REVIEW OF DESIGN FIRES IN RAILWAYS

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WHAT IS A DESIGN FIRE ?

DESIGN FIRE: quantitative description of assumed fire characteristics within a design fire scenario

Note 1 to entry: Typically an idealized description of the variation with time of important fire variables, such as heat release rate and toxic species yields, along with other important input data for modelling such as the fire load density.

(ISO 16733-1:2015(en), 3.1)

REGULATION

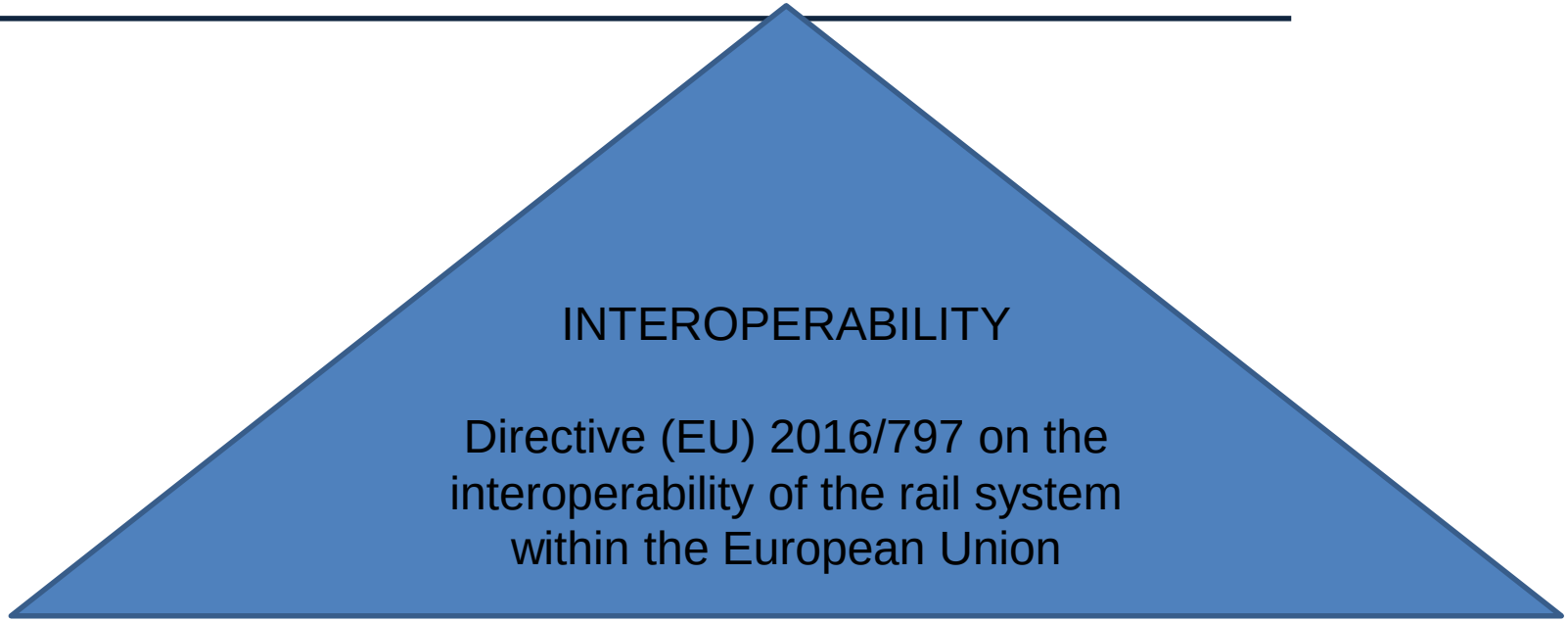
- Interoperability Directive 2016/797/EC: New approach directive. Objectives are explicit.

- TSIs decline the essential objectives at sub-system level (e.g. rolling stock, tunnels, etc)

- Prescriptive approach is indicative. Objectives are deemed to be satisfied when compliant, e.g. EN 45545-2 for rolling stock

BUT several ways to demonstrate compliance are allowed and as acceptable as prescriptive ones, submitted to authorities

REGULATION


INTEROPERABILITY
Directive (EU) 2016/797 on the interoperability of the rail system within the European Union
INFRASTRUCTURE
Commission Regulation (EU) No 1303/2014 concerning the technical specification for interoperability relating to safety in railway tunnels of the rail system of the European Union.
ROLLING STOCK
Commission Regulation (EU) No 1302/2014 concerning a technical specification for interoperability relating to the ‘rolling stock — locomotives and passenger rolling stock’ subsystem of the rail system in the European Union

DESIGN FIRES AND DESIGN FIRE SCENARIOS FOR APPLICATION OF TSI LOC&PAS

APPLICATION TO TSI LOC&PASS

- Essential requirement: section 4.2.10.1

"Rolling stock shall be designed such that it protects passengers and on-board staff in case of hazard fire on board and to allow an effective evacuation and rescue in case of emergencies. This is deemed to be fulfilled by complying with the requirements of this TSI."

