Fire Classifications and Fire Test Methods for the European Railway Industry

(EN 45545-2; EN 17084; EN 16989)

firetesting technology

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European Regulations such as the Construction Products Regulations have led European regulators and industries to utilise harmonised testing methods and classification system for assessing the products used in the construction of buildings. The European Rail Industry is similarly developing harmonised procedures particularly to facilitate interoperability of railway rolling stock. Growth in European crossborder rail movements has further emphasized the need for European harmonisation both of these test methods and classification systems for the materials are used in vehicles.

The European Commission mandated CEN (CEN/TC 256/WG 1) to identify and standardise the fire test methods for use in the classification of products and materials employed in railway carriages throughout Europe. In 2013, CEN/TC 256 and CENELEC/TC 9X published a 7-part standard EN 45545, "Fire Protection on Railway Vehicles" which includes:

- Part 1: General
- Part 2: Requirements for fire behaviour of materials and components
- Part 3: Fire resistance requirements for fire barriers
- Part 4: Fire safety requirements for railway rolling stock design
- Part 5: Fire safety requirements for electrical equipment including that of trolley buses, track guided buses and magnetic levitation vehicles
- Part 6: Fire control and management systems
- Part 7: Fire safety requirements for flammable liquid and flammable gas installations

Part 2 describes the reaction to fire test methods, test conditions and reaction to fire performance required for classification of structural products including flooring, seats, cables and non-listed items.

This standard specifies that:

- Railway vehicles are classified in accordance with the fire hazard level associated with their design and operation.
- Three hazard levels HL 1 to HL 3 are defined, HL 1 being the lowest requirement and HL 3 being the highest.
- The test methods used depend on the product under investigation.

The performance of all the products is determined with respect to ignitability, flame spread and the amounts of heat, smoke and toxic fumes produced. These reaction to fire tests aim to qualify and classify the products according to their final applications which are separated into groups, including: structural products, seats, cables and nonlisted items. Each of these product groups are required to meet a specific set of performance requirement levels (listed R1 to R26). Each requirement has a corresponding series of test performance criteria imposed for each fire risk levels HL 1 to HL 3.

TEST GROUP	TEST PARAMETER	STANDARD/TEST METHOD	FTT INSTRUMENT
STRUCTURAL PRODUCTS (including flooring)	Flame spread ISO 5658-2	Lateral spread on building products in vertical configuration	Lateral Flame Spread Test
	Heat release ISO 5660-1	Heat release, smoke production and mass loss rate – Part 1: Heat release rate	Cone Calorimeter
	Flame spread of EN ISO 9239-1 floorings	Horizontal surface spread of flame for floor coverings	Flooring Radiant Panel
	Smoke production ISO 5659-2 and toxicity	Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test	NBS Smoke Density Chamber with FTIR
	Ignitability and EN ISO 11925-2 flaming droplets	Ignitability of building products subjected to direct impingement of flame	Single Flame Source Test
SEATS	Heat release ISO 9705	Full-scale room test for surface products	Furniture Calorimeter
	Heat release ISO 5660-1	Heat release, smoke production and mass loss rate – Part 1: Heat release rate	Cone Calorimeter
	Smoke production ISO 5659-2	Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test	NBS Smoke Density Chamber with FTIR
CABLES	Flame spread of EN 60332-1-2 electric cables	Tests on electric and optical fibre cables under fire conditions –single insulated wire or cable, 1 kW pre-mixed flame	EN 60332-1-2 Vertical Flame Propagation Test for a Single Cable
	Flame spread of EN 60332-3-24 electric cables	Common test methods for cables under fire conditions – Test for vertical flame spread of vertically-mounted bunched wires or cables (for d ≥ 12 mm)	EN 60332-3 Vertical Flame Propagation Test for Bunched Cables
	Flame spread of EN 50305 electric cable	Railway applications – Railway rolling stock cables having special fire performance (for d ≤ 6 mm)	EN 60332-3 Vertical Flame Propagation Tests for Bunched Cables
	Smoke production EN 61034-2	Measurement of smoke density of cables burning under defined conditions – Part 2: Test procedure and requirements	3M Cube Smoke Density Test
NON-LISTED ITEMS	Oxygen index ISO 4589-2	Plastics – Determination of burning behaviour by oxygen index – Part 2: Ambient temperature test	Oxygen Index
	Heat release ISO 5660-1	Heat release, smoke production and mass loss rate – Part 1: Heat release rate	Cone Calorimeter
	Flame spread ISO 5658-2	Lateral spread on building products in vertical configuration	Lateral Flame Spread Test
	Smoke production ISO 5659-2	Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test	NBS Smoke Density Chamber
	Toxicity NF X 70-100	Fire behaviour test Analysis of pyrolysis and combustion pipe still method	Toxicity Test

