SEVENTH FRAMEWORK PROGRAMME

transfeu

Complete presentation

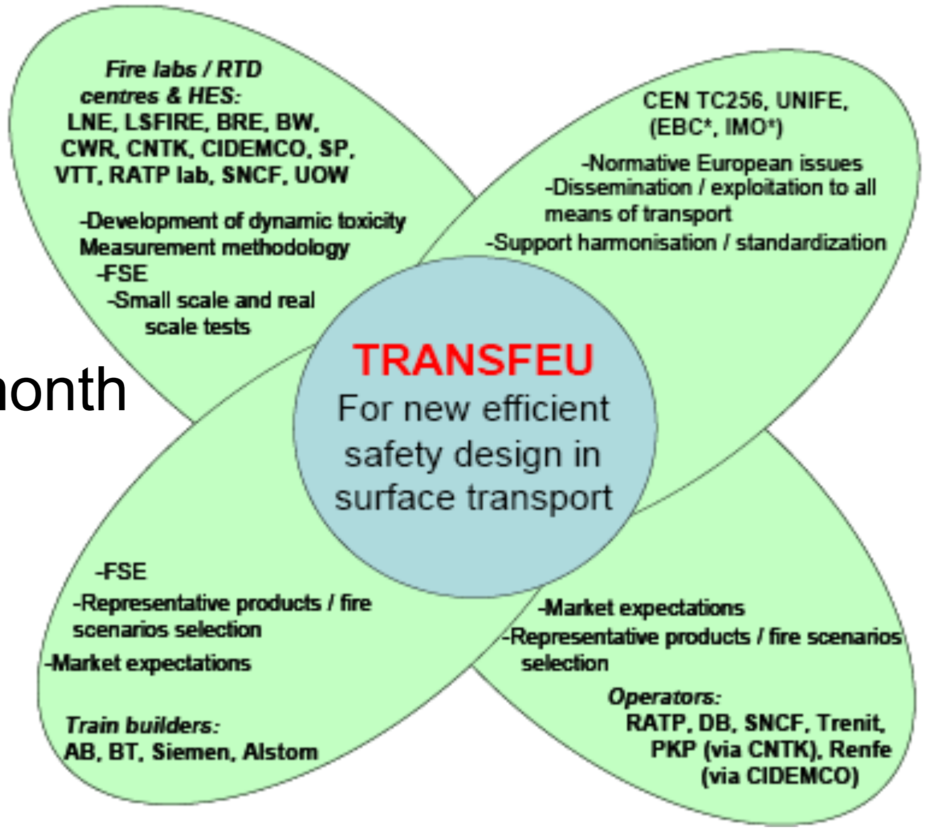
SUMMARY

- Presentation of a new European project "TRANSFEU"
- Why FSE for railways rolling stock
- General methodology for FSE
- Method for fire toxicity evaluation

Overview

- TRANSFEU (*Transport Fire Safety Engineering in the European Union)* European Research project of FP7-SST-2008-RTD-1 for Surface transportation

- Budget: 5.54 M€
- Starting date: April 2009
- Duration: 42 months
- Labour effort: 314.89 Person month
- Consortium
  - LNE coordination
  - 21 partners



Consortium

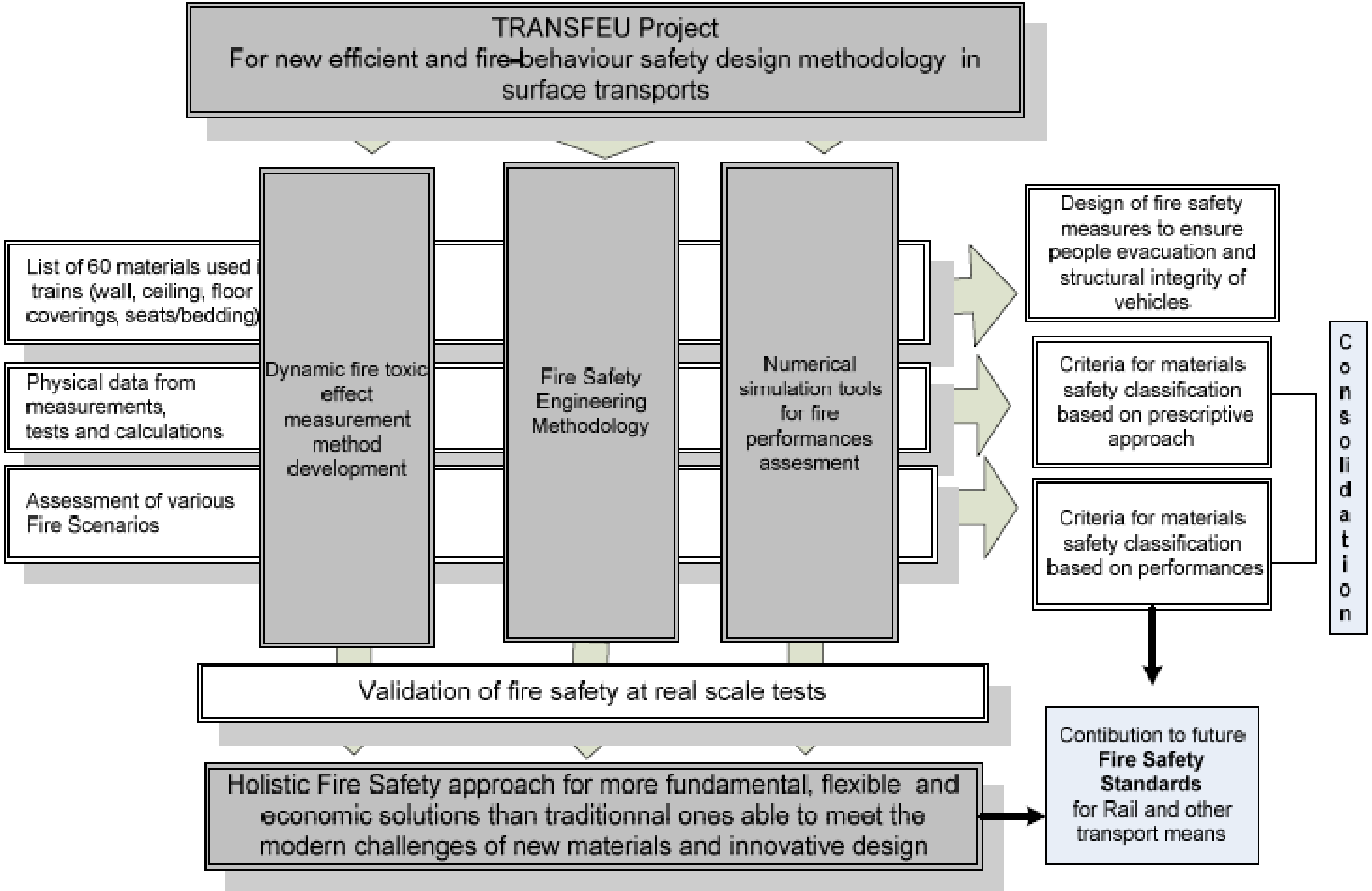
- LNE — Le progrès, une passion à partager
- L.S.FIRE LABORATORIES™
- SP
- VTT
- Exova Warringtonfire
- breglobal
- CURRENTA — Performance for the chemical industry
- [redacted]
- AnsaldoBreda — Una Società Finmeccanica
- BOMBARDIER
- SIEMENS
- cidemco tecnalia
- CNTK
- DB Mobility Networks Logistics
- RATP
- SNCF
- TRENITALIA — GRUPPO FERROVIE DELLO STATO
- BERGISCHE UNIVERSITÄT WUPPERTAL
- DIN
- ALMA Consulting Group