- Concerns, among others:
  - Material requirement -> reference to EN 45545-2 version 2013
  - Fire detection systems
  - Fire containment and control systems for passenger rolling stoc

APPLICATION TO TSI LOC&PASS

- What are the reference scenarios for this?

- EN 45545-2 scenarios:
  - Established during FIRESTARR study, 1997-2001
    - ✓ Based on feedback from railways operators prior to 1997
    - ✓ Based on rolling stock compliant with previous national standards
    - ✓ Introduction of arson fires
  - Refined within JWG CEN TC256/CENELEC TC9X, 2002-2003
  - Define criteria, and heat flux exposure for prescriptive tests
  - Published (not explicitely) in appendix A of EN 45545-1

APPLICATION TO TSI LOC&PASS – EN 45545-1 IGNITION SCENARIOS

Ignition model 1

This represents a typical ignition source due to arson or vandalism, for example newspapers or rubbish. The ignition model is a flaming source of 3 min duration and average power output of 7 kW generating a flux of 25 kWm^{-2} to 30 kWm^{-2}.

NOTE The ignition model 1 has been developed from the UIC 564-2 paper cushion.

Ignition model 2

This represents the effect of an early developing fire on surfaces near to the fire, for example horizontal surfaces of seats and floors. The ignition model is a radiant flux of nominal value 25 kWm^{-2} applied to an area of 0,1 m^2.

Ignition model 3

This represents the effect of a more developed fire than ignition model 2 or the effect of a developing fire on surfaces above or alongside the fire, for example wall and ceiling surfaces. The ignition model is a radiant flux of nominal value 50 kWm^{-2} applied to an area of 0,1 m^2.

Ignition model 4

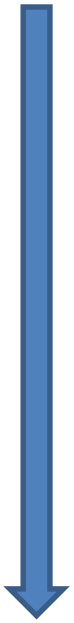
This represents the effects of arcing, for example resulting from the normal operation of high power electrical equipment (where Type A arc barriers would be required as set out in EN 45545-5) and low power electronic equipment faults. The ignition model is a flaming source of power 1 kW and 30 s duration.

Ignition model 5

This represents fires which are more severe than ignition models 1 to 4, for example luggage fires, and arson. For these fires the ignition model is a flaming source generating a radiant flux of nominal value in the range 20 kWm^{-2} to 25 kWm^{-2} applied to an area of 0,7 m^2 with an average power output of 75 kW for a period of 2 min followed immediately by a flux of nominal value in the range 40 kWm^{-2} to 50 kWm^{-2} applied to the same 0,7 m^2 area with an average power output of 150 kW for a period of 8 min.

These five ignition models are used to achieve the objectives set out in 4.2, 4.3 and 4.4.

Furniture (arson)



Luggage fire

BUT THESE ARE NOT DESIGN FIRE SCENARIOS

- These are ignition scenarios

- Design Fire Scenarios shall :
  - Be associated with a probability of occurence
  - Include contribution from train materials

(See ISO 16733-1 and ISO 16733-2)

ISO 16733-1:2015. Fire safety engineering — Selection of design fire scenarios and design fires — Part 1: Selection of design fire scenarios

ISO/TS 16733-2:2021. Fire safety engineering — Selection of design fire scenarios and design fires — Part 2: Design fires