Heat release

Heat Release Rate is the key measurement required to assess the fire hazard of products and materials, as it quantifies fire size, rate of fire growth and consequently the release of associated smoke and toxic gases. It is measured using a technique called oxygen consumption calorimetry.

A new Rate of Heat Emission parameter has been introduced in EN 45545-2.

This parameter is known as MARHE or Maximum Average Rate of Heat Emission. The heat release rate is determined using the oxygen consumption technique from which an Average Rate of Heat Emission (ARHE) is calculated. The maximum ARHE over the testing period is MARHE. The MARHE parameter was selected because it is not greatly affected by normal experimental variation or measurement noise. It has also proved to be a fairly robust measure of the propensity for fire development under real scale conditions.

ISO 5660-1 Cone Calorimeter

Heat Release Rate is determined with the Cone Calorimeter according to ISO 5660-1. Thresholds concerning the potential heat release for almost all combustible materials and products used in the railway industry are required by EN 45545-2.

These requirements depend on the end use of the product and the Hazard Level of the carriage.

The Cone Calorimeter is the most significant bench scale instrument in the field of fire testing because it measures important real fire properties of the material being tested, under a variety of preset conditions. These measurements can be used directly by researchers or can be used as data for input into correlation or mathematical models used to predict fire development.

The **FTT** Dual Cone Calorimeter has been the benchmark in this field for its ease of use, robustness, sophisticated software that guides users through the calibration, testing and report protocols.

Building on this expertise **FTT** has developed a new generation of the Cone Calorimeter called ***i***Cone that utilise state-of-the-art technology to improve the efficiency and accuracy of the fire test process.

The ***i***Cone is an automatic and interactive system. Not only does it possess all the advantages of a conventional Cone Calorimeter, it also features an interactive and intuitive interface, flexible control options, and built-in data acquisition technology and reporting with the user-friendly ConeCalc software. It has been designed using **FTT**'s decades of experience in calorimetry and

Figure 1: FTT ISO 5660-1 *i*Cone^{2+} Calorimeter

Table 1: Requirements concerning Heat Release (MARHE)

Requirement set	Heat flux	Test parameter and unit	Maximum threshold		
			HL1	HL2	HL3
R5, R20	25kW/m²	MARHE [kW/m²]	50	50	50
R9			90	90	60
R8			–	50	50
R10			–	–	–
R19, R21			75	50	50
R1, R7	50kW/m²		–	90	60
R6, R11			90	90	60
R12			60	60	60
R17			–	90	60
R2			–	–	90

incorporates many new features, not seen by fire testing laboratories up until now. It is perceived as the new benchmark in calorimetry.

Directly measured properties include:

- Rate of Heat Release
- Time to Ignition
- Critical Ignition Flux
- Mass Loss Rates
- Smoke Release Rates
- Effective Heat of Combustion
- Rates of Toxic Gas Release (e.g. carbon oxides) According to EN 45545-2, the electrical heater within the Cone Calorimeter must impose two different irradiance levels: 25kW/m² and 50kW/m².

ISO 9705-2 Furniture Calorimeter Vandalised Seat

According to EN 45545-2, the burning behaviour of passenger seats should be tested on the complete seat, including upholstery, head rest, seat shell and arm rest. In addition, the seat shell and any vertical faces of the arm rests should also be tested in relation to fire integrity.

