that develop the deepest fire safety expertise today will be best positioned to design the safe, sustainable railways of the next generation. The standard is high. The stakes are higher.

Partner with Prospec Labs to ensure your materials don't just pass tests — they perform when it matters most.