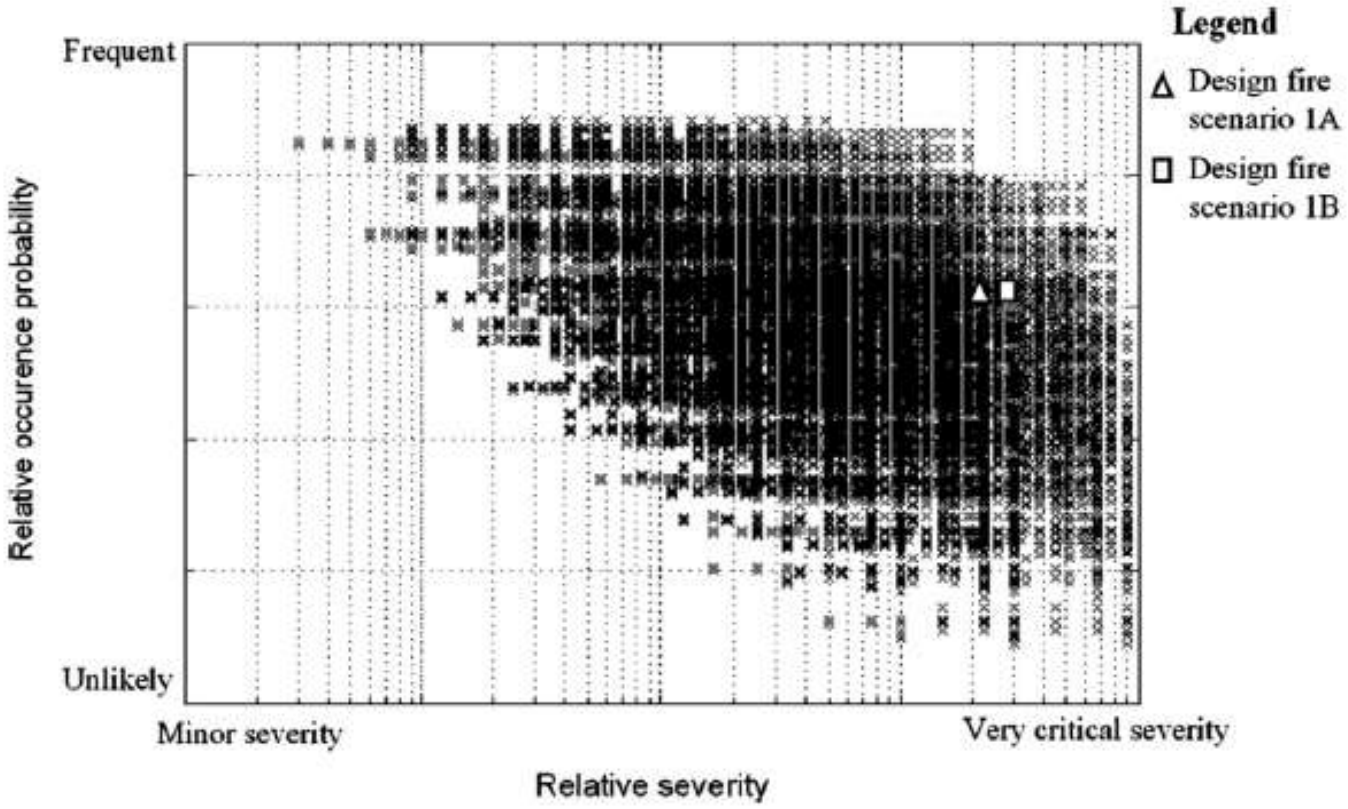
DESIGN FIRE SCENARIOS : INPUT FROM TRANSFEU

- EU Research program, 2009-2012

- WP4 to WP6: Definition of Fire Safety Engineering methodology for railways rolling stock compliant with EN 45545-2

