

How to test and certificate for the fire safety of products on European railway vehicles

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Objectives of European Rail Directives, TSIs and ENs

1. European harmonization -----> Interoperability across national borders
2. Need to consider wide variation of vehicle types, design and operating conditions to define fire risks on railway vehicles
3. Railway vehicles are generally considered to be track guided public passenger land transport vehicles, including
 - Multiple unit trains
 - Underground vehicles
 - Trams
 - Magnetic levitation vehicles

Operation categories of railway vehicles and fire risks

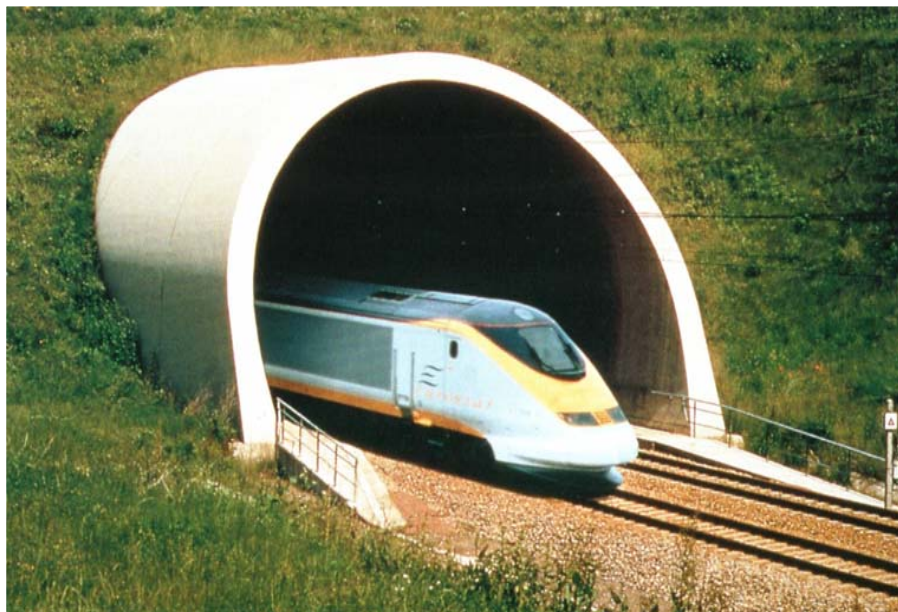
- Surface vehicles which may be stopped with minimum delay and allow immediate side evacuation to a place of ultimate safety -----> OC1
- Vehicles that can run on underground sections, tunnels and/or elevated structures : -
 - Side evacuation and where place of ultimate safety is reachable within 4 minutes -----> OC2
 - Side evacuation and where place of ultimate safety is reachable within 15 minutes -----> OC3
 - No side evacuation but a place of ultimate safety is reachable within 4 minutes -----> OC4

Underground Trains - OC4 Highest risk



Safety in Rail Tunnels

SRT TSI



Design categories of railway vehicle pose additional fire risk considerations

- A** Automatic train
- D** Double deck vehicle
- S** Sleeping and couchette vehicle
- N** All other vehicles (standard)

Development of CEN/TS 45545 by CEN/TC 256 and CENELEC/TC 9X Joint Working Group

- Part 1 General
- Part 2 Reaction to fire requirements (all products)
- Part 3 Fire resistance requirements (fire barriers)
- Part 4 Design requirements
- Part 5 Requirements for electrical equipment
- Part 6 Active fire control systems
- Part 7 Requirements for flammable liquid and gas installations

Mainline Trains – HS TSI



CEN/TS 45545 part 2 reaction to fire requirements will apply to a wide range of listed products on railway vehicles



CEN/ TS 45545 Part 2

Reaction to fire requirements



- Fire parameters specified include: -
- Ignitability
- Spread of flame
- Rate of heat release
- Smoke density
- Toxic gas emission