Main Objectives

A holistic approach of the fire safety (the passengers and staff) by design as following

- Develop an improved method for the assessment of the toxicity of fire effluents from products used on trains (small scale test method) under dynamic conditions:
- Develop a methodology using FSE to predict fire effect on people (combine active and passive security approach)
- Define thresholds for a classification system for the toxicity of fire effluents from products used on train
- Develop a guide on parameters which size fire safety, like design and ventilation, and their effects on people
- Contribute substantially into the future standards of the European railway and ships industry, and interoperability by disseminating the research results to the rail industry and other interested surface transport

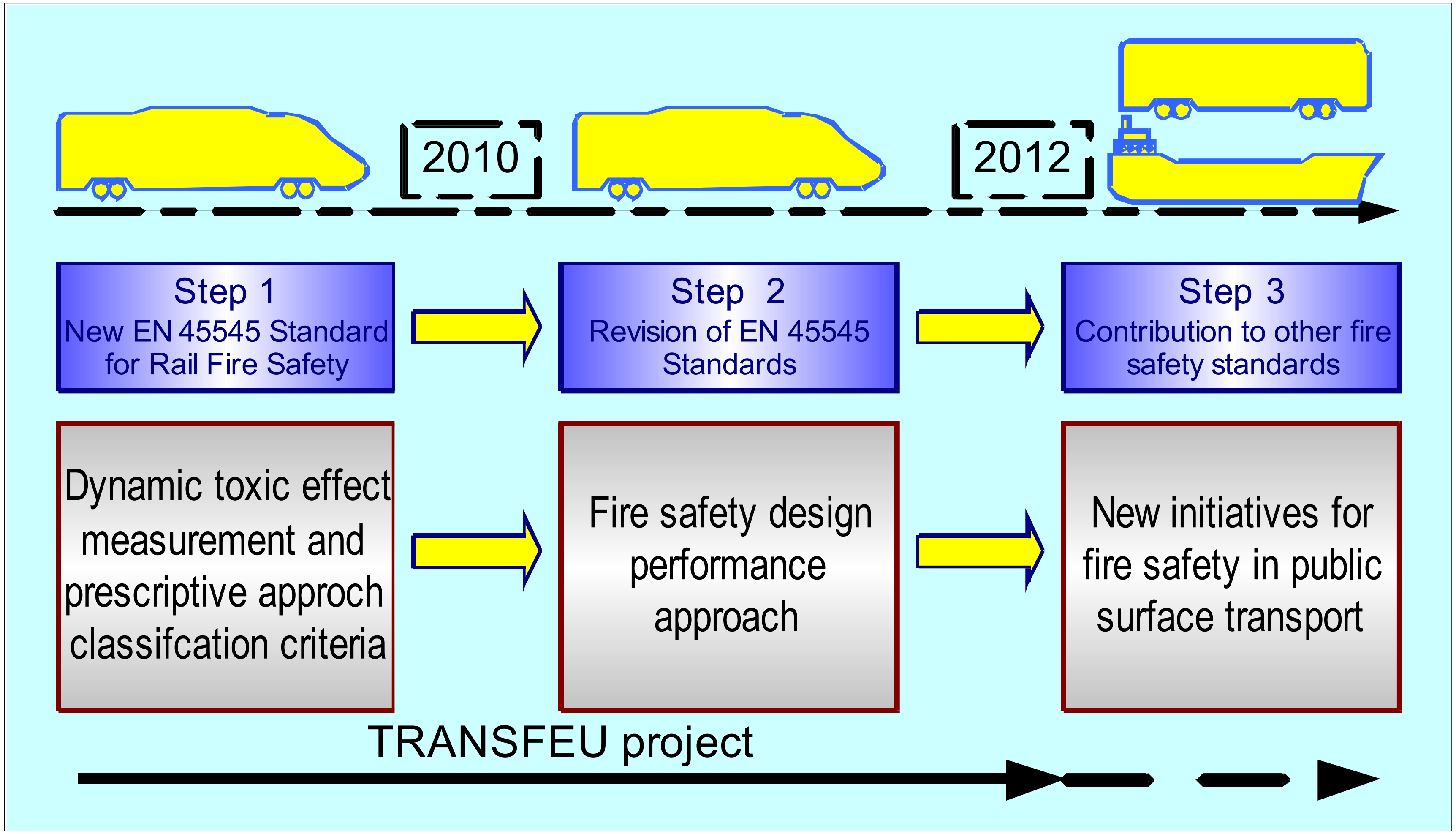
Transfeu holistic concept fire safety



Programme

- WP1 : Management of the project
- WP2 : Fire test for toxicity of fire effluents
- WP3 : Development of conventional pragmatic classification system for the toxicity of fire effluents released from products on trains
- WP4: Fire Safety Engineering methodology for public surface transport
- WP5: Development of numerical simulation tools for fire performance, evacuation of people and decision tool for the train conception
- WP6 : Validation of the conventional toxicity classification and the numerical simulation tools for the prediction of fire effect on people
- WP 7 : Exploitation, Dissemination and Contribution to standards

Work progress



The two steps strategy of TRANSFEU project and its contribution to fire safety standards

Expected impact

- ✓ Close the open point of TS45545 and facilitate its transition to an international standard
- ✓ Improve the protection of passengers
- ✓ Improve the homologation process and reduce the cost of approval for new vehicles thanks to virtual testing
- ✓ Decrease of 10% of the car body weight, and reduce energy consumption accordingly up to 10%
- ✓ In line with the rail sector and ERRAC objectives.

- ✓ Benefits for the Train manufacturers:
  - decrease test price of a fire resisting of the car body structure up to 50%; explore new innovative designs and materials using the fire engineering simulation tools
- ✓ Benefits for the railway suppliers:
  - develop and provide new light materials
- ✓ Benefits for the railway operators:
  - opportunities for interior refurbishment and better designs at lower cost

Why FSE in the field of transportation ?

Three answers…

- People potentially exposed to smoke hazards (visibility, temperature, heat flux, toxicity) and materials generally known

- Functional exigencies: maintaining structure, drive capability…

- Need for innovation: introduction of new materials for design / weight.