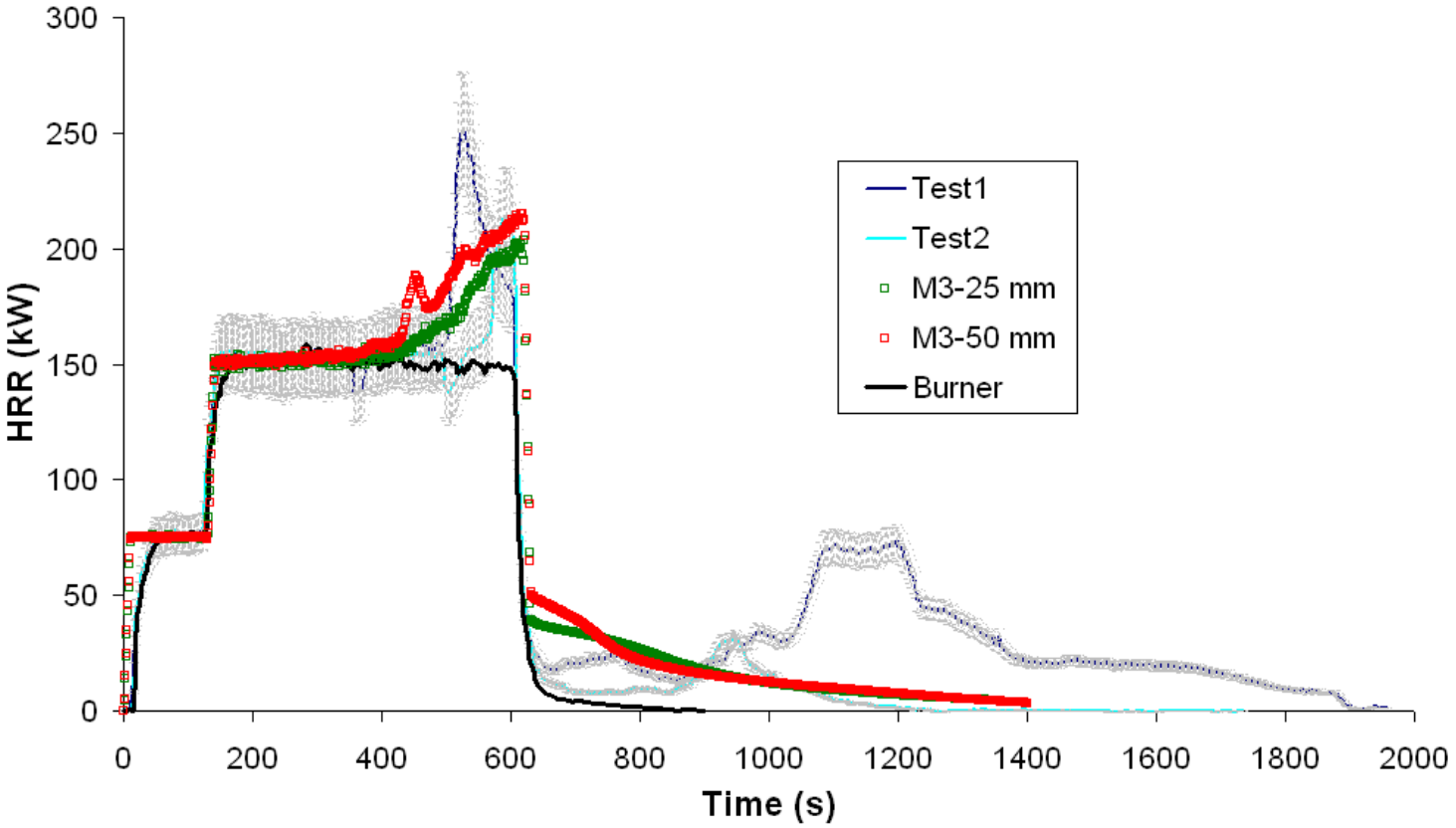
Final report available on EU website:
https://cordis.europa.eu/project/id/233786/reporting

DESIGN FIRE SCENARIOS : INPUT FROM TRANSFEU (EXAMPLE)



A. Camillo, E. Guillaume, T. Rogaume, A. Allard, F. Didieux. Risk analysis of fire and evacuation events in the European Railway Transport Network. Fire Safety Journal, vol. 60:25-36, 2013

DESIGN FIRE SCENARIOS : INPUT FROM TRANSFEU (EXAMPLE)