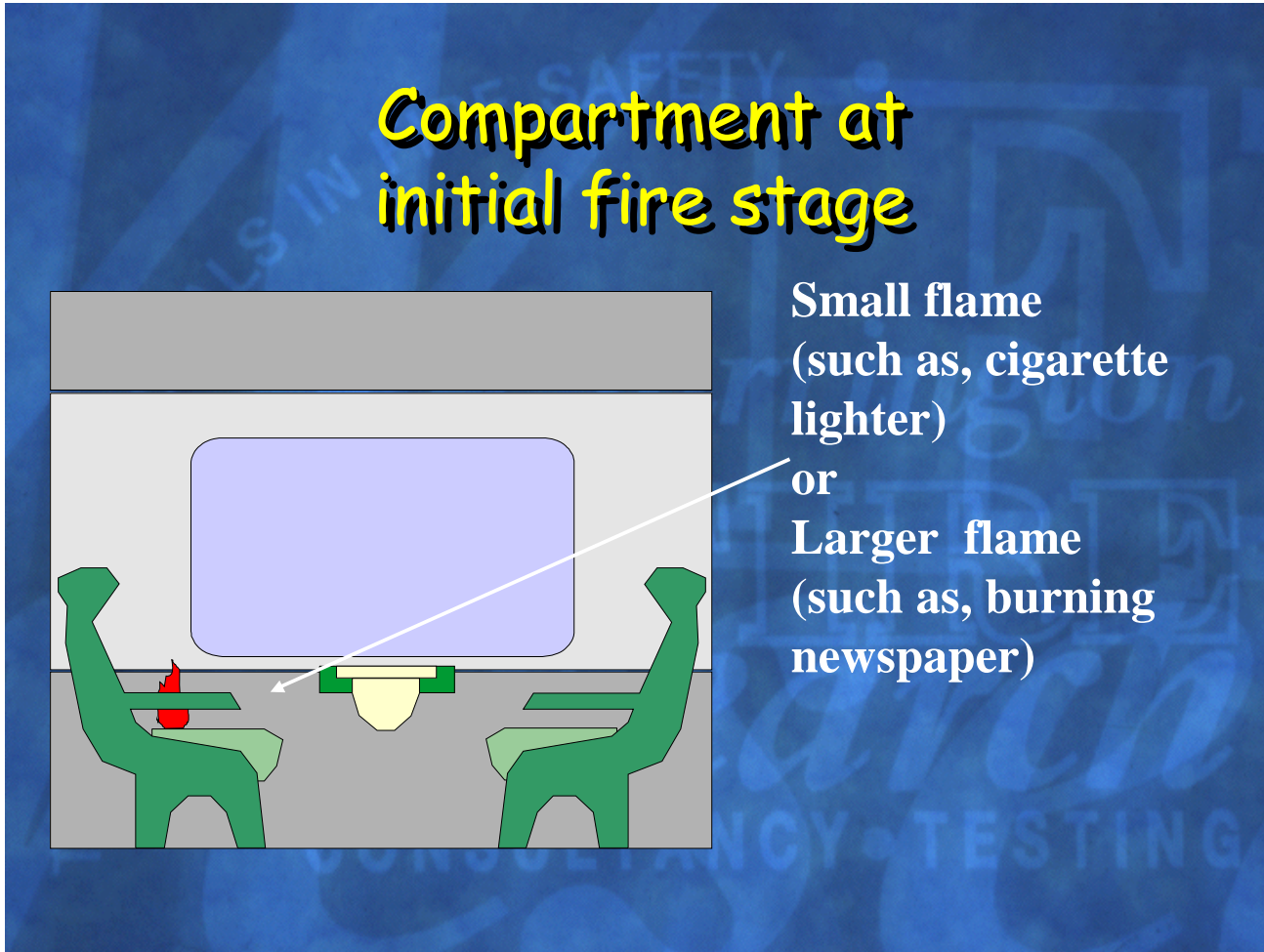
Prenormative Research for CEN/ TS 45545 Part 2

- European Commission FIRESTARR project (1995 to 2000)
- Determined realistic reaction to fire tests and performance criteria for all products on European railway vehicles
- Tested 80 products (structural, furniture and electrical) to standard small-scale fire tests
- Also performed large-scale tests on 30 wall and ceiling linings, seats and bedding, and electrotechnical products

Fire Scenarios studied in FIRESTARR project

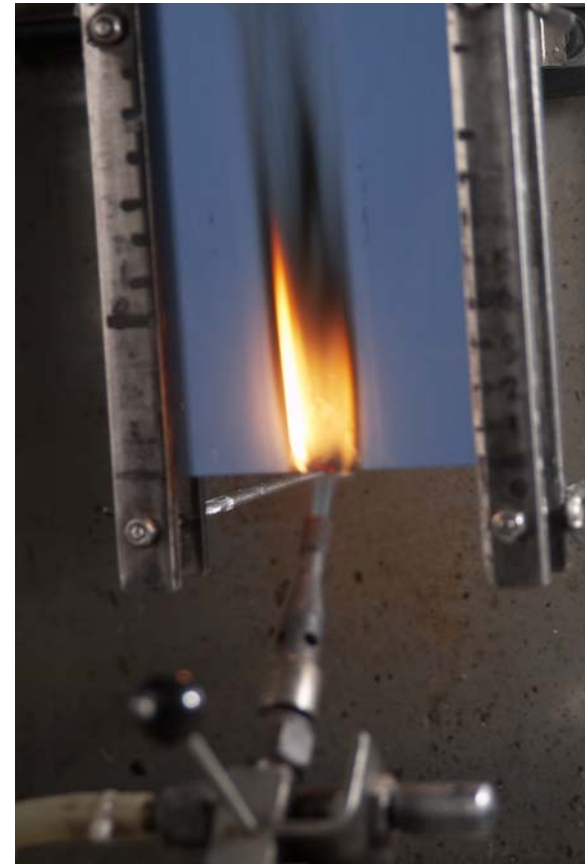
- Statistical evaluation showed arson and technical faults were main causes of fires on European trains
- Two key fire scenarios studied: -
 1. Vandalized seats
 2. Technical cabinets