In order to determine MARHE, a complete seat assembly should be tested using the ISO 9705-2 as a furniture calorimeter.

FTT builds and supplies the ISO 9705-2, complete with the appropriate instrumentation package or supply instrumentation to clients wishing to upgrade existing facilities or with a wish to build their own apparatus. In the latter cases we supply a Gas Analysis Console and an Instrumented Duct Insert section. The console is housed in a 19" instrument rack and it contains all the necessary instrumentation to measure Heat Release Rates and other associated parameters.

The Gas Analysis Console contains:

- A Paramagnetic Oxygen Analyser supplied with temperature and pressure compensation for primary heat release measurement.

Figure 2: FTT ISO 9705-2 Large Scale Calorimeter with Weight Measurement (Room chamber on left not included in standard configuration)

Courtesy from the Shanghai Fire Research Institute

Figure 3: 19" Gas Analysis Rack

Figure 4: Instrumented Duct Insert

Figure 5: DIN 50055 White Light System Controller

- An Infrared Carbon Dioxide Analyser for use in heat release measurement.
- A Dual Stage Soot Filter, Refrigerant Cold Trap, Drying Column, Pump and Waste Regulators for conditioning the sample gases prior to analysis.
- Controls for the smoke measurement system.
- Data logger.

The specification of this instrumentation is the same for both large and small scale calorimeters and can therefore also be conveniently used with the **FTT** Dual Cone Calorimeter.

The duct section houses all the sampling, temperature and mass flow probes required for gas sampling and air velocity measurement along with smoke measurement equipment (white light or laser). Most dynamic fire testing apparatuses can be instrumented with this equipment to measure heat released and smoke produced from products burnt in them.

Table 2: Requirements concerning Passenger Seats

Requirement set	Test method	Test parameter and unit	Maximum threshold		
			HL1	HL2	HL3
R18*	ISO 9705-2	MARHE [kW]	75	50	20
		HRR Peak [kW]	350	350	350
R21	ISO 5660-1: 25kW/m²	MARHE [kW/m²]	75	50	50
	ISO 5659-2: 25kW/m²	D_s max	300	250	200
		CIT_G	1.2	0.9	0.75
R19	ISO 5660-1: 25kW/m²	MARHE [kW/m²]	75	50	50
R6	ISO 5660-1: 50kW/m²	MARHE [kW/m²]	90	90	60
	ISO 5659-2: 50kW/m²	$D_s(4)$	600	300	150
		VOF_4 [min]	1200	600	300
		CIT_G	1.2	0.9	0.75

* : – during the test, the flame spread shall not reach the edges of the seat surface or the backrest;
– during the test, the flame height above the highest point of the seat surface shall not exceed 1,000mm;
– if the peak heat release values are too high for test equipment safety then the product is not compliant.

Table 3: Requirements concerning Flame Spread for ISO 5658-2 test

Requirement set	Test parameter and unit	Maximum threshold		
		HL1	HL2	HL3
R1, R7	ISO 5658-2: Critical Heat Flux at Extinguishment	20*	20*	20*
R2, R3, R17		13*	13*	13*
R4		13*	13*	13*
R11		30*	30*	30*
R12		40*	40*	40*

* If droplets/particles that exhibit sustained flaming are reported during the test ISO 5658-2,or for the special case of materials which do not ignite in ISO 5658-2 and are additionally reported as unclassifiable, the following requirements shall be added:
Test to the requirements of EN ISO 11925-2 with 30 s flame application.
The acceptance requirements are:
– flame spread < 150 mm within 60 s;
– no burning droplets/particles.

The requirement sets in relation to passenger seats are:

- R6: Passenger seat shell – Base and Back
- R18: Complete passenger seats
- R19: Seats in staff areas
- R21: Upholstery for passenger seats and head rest

ISO 5658-2 Lateral Flame Spread Apparatus

Flame spread of structural products including floorings and insullation materials is determined according to ISO 5658-2.

The requirements specified in EN 45545-2 depend on the end use of the product and the Hazard Level of the carriage.