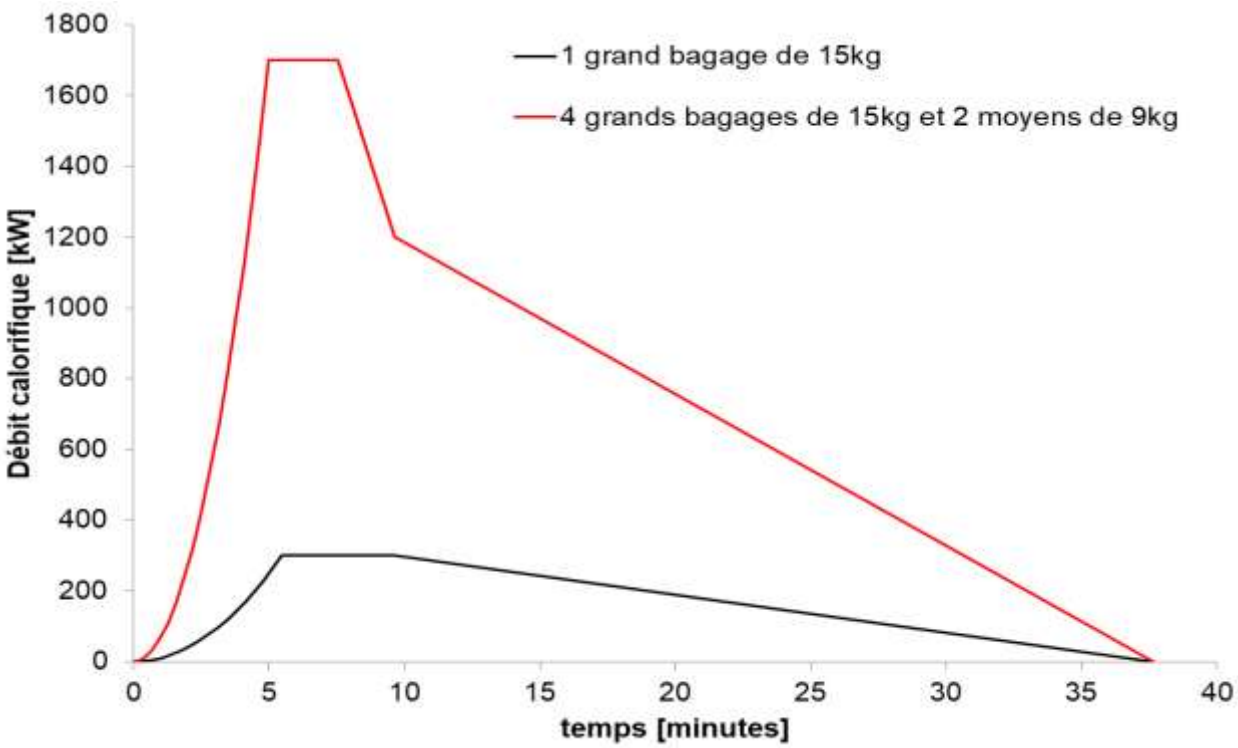


E. Guillaume, A. Camillo, A. Sainrat. Application of Fire Safety Engineering to Rolling Stock. Problemy Kolejnictwa, Vol. 160:4, pp 51-75, 2013.

E. Guillaume, A. Camillo, T. Rogaume. Application and limitations of a method based on pyrolysis models to simulate Railway rolling stock fire scenarios. Fire Technology, Vol.50(2), pp 317-348, 2014

RECENT INSIGHTS - EXAMPLES

- Luggage fires, research program Re(h)strain



Calculs des impacts sur l'évacuation des personnes et les structures d'une incendie criminel précédé d'une explosion dans une gare souterraine – Projet ANR Rehstrain. Présentation LCPP/Efectis. 24ème journées du GDR CNRS 2864 Incendie, Toulouse, 12 et 13/10/2017

DESIGN FIRES AND DESIGN FIRE SCENARIOS FOR APPLICATION OF TSI SRT

APPLICATION TO TSI SRT

In respect of fire safety requirements, four categories of rolling stock are defined and specified in the TSI SRT.

- Category A passenger rolling stock (including passenger locomotive),
- Category B passenger rolling stock (including passenger locomotive),
- Freight locomotive, and self-propelling unit designed to carry other payload than passengers (mail, freight, infrastructure inspection vehicle, etc.),
- OTMs.

EXAMPLE CASES – TRANSFORMER FIRE IN HIGH-SPEED TRAIN

- Pont de Veyle, January 10th, 2009
- Transformer oil fire
- Estimate 3-5 MW

EXAMPLE CASES – FREIGHT CAR FIRE

- Belfort, April 6th, 2010

- New cars, 6 cars involved simultaneously, estimation about 40 MW peak
- Good accessibility, extinguished in only 30 min!