Compartment at initial fire stage

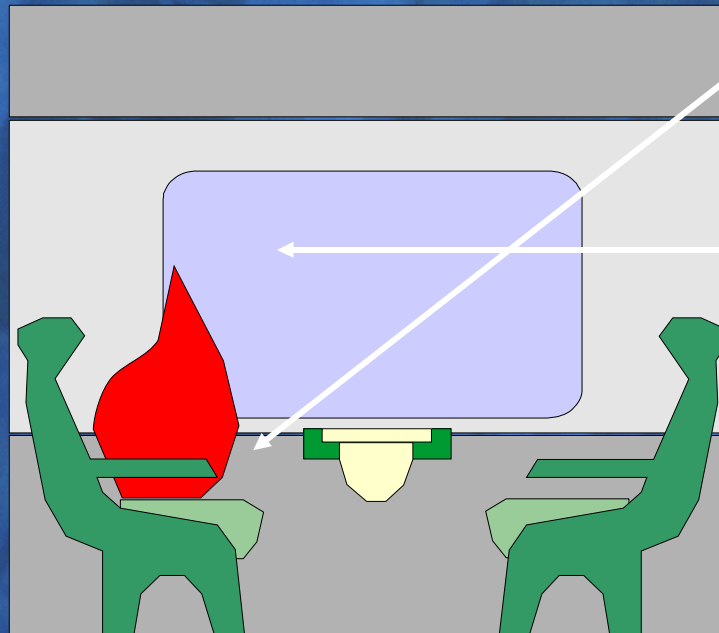


EN ISO 11925 Part 2 Small flame test

- Flame is similar to a match and is applied to some products (such as air filter materials for ventilation, heating and air conditioning equipment) for 30 seconds