The Lateral Flame Spread Apparatus measures the lateral spread of flame on vertically oriented specimens using a rectangular radiant panel and an additional gas burner flame as the ignition source.

It provides data suitable for comparing the performance of essentially flat materials, composites or assemblies, which are primarily used as the exposed surfaces of walls.

Following ignition, any flame front which develops is noted, and the progression of the flame front horizontally along the length of the specimen in terms of the time it takes to travel various distances is recorded.

The results are expressed in terms of the flame spread distance/time history, the flame front velocity versus heat flux, thecritical heat flux at extinguishment and the average heat for sustained burning.

Figure 6: FTT ISO 5658-2 Lateral Flame Spread Apparatus

Single Flame Source Test Apparatus

Flame spread of light diffusers and air filters are determined according to EN ISO 11925-2.

This test is also required as part of the European construction products regulation for assessing and qualifying reaction to fire performance of all types of construction products to classes B, C, D and E.

EN ISO 11925-2 is based on the Kleinbrenner method for determining ignitability of materials in the vertical orientation by direct small flame impingement under zero impressed irradiance. It is supplied as a complete easy-to-use system incorporating safety features. The combustion chamber is made from corrosion resistant stainless steel, to maximise operating life. It has large front and side doors which are glazed with toughened glass for full view of the specimen during a test and easy access.

Figure 7: FTT EN ISO 11925-2 Single Flame Source Test Apparatus

Table 4: Requirements concerning Flame Spread for EN ISO 11925-2 test

Requirement set	Test parameter and unit	Maximum threshold		
		HL1	HL2	HL3
R4	Flame spread [mm]	150 (within 60 s)		
	Flaming droplets	0		
R5	Flame spread [mm]	150 (within 60 s)		

EN ISO 9239-1 Flooring Radiant Panel

The burning behaviour of floorings, including any substrates if used, is tested according to EN ISO 9239-1 in a closed chamber using a radiant panel heat source.

The **FTT** Flooring Radiant Panel (FRP) evaluates the critical radiant flux below which flames no longer spread over a horizontal surface.

This test method is used to measure the critical radiant flux of floor covering systems exposed to a flaming ignition source in a graded radiant heat environment, within a test chamber.

A smoke measuring system according to DIN 50055 is mounted on a separate frame at the exhaust stack. It can also be used to measure this same critical radiant flux for exposed attic floor cellulose insulation.

The **FTT** Flooring Radiant Panel can also comply with ASTM E648, ASTM E970, NFPA 253 and DIN 4102 Part 14.

The Critical Heat Flux at extinguishment value (CHF-value) is the incident heat flux at the specimen surface, at the point where the flame ceases to advance and may subsequently go out. For classification purposes, the CHF-values in kW/m^2 for each Hazard Level, are shown in Table 5.

Figure 8:
FTT EN ISO 9239-1
Flooring Radiant Panel

Table 5: Requirements concerning Flame Spread for EN ISO 9239-1 test

Requirement set	Test parameter and unit	Minimum threshold		
		HL1	HL2	HL3
R8, R10	CHF [kW/m^2]	4.5	6	8

EN 60332-1-2 and EN 60332-3-24 Vertical Flame Propagation Test Apparatuses

According to EN 45545-2, the fire behaviour and the flame impingement duration of cables should be tested and evaluated in respect to the diameter of the cables in question.

In addition, these cables are separated into two groups:

I. Cables for Interior (Requirement category R15)
II. Cables for Exterior (Requirement category R16)

Figure 9: FTT EN 60332-1 Flame Propagation Test for a Single Wire or Cable

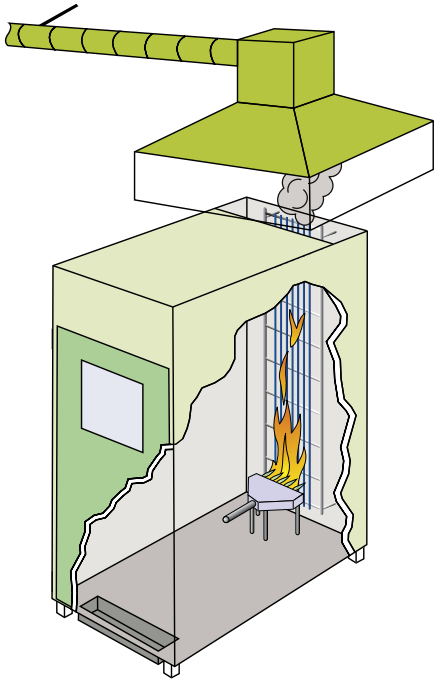

Figure 10: FTT EN 60332-3 Vertical Flame Propagation Test for vertically mounted bunched cables

Table 6: Flame Impingement related to the Outer Cable Diameter

Outer diameter D of specimen (mm)	Flame impingement(s)
D ≤ 25	60
25 < D ≤ 50	120
50 < D ≤ 75	240
D > 75	480

Table 7: Requirements concerning Electric Cables

Requirement set	Test method	Test parameter	Minimum threshold		
			HL1	HL2	HL3
R15, R16	EN 60332-1-2	Unburned length [mm]	Burned part ≤ 540 and unburned part > 50		
	EN 60332-3-24 (for d ≥ 12mm)	Flame propagation [m]	2.5		
	EN 60332-3-24 (for 6mm < d < 12mm)		2.5		
	EN 60332-3-24 (for d ≤ 6mm)		1.5		

Smoke production and toxicity

There are two test methods detailed in EN 45545-2 that can be used for determining the toxic composition of gases and fumes generated by the combustion of specified railway products. These two methods, EN ISO 5659-2 and NF X 70-100-1 are described as follows:

EN ISO 5659-2 Smoke Density Chamber with FTIR Toxicity Test Apparatus

This method consists of a smoke density chamber as described in EN ISO 5659-2 and an FTIR toxicity test and sampling system. The two instruments dedicated respectively to the analysis of the opacity of the smoke and to the qualitative and quantitative analysis of gases emitted during the test, are capable of operating simultaneously as well as independently using two specific procedures for the acquisition of FTIR spectra and smoke opacity.

The NBS Smoke Density Chamber (SDC) has been established for many years and is used widely in all industrial sectors for the determination of smoke generated by solid materials and assemblies mounted in the vertical position with a closed chamber. It measures the specific optical density of

Figure 11: FTT Smoke Density Chamber

smoke generated by materials, when an essentially flat specimen, approximately 25mm thick, is exposed vertically to a heat source of 25kW/m^2, in a closed chamber, with or without the use of a pilot flame. The **FTT** smoke density chamber has been designed specifically to incorporate the ISO 5659 Conical Radiant Furnace. This extends the potential of the SDC by allowing testing at heat fluxes up to 50kW/m^2, horizontal orientation of the specimen and the measurement of mass loss rate of the specimen.

Features of the **FTT** NBS Smoke Density Chamber include:

- Test chamber with full width opening door, allowing easy access for sample loading and chamber cleaning.
- Photomultiplier control unit with all manual controls and digital display of optical density and relative intensity. Computer setting for use with **FTT** software to perform automatic control of the test procedure on the SDC.
- Controls are mounted beside chamber for convenient operation. They are not obstructed when the door is open.
- Smoke density and temperature are on digital displays, for easier use and greater accuracy.
- Chamber walls are preheated for easier start-up and convenient equipment operation.
- Safety blowout panel, easily replaceable, allows for safe operation of test method.
- Gas measurement ports are provided, for optional measurements of toxic gases.
- Cabinet designed with a standard 19" rack, for simple addition of gas analysers, chart recorder and other control units.
- Air cooled radiometer for furnace flux calibration.

The **FTT** SDC is supplied with a software package called SmokeBox, which is designed as a data acquisition and presentation package allowing either manual or automatic control. This enables a more efficient use of the instrument, leading to larger daily throughput of testing and enhanced quality graphical data presentation.