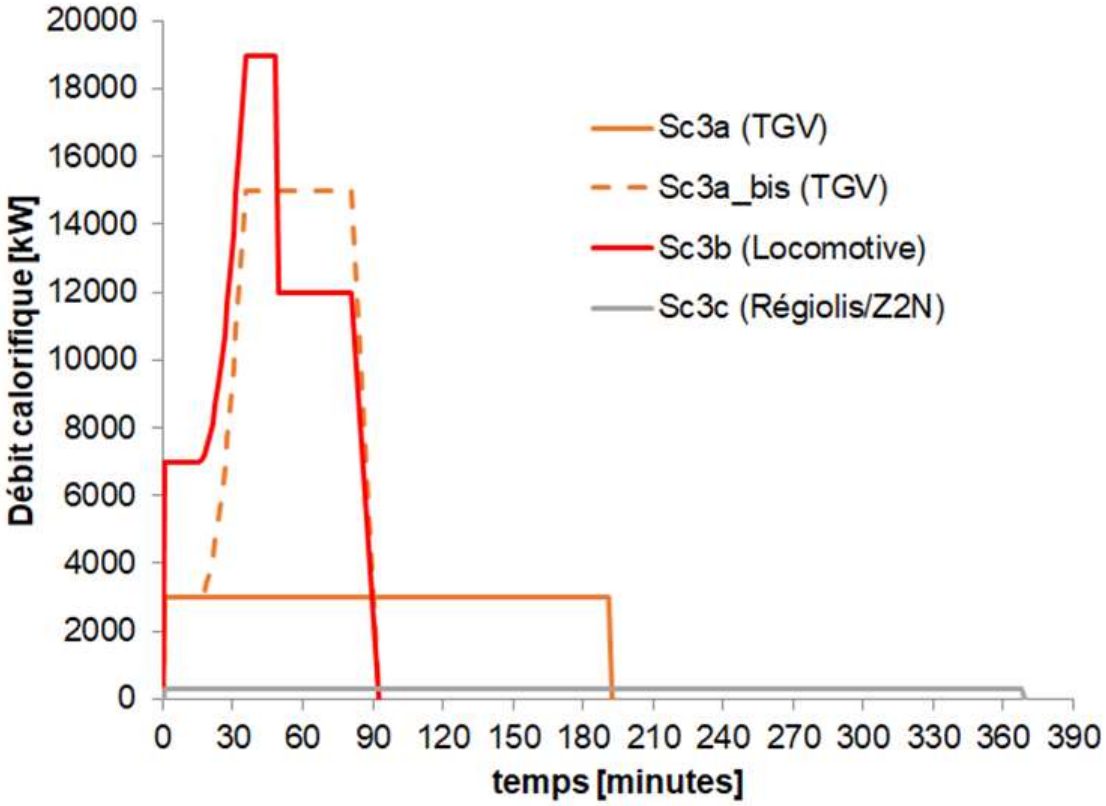
WHAT IF? IF OCCURS IN UNDERGROUND FACILITIES?

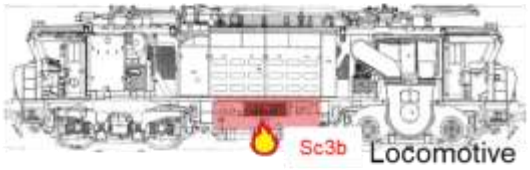
- Valenciennes, March 25th 2022

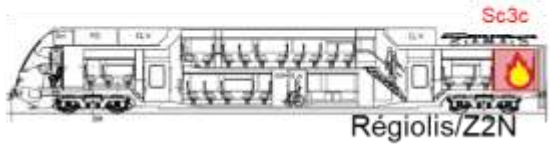
- Freight train, tyres burning in station

EXAMPLES OF DESIGN FIRES FOR INFRASTRUCTURE (1)