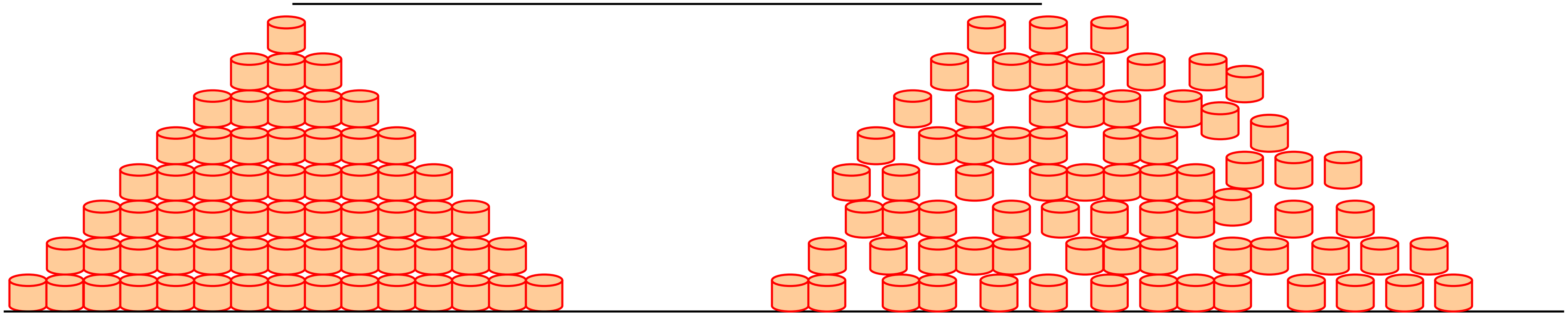
  Introduction of composite materials…

Comparison between prescriptive and FSE

Performance based code

Prescriptive code

Safety level



63 elements

73 elements

Structure of prevention or protection elements

Fundamental differences

Performance-based code :

Based on evaluation of performances

These performances can be absolute or relative

Obligation of results

Allows innovation

Especially applicable for non-conventional design / situations

Prescriptive code :

Based on conventional tests

Obligation of elements

Supposed to reach a non explicit safety level, based on feed-back to regulator

Limitation for innovations

Only way available in the past

General methodology for FSE (WP4)

- Definition of fire safety objective and associated criteria of performance and acceptance
- Fire risk analysis and design fire scenarios
- Choice of numerical simulation tools for the evaluation of fire performance
- Input data to use in the numerical simulation tools
- Simulation of fire effect

Example of Safety objectives

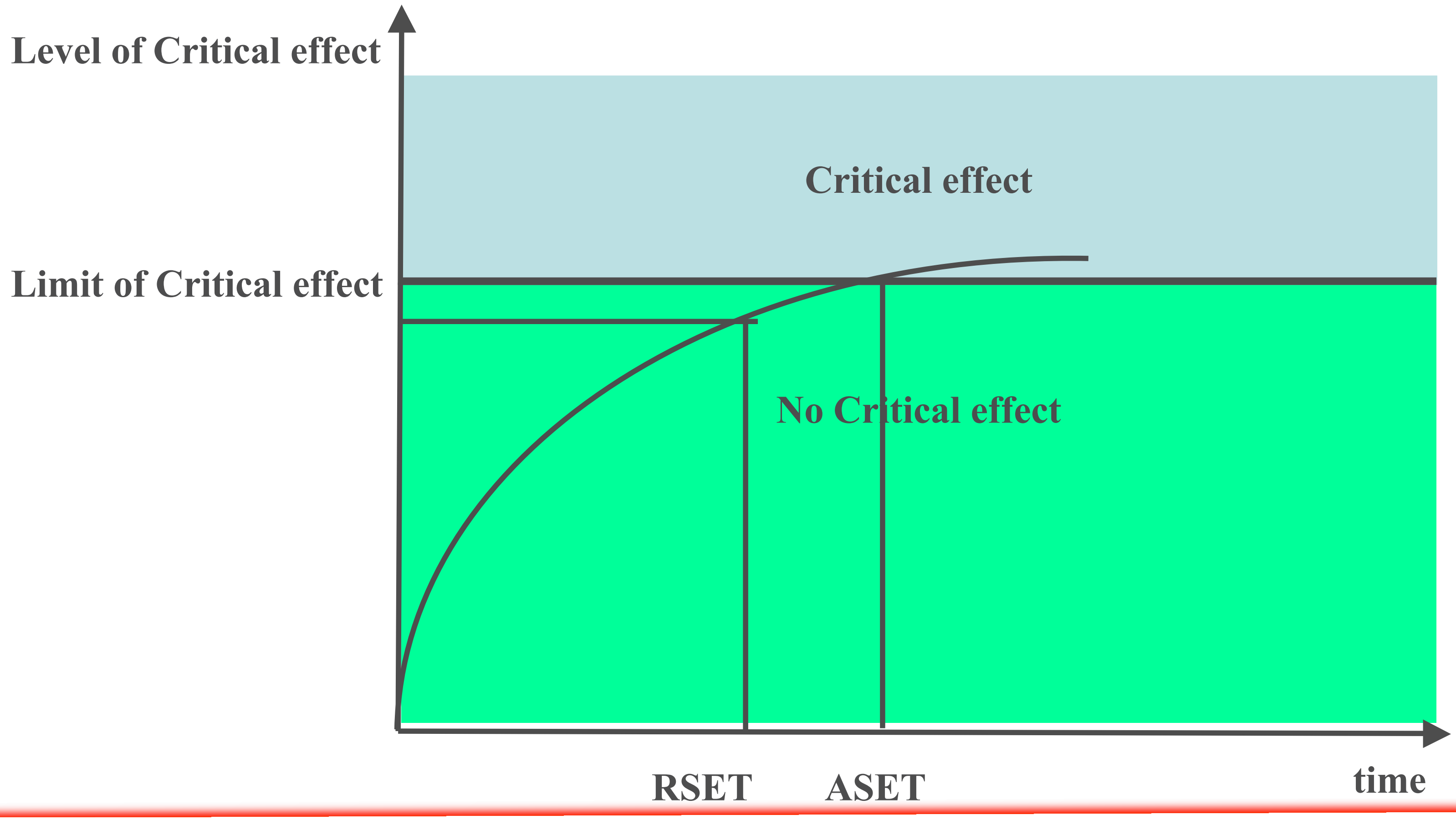
- Principal objective
  - Protection of life and health

- Sub-objective
  - Passengers
  - Neighbours
  - Rescue ans fire service
  - Domestic animals

- Based on acceptance and performance criteria

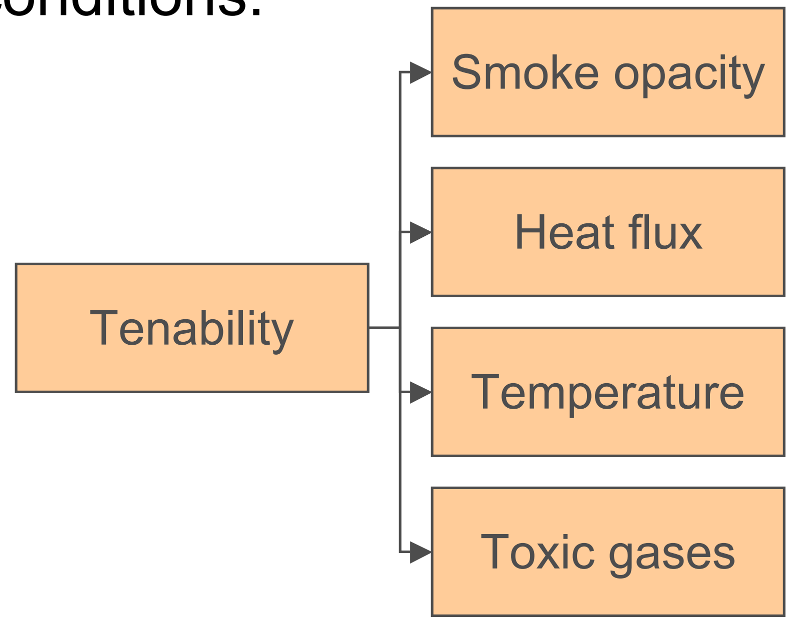
Example of acceptance criteria

- by consideration of Available Safe Escape Time (ASET) and Required Safe Escape Time (RSET), with ASET > RSET