Compartment at early developing stage

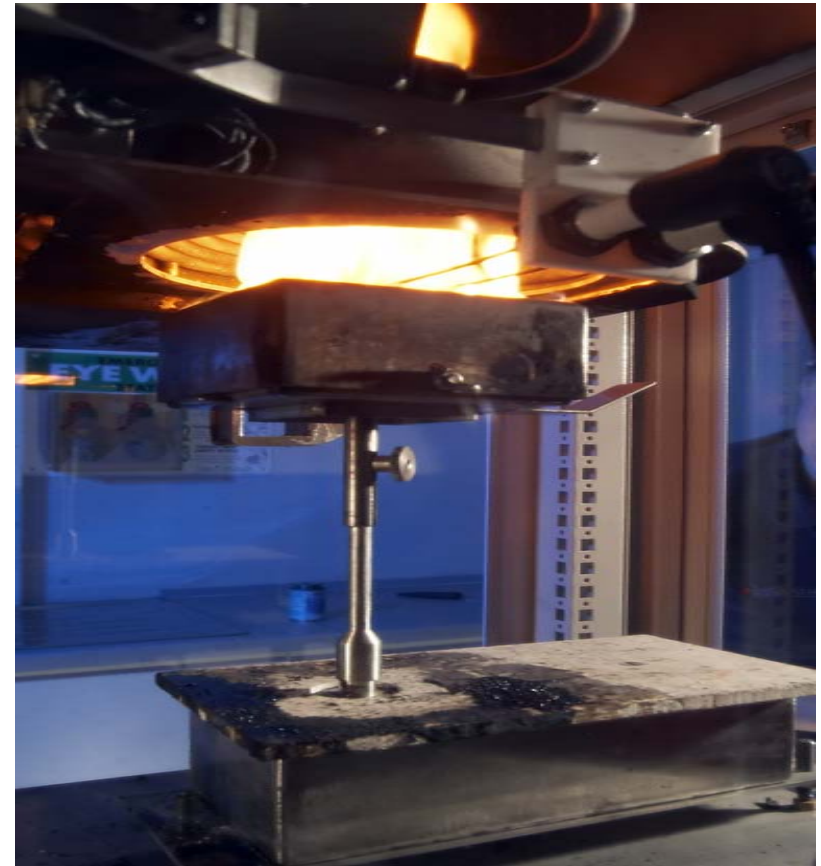


Post ignition source
for 1st seat

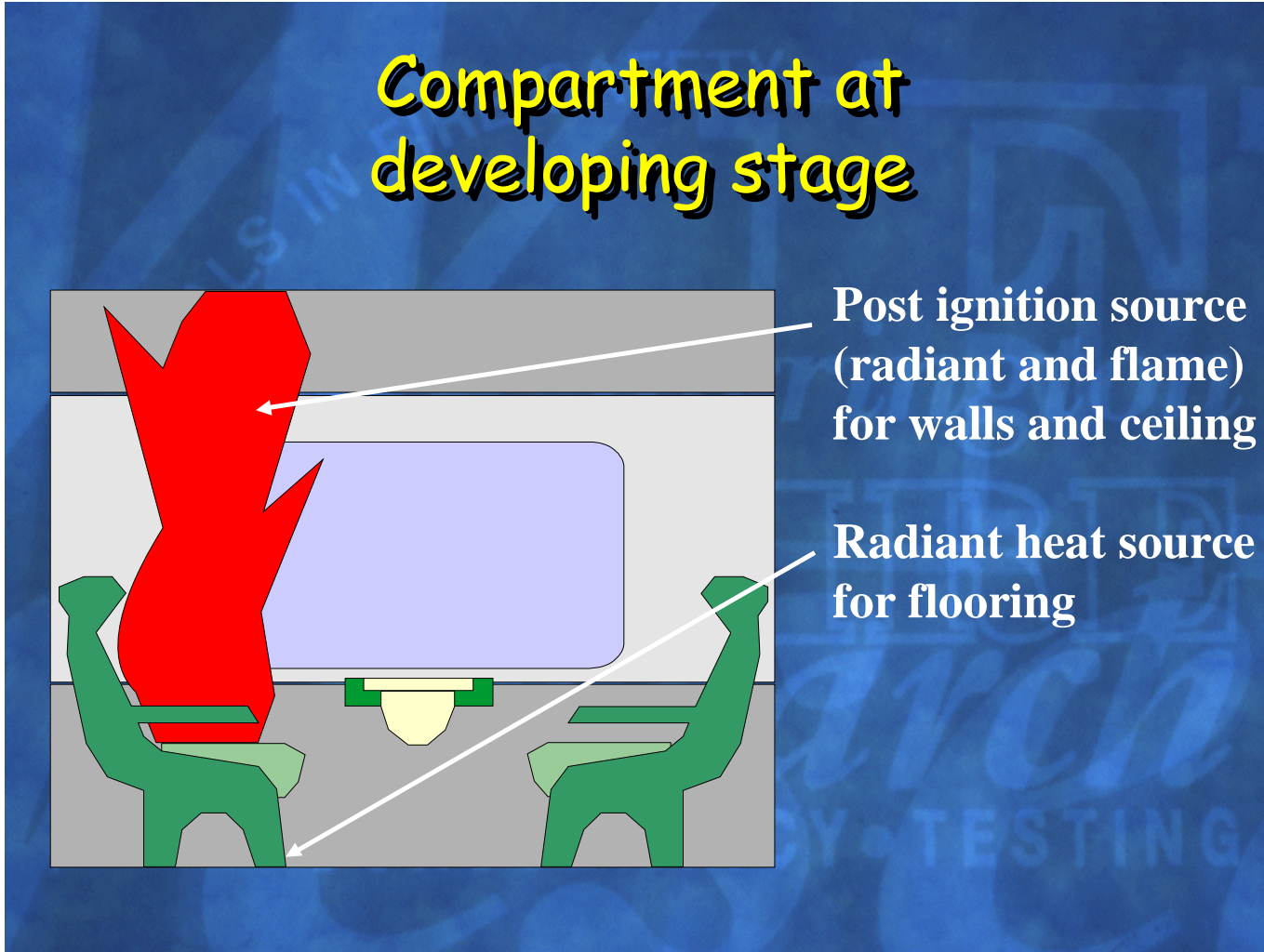
Primary ignition source
(radiant) for walls,
curtains &
adjacent seats