- Transformer + power fires

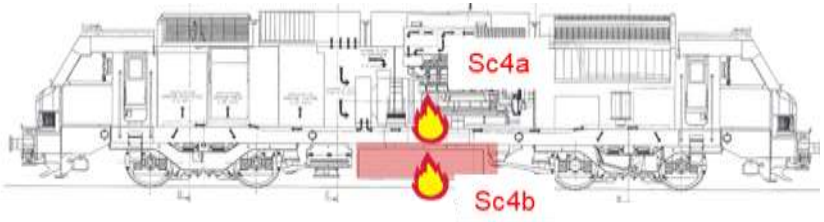


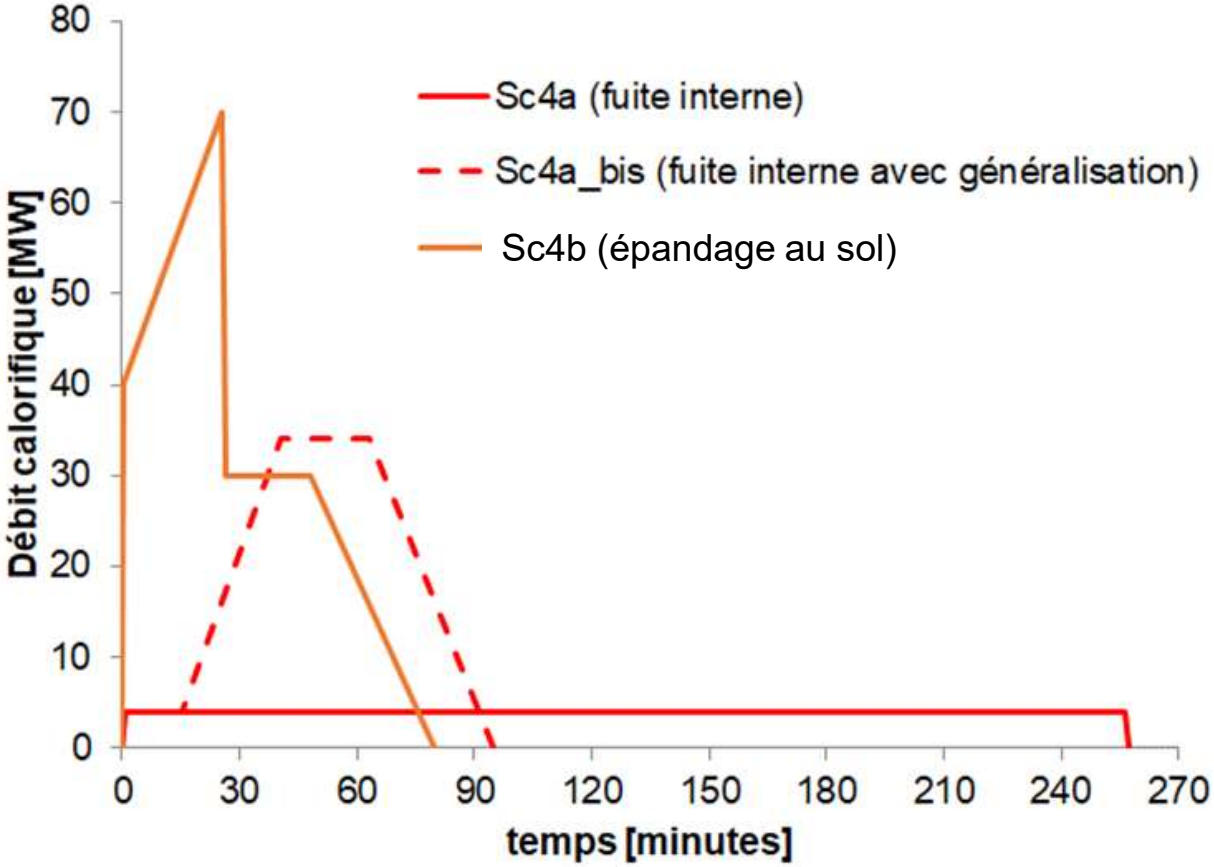




EXAMPLES OF DESIGN FIRES FOR INFRASTRUCTURE (2)

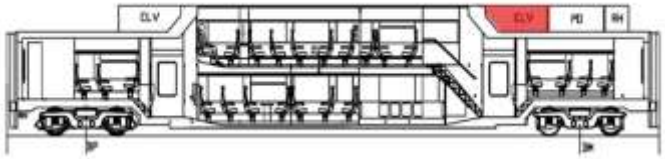
- Diesel engine fires

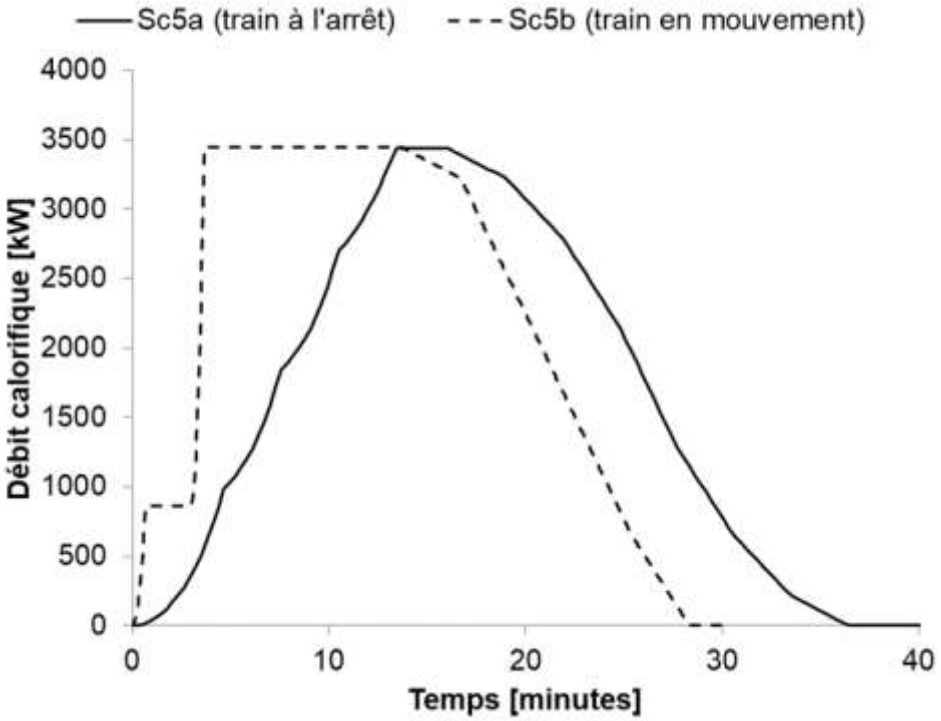




EXAMPLES OF DESIGN FIRES FOR INFRASTRUCTURE (3)