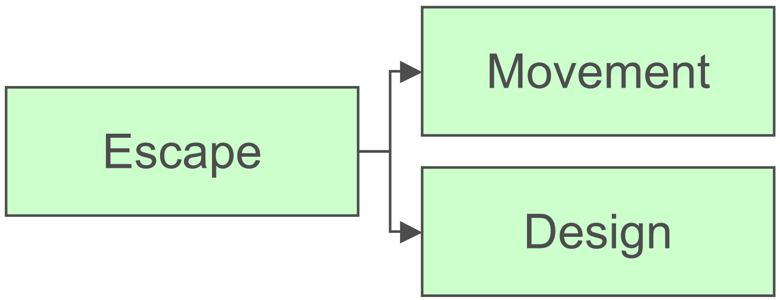
Example of performance criteria

- ASET will be taken from literature, e.g. ISO guidance documents and adapted to surface transportation
  - depends on the necessary escape/rescue times and refer to (typical) exposure conditions
  - Exposure conditions:

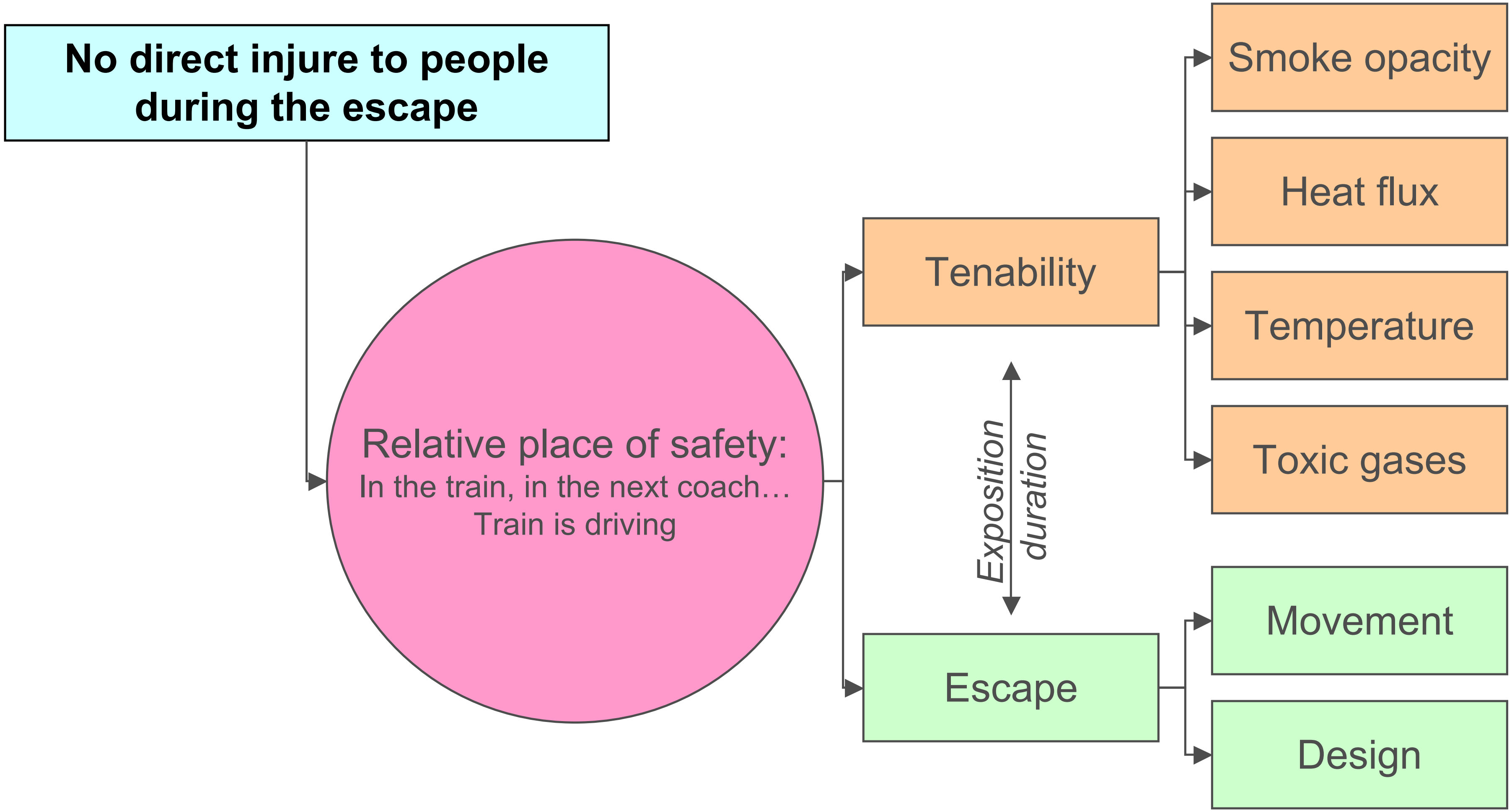


Example of performance criteria

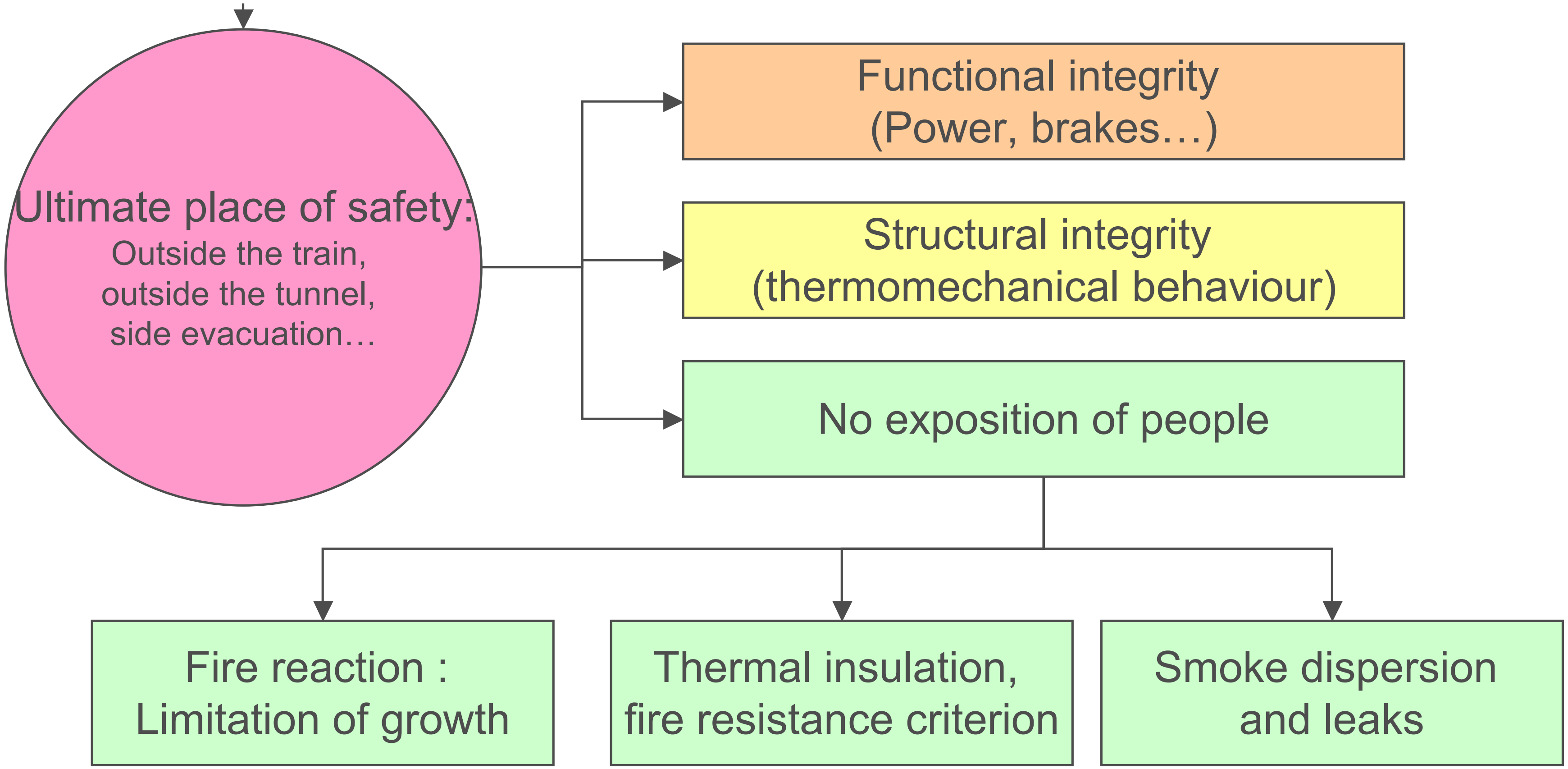
- RSET are holistic and applicable to any environmental conditions
  – depends strongly on the availability of areas of relative safety (i.e. compartment) or ultimate safety.



Example of performance criteria for area of relative safety



Example of performance criteria for area of ultimate safety

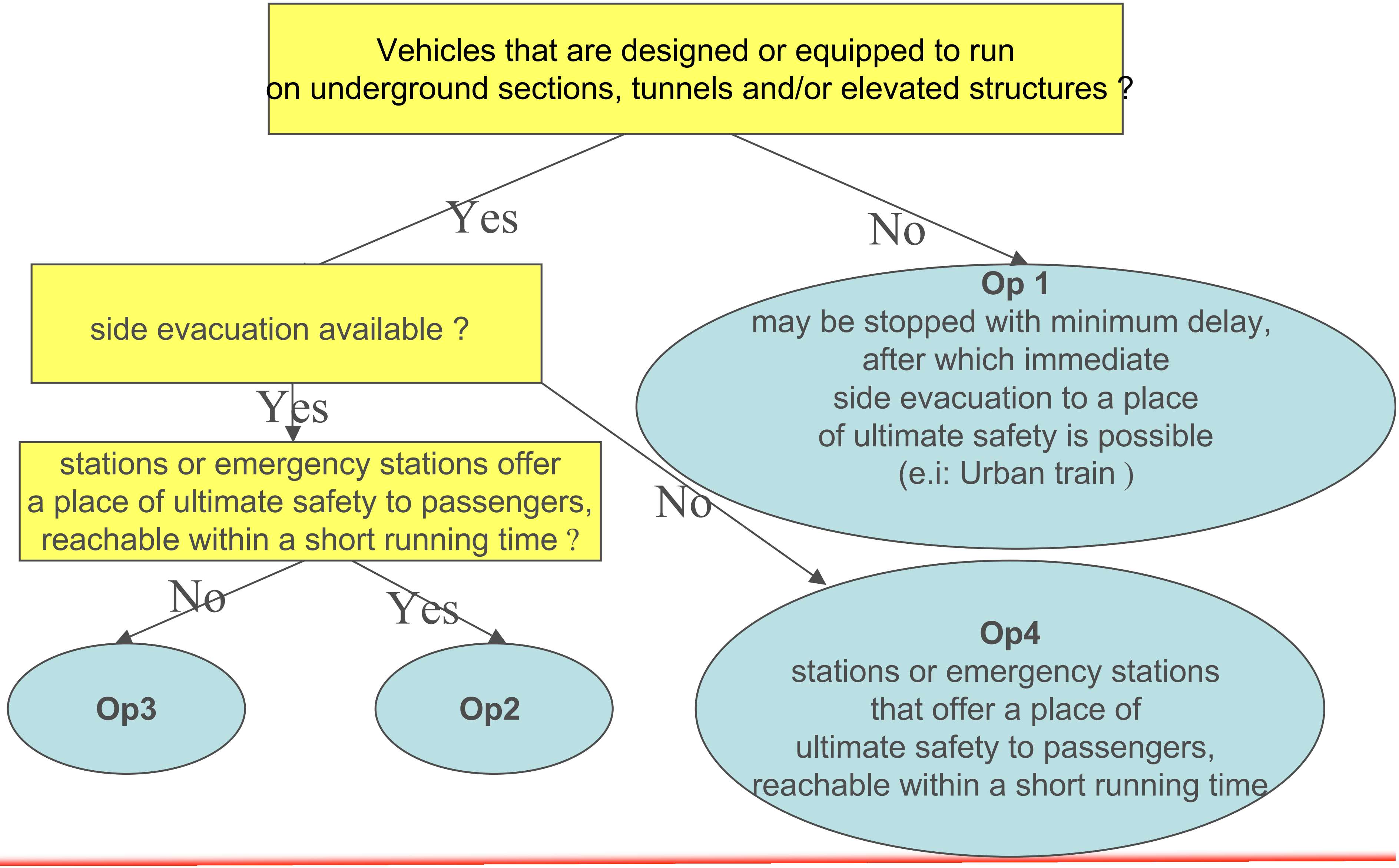


Example performance criteria

- The level of RSET depend of the operation and design category of vehicle

- It could be calculated
  - with simulation tools like EXODUS and FDS+Evac
  - or estimated according to the experiment
    - In annex B of EN 45545-1 examples of estimation of the duration to reach a place of ultimate safety in function of the operation category are given
      - Op2: should not take longer than 4 minutes
      - Op3: should not take longer than 15 minutes

Example of operation categories of vehicle



Example of design category of vehicle

- A: Vehicles forming part of an automatic train having no emergency trained staff on board;
- D: Double decked vehicles;
- S: Sleeping and couchette vehicles;
- N: All other vehicles (standard vehicles).