ISO 5660 Cone Calorimeter

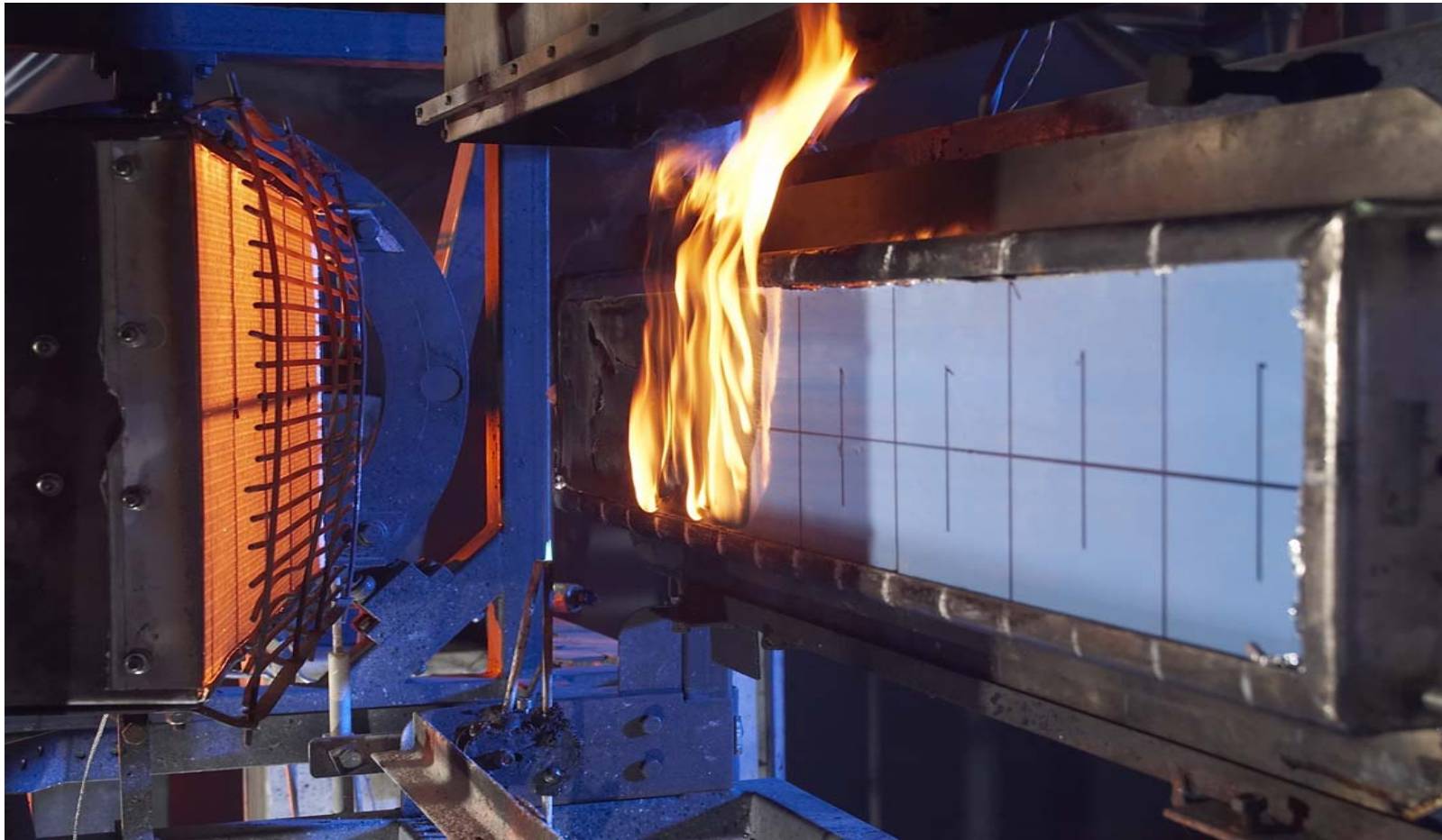
- Wall and ceiling linings exposed at 50 kW/m²
- Seat upholstery and floor composites exposed at 25 kW/m²
- New parameter MARHE introduced to assess rate of heat release