'SmokeBox' is a Microsoft Windows based package which collects test data and assists with all calibration routines.

According to EN 45545-2, the optical density of flat products, i.e. interior walls, floor coverings, seat backs and seat coverings should be determined using the closed chamber according to EN ISO 5659-2.

The smoke opacity during the combustion of the material is determined measuring the attenuation of a white light beam by the effluents.

The obscuration produced from the smoke is measured as a fraction of the light intensity reaching the photometric detector in the presence of smoke to the value corresponding to the luminous transmission in the absence of smoke before the start of the test.

Two different levels of irradiance have been standardised, depending on the application of the product:

- 50kW/m^2 with no additional gas ignition source.
- 25kW/m^2 with an additional gas ignition source.

The exposure conditions of the test specimen in the smoke chamber are radiant heat with or without application of a pilot flame. For large area products such as walls and ceilings, the test specimens shall be exposed to radiant heat flux conditions that simulate a developed stage of a fire; that is a heat flux of 50 kW/m^2 without a pilot flame.

For floor coverings that generally receive lower levels of radiant heat during a fire, the test specimens shall be exposed to a radiant heat flux of 25 kW/m^2 with a pilot flame.

The optical density of the smoke produced is measured continuously by an optical system. Toxic effluents are analysed using FTIR Spectroscopy. For assessment of toxic gases from railway products the Conventional Index of Toxicity (CIT) is used which is always calculated from test data and is dimensionless. The analysis of the spectrum collected during the test determines the concentration of gases.

According to EN 45545-2 the analysis is carried out using the equipment and the procedures for testing and calibration described in ISO 19702.

Table 8: Reference concentrations of the gas components according to ISO 19702

Gas component	Reference concentration (mg/m³)
CO_2	72,000
CO	1,380
HBr	99
HCl	75
HCN	55
HF	25
NO_x	38
SO_2	262

The 8 gas components need to be analysed and their reference concentrations (see Table 8).

FTT FTIR is a modular construction that typically comprises of a FTIR gas analyser, heated sampling unit and an industrial PC which are mounted in a 19" cabin. The FTIR gas analyser is an integral part of the system which allows simultaneous measurement of multiple gas compounds. Typically concentrations of H_2O, CO_2, CO, SO_2, NO, NO_2, HCl, HF, HBr, HCN, NH_3, etc. are continuously measured. The FTIR gas analyser has a multi-pass sample cell which is heated to 180°C and features gold plated mirrors with protective MgF_2 coating which ensures high performance even in high water vapour concentrations or corrosive gases.

NF X 70-100 Toxicity Test Apparatus

This method is based on the exposure of 1 g of test specimen. The test apparatus and conditions for this method are described in NF X 70-100-2 with additional gas analysis information provided in EN 45545-2.

The exposure conditions of the test specimen in the tube furnace are generally set at 600°C, a fixed ventilation condition which represents a developing fire condition for railway products.

When the CIT for a product on a railway vehicle is required, only one method is used for the testing, gas analysis and calculation of CIT. The method to be used is shown in Table 9.

The test conditions specified for use when performing EN ISO 5659-2 or NF X 70-100-2 depend upon the application and position of the

Figure 12: FTT NF X 70-100-2 / EN 50267-2-3 Toxicity Test

Table 9: Test method to be used for determination of Conventional Index of Toxicity (CIT)

Product	EN ISO 5659-2 Smoke Chamber with FTIR	NF X 70-100-2
Products with large areas or significant surface areas; e.g. interior walls, floor coverings, seat backs and coverings	Yes	No
Nonlisted products; e.g. minor mechanical components	No	Yes

product on the railway vehicle. The conditions selected are representative of fires that may impact on the railway product, during either the developing stages or the developed stage of a fire inside or outside the railway vehicle.

EN 61034 3 Metre Cube Smoke Test Apparatus

The 3 Metre Cube is used for measuring smoke emission when electric cables are burned under defined conditions, for example, a few cables burned horizontally. These units are produced to meet the specification used in many electric cable tests. The unit can be supplied in a self-assembly kit form or can be fully installed by FTT Engineers.