Fire risk analysis and Design Fire Scenario

- Risk analysis
  - based on the following investigations:
    - Analysis of accidental fires with regard to ignition sources, type, intensity and location.
    - Identification of fire hazards (different procedures will be used to identify the hazards; HAZOP, PHA, FMEA etc.
- Design fire scenario
  - will take into account:
    - Vehicle geometry (train, ship, bus),
    - ventilation,
    - passive fire protection (reaction to fire performance of materials and products,
    - fire resistance of structures, escape routes),
    - active fire prevention (detection, smoke extraction, extinguishing).
  - Will define the design fire

Design fire

- It could be determined according to the design fire scenario or conventional approach like EN 45545-1

- Design fire according to EEN 45545-1

1) Flaming source is 3 min duration and average power output of 7 kW generating a flux of 25 kW/m^2 to 30 kW/m^2.

2) A radiant flux of nominal value 25 kWm^{-2} applied to an area of 0,1 m^2.

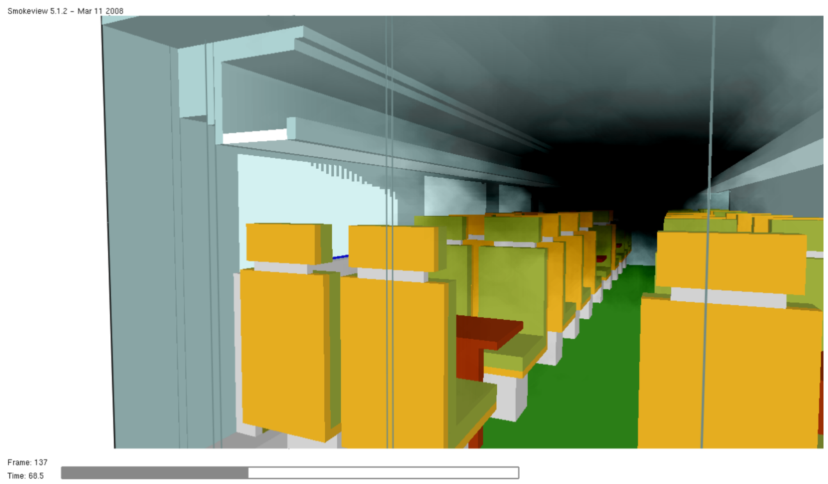
3) A radiant flux of nominal value 50 kWm^{-2} applied to an area of 0,1 m^2.

4) Flaming source of power 1 KW and 30 s duration.

5) 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 heat 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 heat of 150 kW for a period of 8 min.

Numerical simulation tools for a FSE study

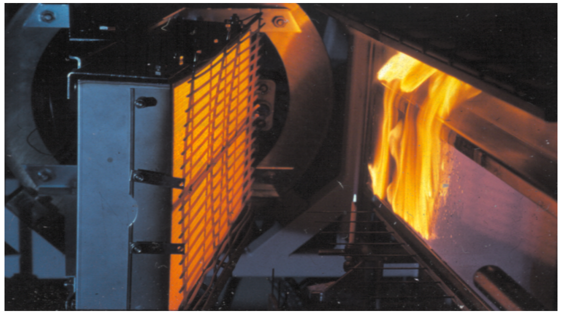
- Calculation tools, to evaluate performances:
  - Fire growth, smoke movements (FDS)
  - Thermal transferes, heat fluxes
  - Structural behaviour in case of fire
  - Atmospheric dispersion
  - Simulation of product reaction or resistance to fire
  - Toxicity effect



Input data for numerical simulation tools

- Types of data:
  - Thermal physical and chemical data
  - Resistance and reaction to fire Small scale tests
  - Large & real experiments for validation of the numerical simulation tools using the thermal physical , chemical data and small scale test results

Reaction to fire Small scale tests

Heat release	Spread of flame
 ISO 5660-1	 ISO 5659-4
Opacity of smoke	**Toxicity**
 ISO 5659-2	to be developed

Large & real experiments for validation of the numerical simulation tools

Small Scale fire Tests on material

Pyrolysis Inputs

Small Scale Fire models

Large scale fire test on product

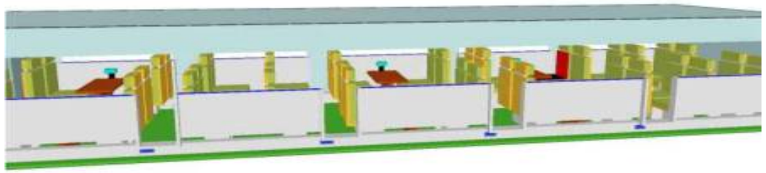
Large Scale Fire models

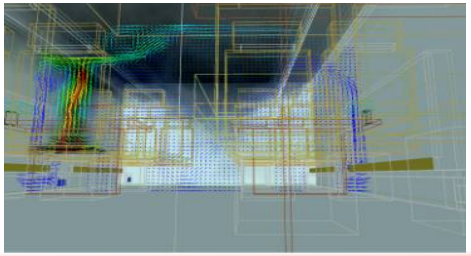
validation

Full scale Fire test on product in vehicle

validation

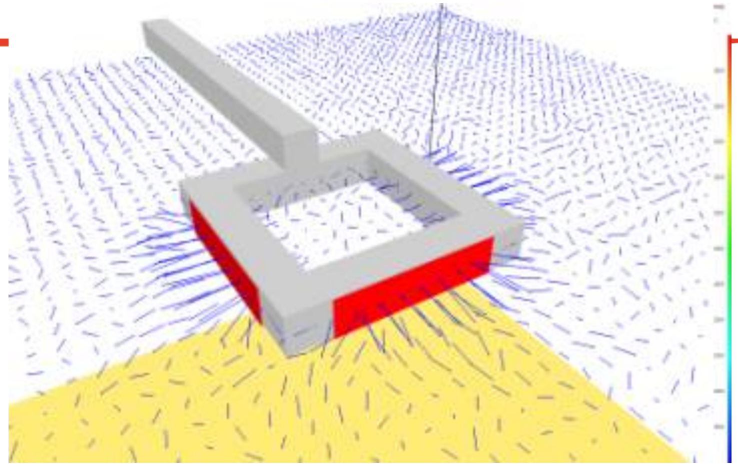
Fire growth, smoke movements models in vehicle