Compartment at developing stage



ISO 5658 Part 2 Lateral flame spread test exposes specimen to 50 kW/m² and measures critical flux at extinguishment



ISO 5659 Part 2 Smoke Chamber used at exposures of 25 kW/m² and 50 kW/m²



FTIR Spectrometer for analysis of gaseous fire effluents

- **CEN/ TS 45545 Part 2 Annex C** specifies use of FTIR spectrometry to analyze the gases generated in the smoke chamber when testing products with large surface areas
- Non-listed products may be tested in the NFX 70-100 tube furnace and the gaseous effluents analyzed by other proven methods (such as ion chromatography)



Determination of Conventional Index of Toxicity (CIT)

CIT for general products is defined as

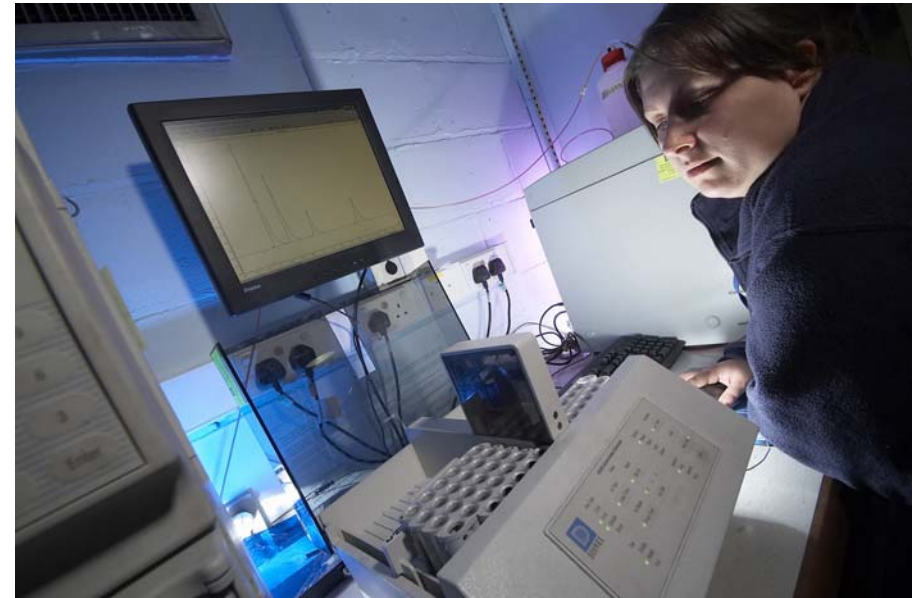
$$CIT_G = 0.0805 \times \sum_{i=1}^{i=8} \frac{c_i}{C_i}$$

where

c_i is concentration of gas i in smoke chamber

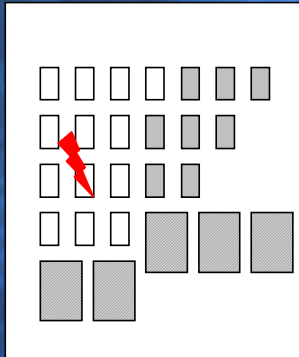
and

C_i is reference concentration of gas i

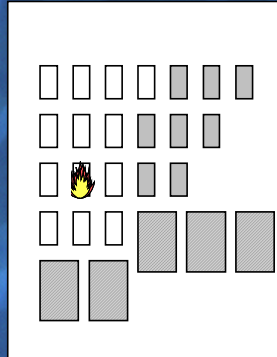


Electrical equipment

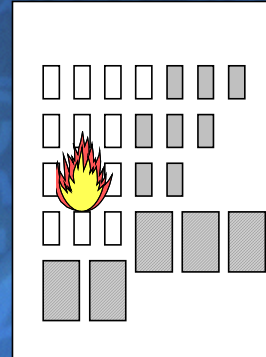
Initial stage
(glowing)