The equipment comprises of:

- A 3 metre cubic chamber assembly
- Photometric system, stands, fans and sample mounting frames
- Extraction fan and ducting
- Chart recorder or Windows based operation software.

Figure 13: FTT EN 61034 3M Cube Smoke Test Apparatus

Table 10: Requirements concerning Smoke Optical Density and Toxicity of Listed Products

Requirement set	Test method reference	Test parameter and unit	Maximum threshold		
			HL1	HL2	HL3
R1, R2, R6, R11, R12	EN ISO 5659-2: 50kW/m²	$D_S(4)$	600	300	150
		VOF_4 [min]	1200	600	300
		CIT_G	1.2	0.9	0.75
R3	EN ISO 5659-2: 50kW/m²	$D_S(4)$	–	480	
		VOF_4 [min]	–	960	480
		CIT_G	1.2	0.9	0.75
R4	EN ISO 5659-2:50kW/m²	CIT_G	1.2	0.9	0.75
R5	EN ISO 5659-2: 25kW/m²	D_S max	300	250	200
		CIT_G	1.2	0.9	0.75
R7	EN ISO 5659-2: 50kW/m²	D_S max	–	600	300
		CIT_G	–	1.8	1.5
R8, R9	EN ISO 5659-2: 25kW/m2	D_S max	–	600	300
		CIT_G	–	1.8	1.5
R10	EN ISO 5659-2:25kW/m²	D_S max	600	300	150
		CIT_G	1.2	0.9	0.75
R17	EN ISO 5659-2: 50kW/m²	D_S max	–	600	300
		CIT_G	–	1.8	1.5
R20	EN ISO 5659-2: 25kW/m²	D_S max	200	200	200
		CIT_G	0.75	0.75	0.75
R21	EN ISO 5659-2: 25kW/m²	D_S max	300	300	200
		CIT_G	1.2	0.9	0.75
R22	EN ISO 5659-2: 25kW/m²	D_S max	600	300	150
	NF X 70-100-1 and 2 600°C	CIT_{NLP}	1.2	0.9	0.75
R23	EN ISO 5659-2: 25kW/m²	DS max	–	600	300
	NF X 70-100-1 and 2 600°C	CIT_{NLP}	–	1.8	1.5

Table 11: Requirements concerning Smoke Production of Electric Cables for EN 61034-2 test

Requirement set	Test parameter	Minimum threshold		
		HL1	HL2	HL3
R15	Transmission %	25	50	70
R16		–	25	50

EN ISO 4589-2 Oxygen Index Test

The Oxygen Index test is specified in EN 45545-2 for testing ignitability of listed and non-listed plastic products, e.g. internal and external seals, isolators, and PCBs. It is also one of the most economical and precise quality control tests for combustible materials. Its ease of use together with high levels of precision has made this technique a primary characterising quality control tool to the plastic and electric cable industries and it has been specified by several military and transport groups.

The technique measures the minimum percentage of oxygen in the test atmosphere that is required to marginally support combustion.

The **FTT** Oxygen Index (OI) and Temperature Oxygen Index (TOI) offer many improvements such as the latest oxygen analyser technology for high accuracy, reliability and long operating life.

Figure 14: FTT Oxygen Index Test

Table 12: Requirements concerning Oxygen Index test

Requirement set	Test parameter	Minimum Threshold		
		HL1	HL2	HL3
R22	Oxygen Index %	28	28	32
R23				
R24				

Figure 15: FTT Vertical Flame Test Apparatus

EN 60695-11-10 Vertical Flame Test

The EN 45545-2 specifies the EN 60695-11-10 for testing small electro-technical products, e.g. lower power circuit breakers, overload relays, contactors, etc.

The **FTT** EN 60695-11-10 Vertical Flame Test Apparatus features digital test duration timers, high precision gas control system and a bench mounted draft free stainless steel combustion chamber having a large inside volume.

The chamber is fitted with an interior light and exhaust fan to enable simple evacuation of combustion products from the tests. The apparatus can also comply with UL 94 and several FAR Bunsen burner tests with addition of the dedicated accessories.