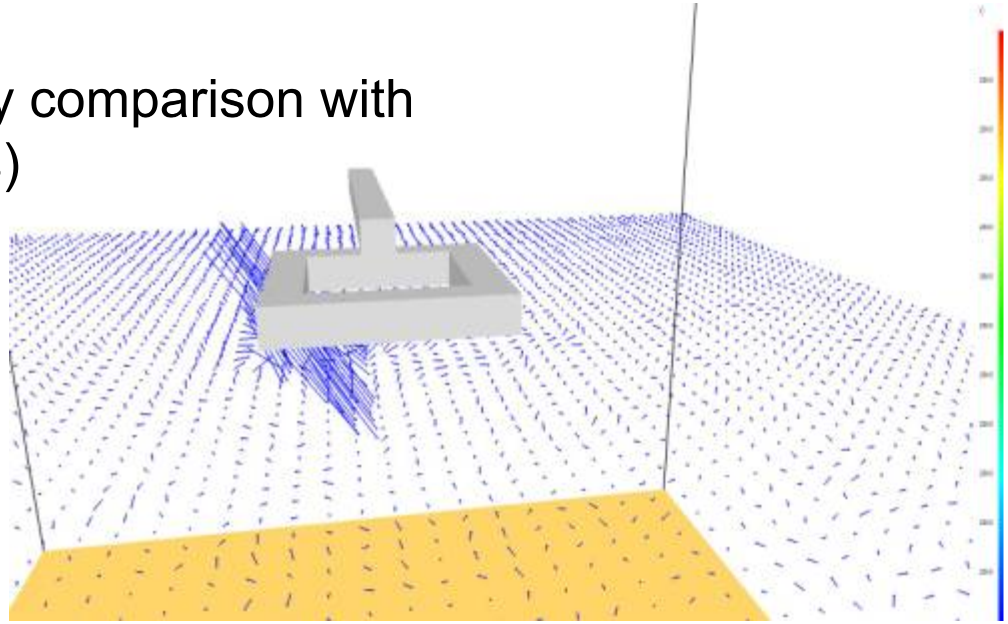




Example Burner modelling

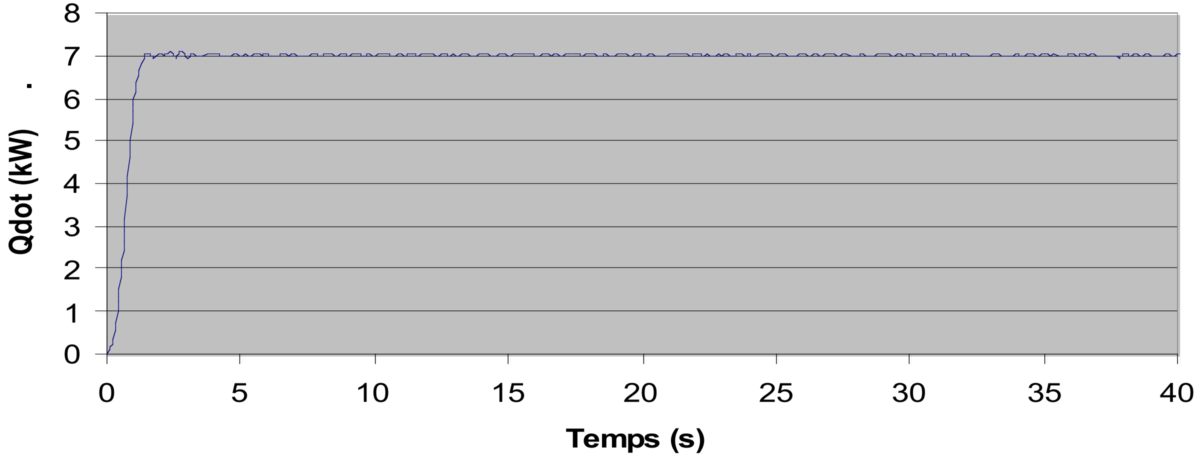
- EN 45545 Belfagore burner
- Global 7 kW HRR
- First step : global validation on HRR
- Second step : local validation by comparison with Firestarr data (Heat flux gauges)



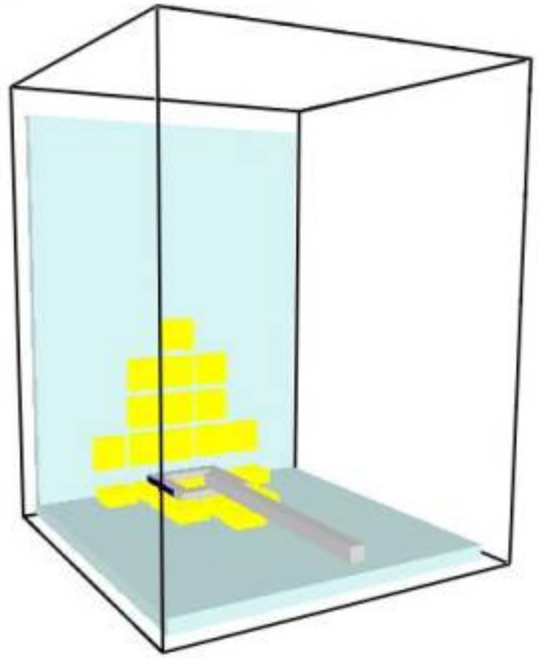


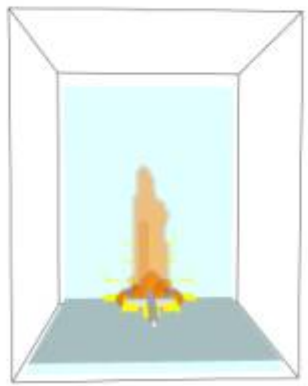
Burner modelling – global validation

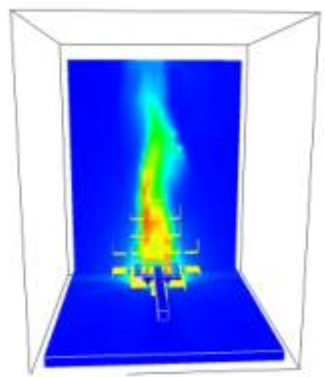
- HRR of 7 kW validated



Time (min)