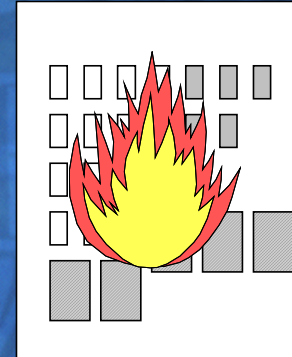
Initial stage
(flaming)



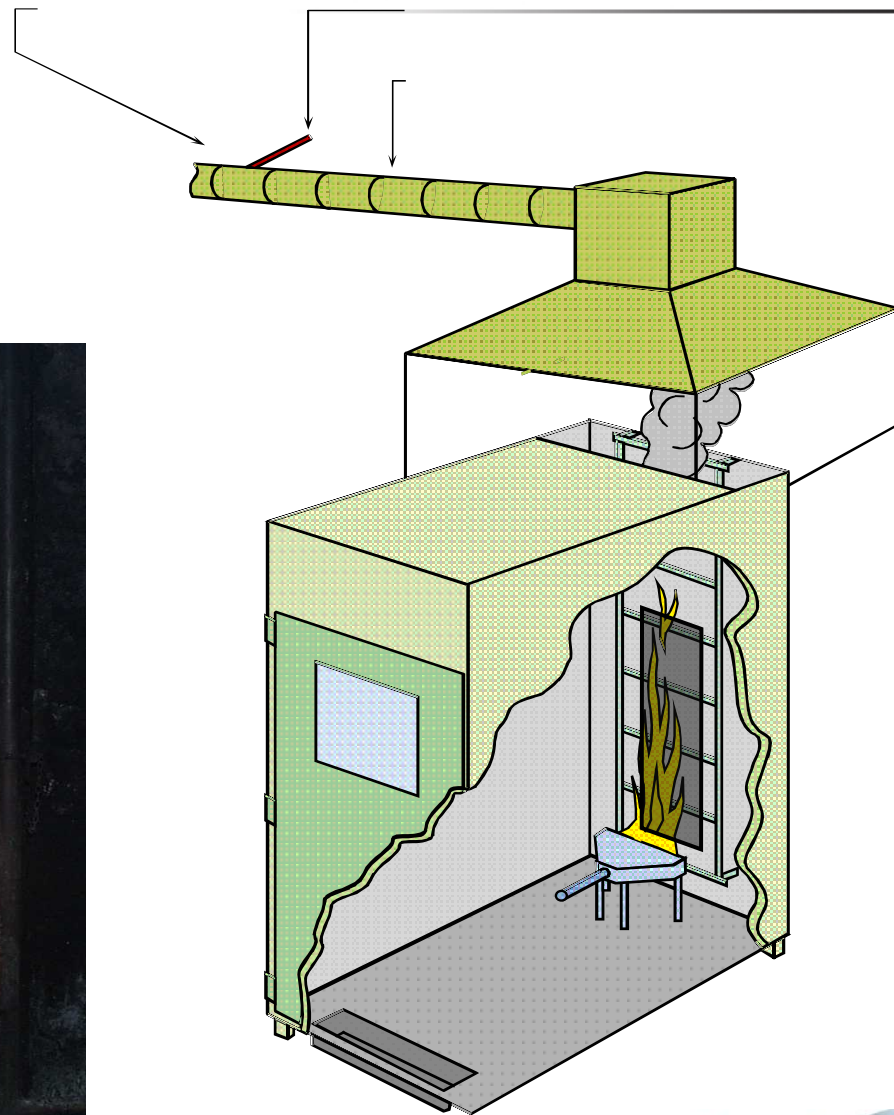
Early
developing



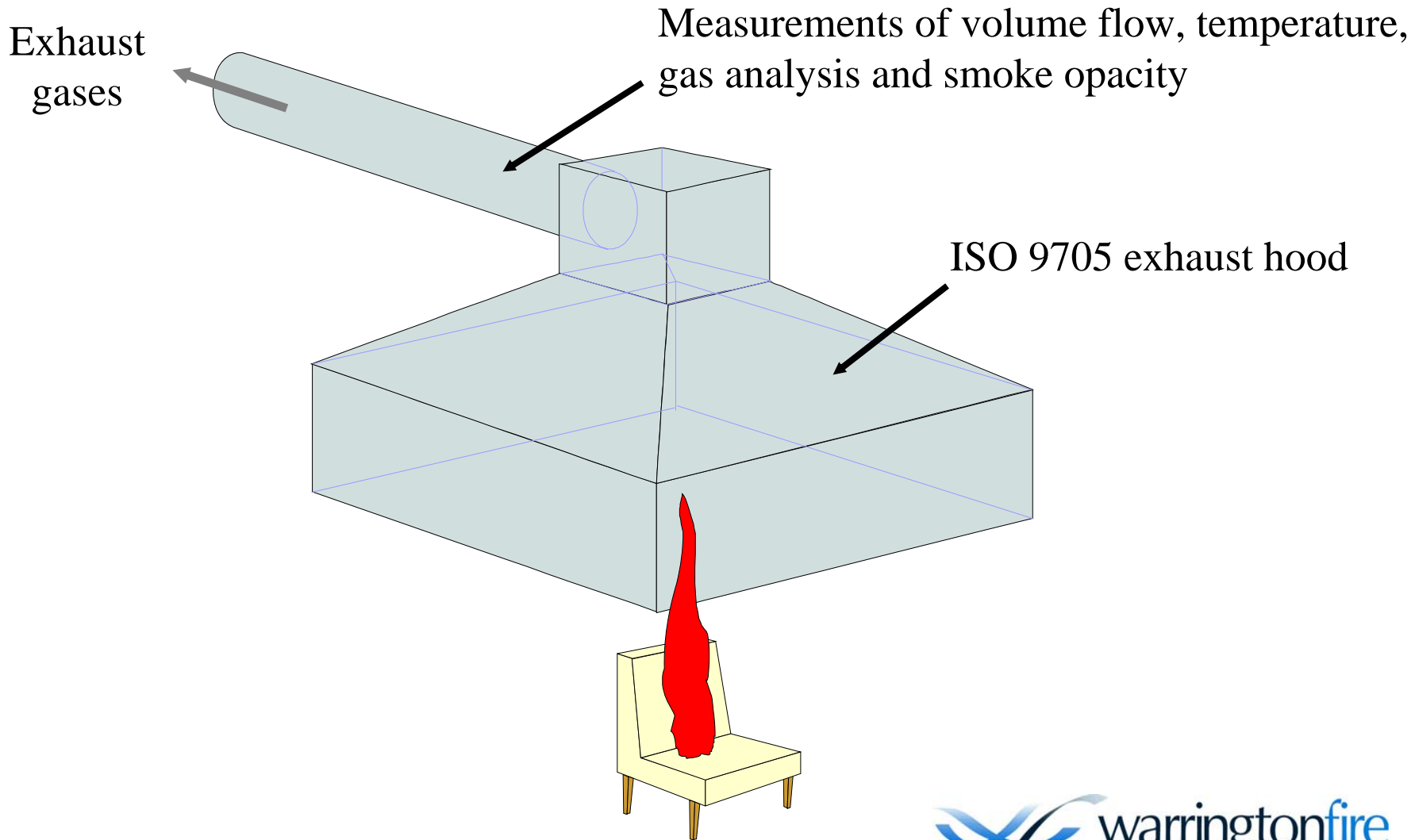
Developing
stage



Intermediate –scale test for electrical cabinet components



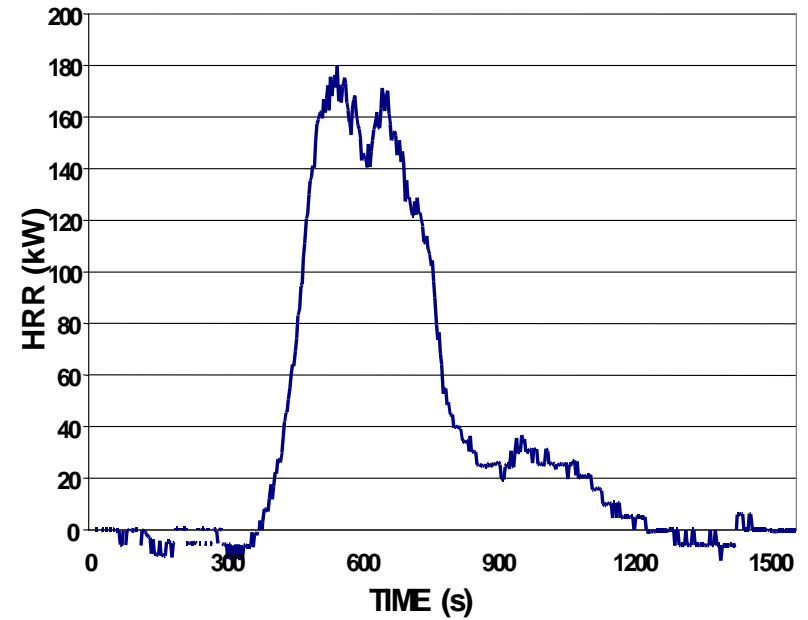
Furniture Calorimeter



Vandalized seat testing with 7 kW square-burner applied for 3 minutes



Developed fire of seat burning in small train compartment



Ignition model for testing wall and ceiling linings in small train compartment

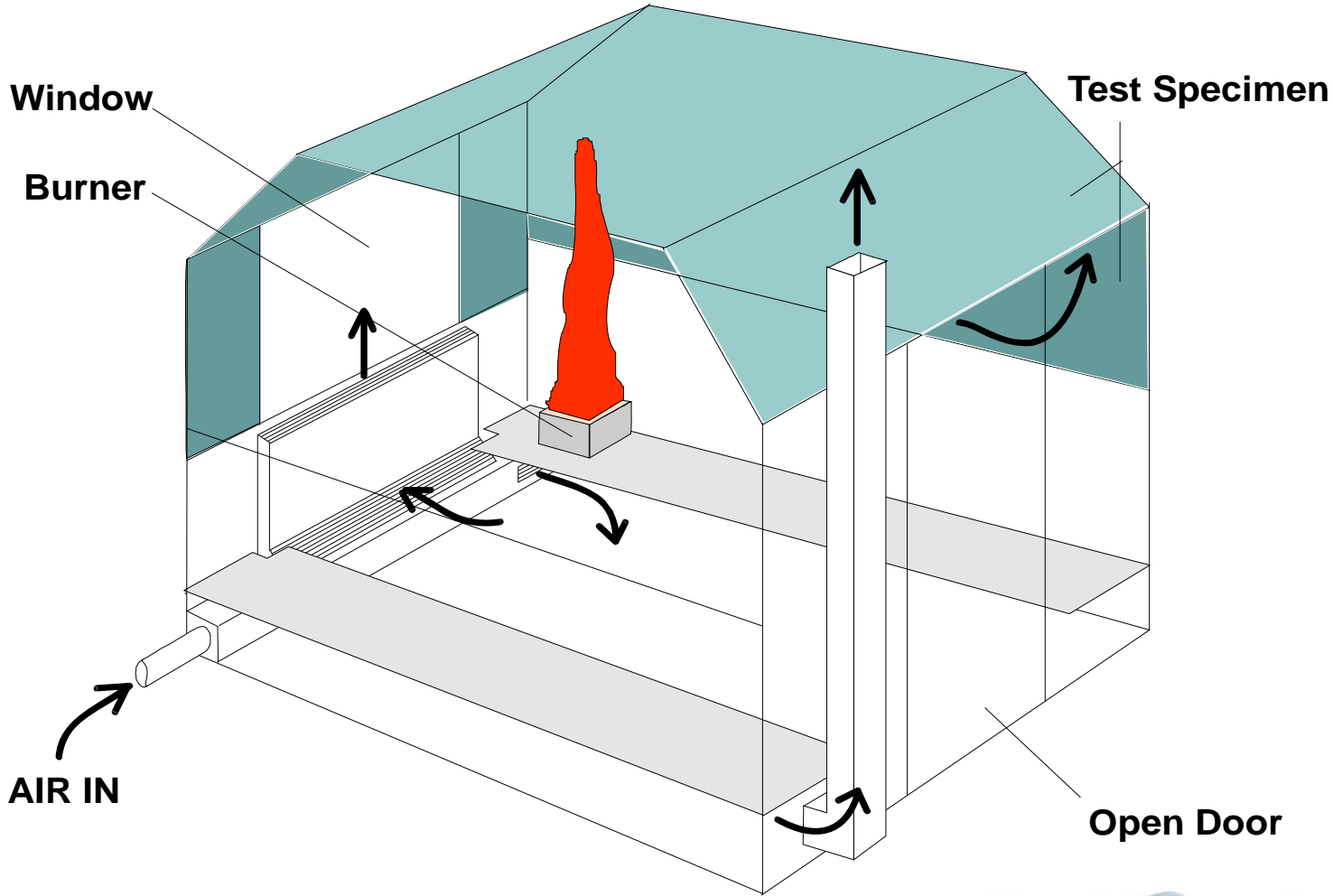


- Propane burner simulates burning seat: -

Step 1 75 kW for 2 minutes

Step 2 150 kW for 8 minutes

Laboratory simulated SNCF Voiture VU78 railway compartment for testing wall and ceiling linings





In the FIRESTARR project, results of compartment tests on wall and ceiling linings were correlated with small-scale results in: -

ISO 5660 Cone calorimeter

ISO 5658-2 Spread of flame test

ISO 5659-2 Smoke chamber

Developed fire on a train



Fire resistance tests for fire barriers

1. EN 1363 Part 1 defines how the integrity, insulation and radiation transfer of fire barriers shall be determined under developed fire conditions
2. EN 13501 Part 2 specifies how the requirements of CEN/ TS 45545 Part 3 shall be assessed (for example, E30 means integrity of the barrier is maintained for 30 minutes and I15 means insulation of the barrier is maintained for 15 minutes)
3. Tests are performed using vertical wall furnaces or horizontal flooring furnaces that expose the test specimens to the ISO 834 temperature/time heating schedule

Fire resistance tests for fire barriers on railway vehicles



EN 1364-1 Passenger area (or luggage compartment) fire to adjacent passenger area



EN 1365-2 Under floor fire to passenger area

Assessment of conformity of fire performance to European rail Directives

1. To establish the EU declaration of conformity or suitability for an interoperability constituent, the manufacturer or supplier shall apply the provisions of the relevant TSI
2. Assessment of conformity or verification of fire performance (such as a required type test certificate) for use of an interoperability constituent shall be carried out by a notified Fire Laboratory before the product may be installed in a European railway vehicle

Future challenges for fire safety engineers?

Long tunnels



Elevated structures