Table 13: Requirements concerning Vertical Flame Test

Requirement set	Test parameter	Minimum Threshold		
		HL1	HL2	HL3
R26	Vertical small flame test	V0		

EN ISO 1182 Non-combustibility Test

The EN ISO 1182 Non-Combustibility Test and EN ISO 1716 Bomb Calorimeter are specified in the EN 13501-1 to classify A1 and A2 class construction products.

Brake resistors used in rolling stock, e.g. casing and any heat shields, are tested to this Euroclass criteria. The EN ISO 1182 test identifies products that will not, or significantly not, contribute to a fire, regardless of their end use. The **FTT** system has been designed with significant new features.

Rather than the traditional variac control, where it is possible to supply too high a current to the heater element during the heating cycle, **FTT** has automated the process by using modern electronics which considerably extend the life of the furnace.

Figure 16: EN ISO 1182 Non-combustibility Test

EN 45545-2

Although EN 45545-2 is published and operable in April 2013, CEN/TC 256 WG 1 is still working to improve the test methods used for both seating and toxic gas measurement.

Please contact us for the latest changes and development of this standard..

Summary of referenced test methods available from FTT:

EN 45545-2 TEST METHOD REF.	STANDARD	SHORT DESCRIPTION	REQUIREMENT SET	FTT INSTRUMENT
T01	EN ISO 4589-2	Determination of burning behaviour by oxygen index – Part 2: Ambient temperature test	R22, R23, R24	EN ISO 4589-2 Oxygen Index Test
T02	ISO 5658-2	Lateral flame spread	R1, R2, R3, R4, R7, R11, R12, R17	ISO 5658-2 Lateral Flame Spread Apparatus
T03	ISO 5660-1	Reaction-to-fire tests – Heat release, smoke production and mass loss rate – Part 1: Heat release rate (cone calorimeter method)	R1, R2, R3, R5, R6, R7, R8, R9, R10, R11, R12, R17, R19, R20, R21	iCone Calorimeter, Dual Cone Calorimeter
T04	EN ISO 9239-1	Radiant panel test for horizontal flame spread of floorings	R8, R10	EN ISO 9239-1 Flooring Radiant Panel
T05	EN ISO 11925-2	Ignition when subjected to direct impingement of flame	R4, R5	EN ISO 11925-2 Single-Flame Source Test Apparatus
T06	ISO 9705-2	Furniture calorimeter vandalised seat	R18	ISO 9705-2 Large Scale Calorimeter
T09.01	EN 60332-1-2	Tests on electric and optical fibre cables under fire conditions – Part 12: Test for vertical flame propagation for a single insulated wire or cable – Procedure for 1 kW premixed	R15, R16	EN 60332-1 Vertical Flame Propagation Test for flame a Single Cable
T09.02	EN 60332-3-24	Common test methods for cables under fire conditions – Test for vertical flame spread of vertically-mounted bunched wires or cables– Part 24: Procedures – Category C	R15, R16	EN 60332-3 Vertical Flame Propagation Test for Bunched Cables
T09.03-04	EN 50305:2002 Clause 9.1	Railway applications – Railways rolling stock cables having special fire performance – Test methods	R15, R16	EN 60332-3 Vertical Flame Propagation Test for Bunched Cables
T10	EN ISO 5659-2	Plastics – Smoke generation – Part 2: Determination of optical density by a single-chamber test	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R17, R20, R21, R22, R23	NBS Smoke Density Chamber
T11	EN 45545-2:2013 Annex C	Gas analysis in the smoke chamber EN ISO 5659-2, using FTIR technique	R1, R2, R3, R4, R5, R6, R7, R8, R9, R10, R11, R12, R17, R20, R21	NBS Smoke Density Chamber with FTIR Gas Analyser
T12	NF X 70-100-1 NF X 70-100-2	Gas analysis for the 8 gases described on 3.1.5	R22, R23	EN 50267-1 Cable Toxicity Test Apparatus
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