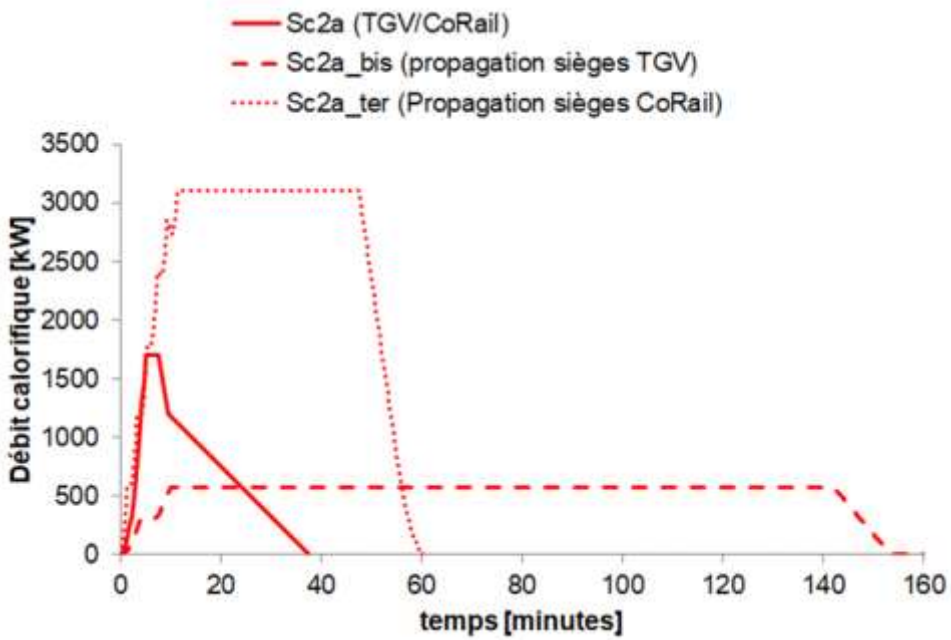
- Urban trains – HVAC technical cabinets on roof

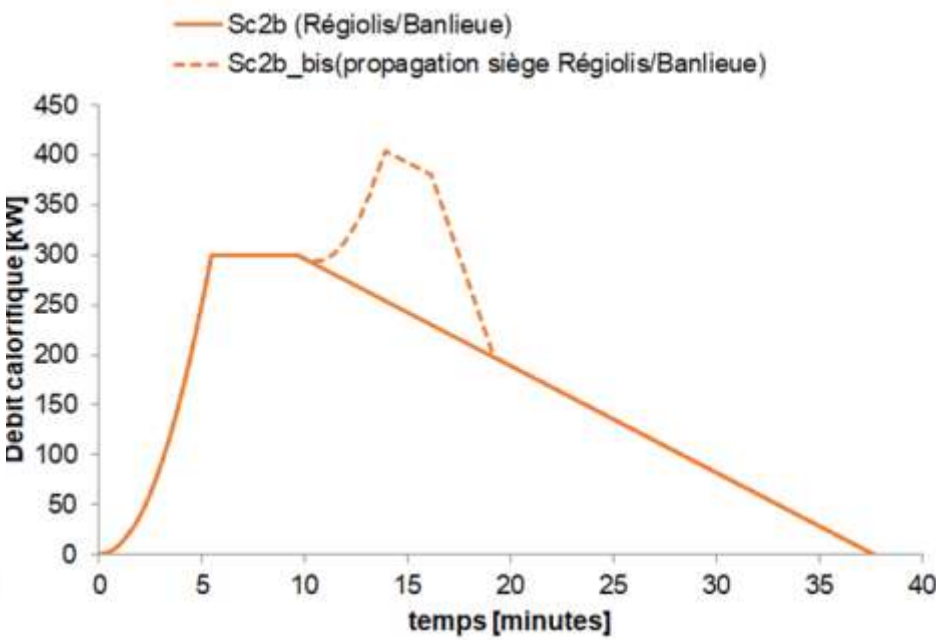




EXAMPLES OF DESIGN FIRES FOR INFRASTRUCTURE (4)

- Interior fires ignited by luggage fires





HOW TO ANTICIPATE FUTURE THREATS

- High correlation between tunnel ventilation and design fire
- Problematic of the interaction tunnel/station
- Evolution of the station usage
- Anticipate technological threats
  - Batteries-powered trains and trams
  - Hydrogen trains

QUESTIONS?