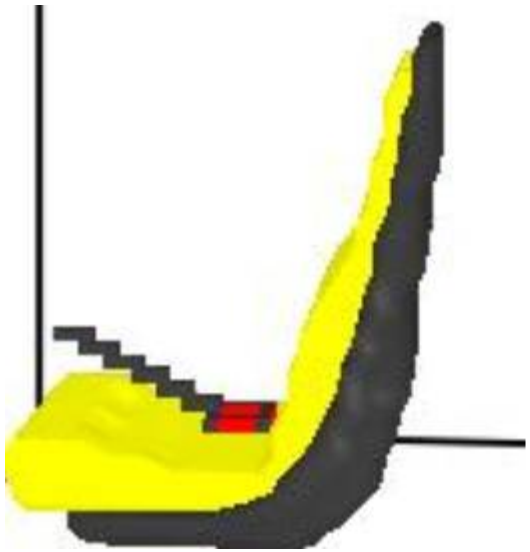






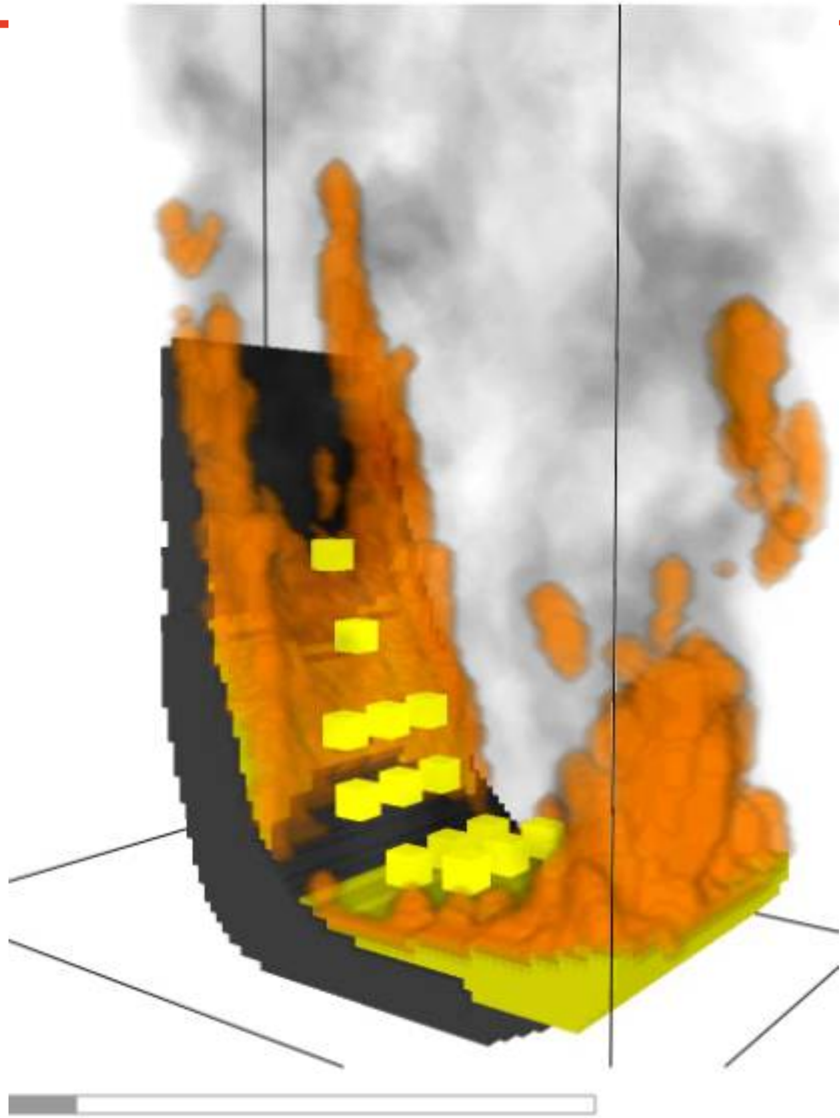
Seat modelling

- Fine modelling of a seat foam (without seat cover)
- Foam properties studied :
  - Thermal capacity and conductivity,
  - Ignition temperature,
  - Critical mass loss rate,
  - Heats of gasification and combustion…
- Modelling option
  - Disappearing of burnt elements



Seat modelling - validations

- Comparison following ISO 16730 between experiment and model
- Evaluation of sensitivity to cells size (1cm – 2 cm – 4 cm)

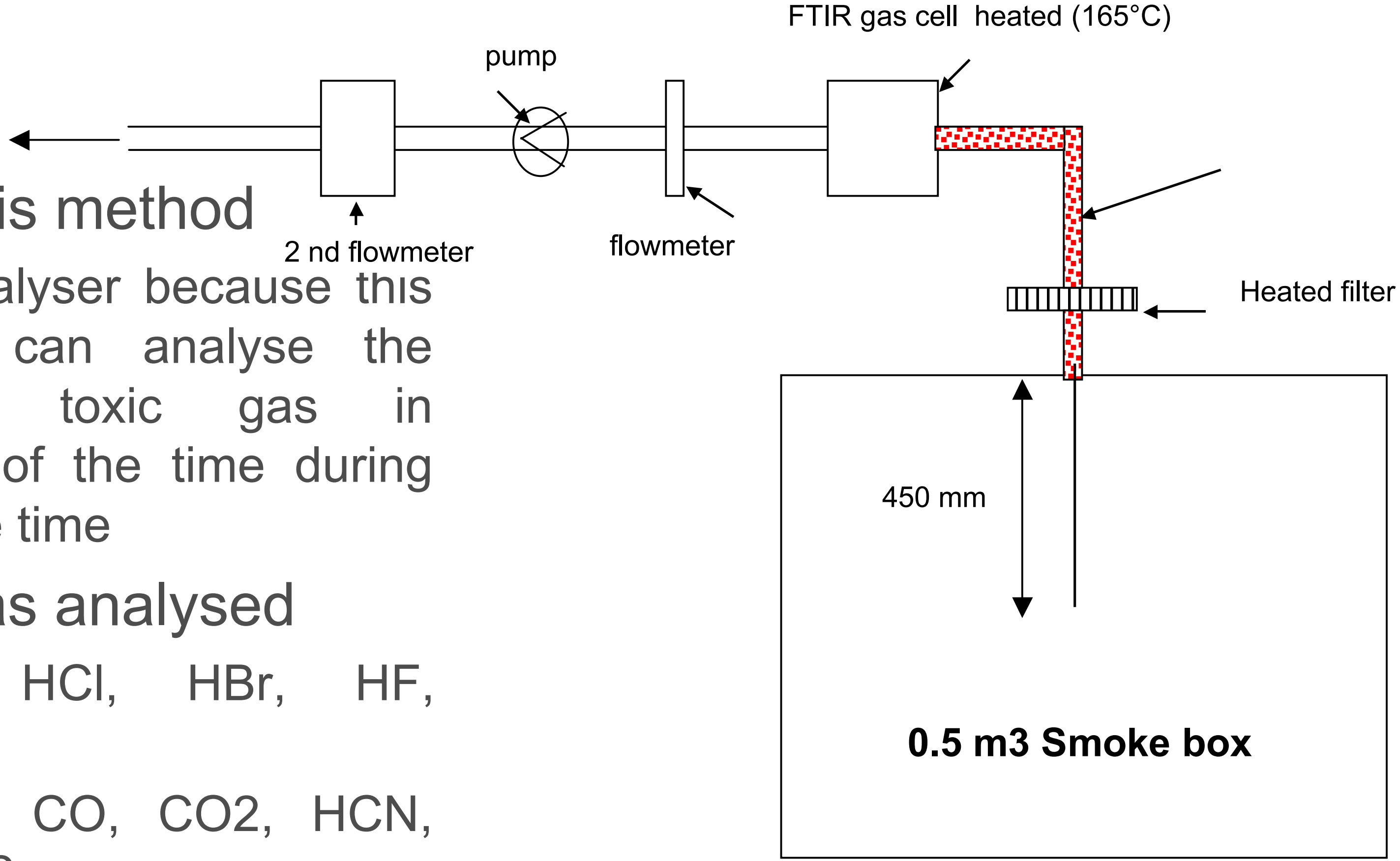


Small scale test method to be developed (WP2) for fire toxicity evaluation

- Objective
  - Developing a small scale test which
    - measure the concentration of toxic gas in function of the time
    - It can be used for the modelling
    - it is repeatable and reproducible

- Model of fire selected:
  - a small closed box (0.5m3) in a vitiated atmosphere which correspond the worst situation in a closed vehicle
  - Ignition source: cone electric furnace combined with a gas pilote flame which reproduce a thermal attack between 25kW/m2 and 50 kW/m2

Small scale test method to be developed (WP2) for fire toxicity evaluation



- Gas analysis method
  - FTIR analyser because this method can analyse the principal toxic gas in function of the time during the same time
- Types of gas analysed
  - Irritant: HCl, HBr, HF, acroléine
  - Narcotic: CO, CO_2, HCN, Nox, SO_2

Classification of toxicity effect of gas (WP3) from Small scale test results

- Pragmatic approach
  - prediction (using a simple model of coach) of the ASET according to the toxic hazard from the results obtained in small-scale tests
  - ASET is determined by the estimation of the time to reach incapacitating toxic conditions (Conventional Index of Toxicity CIT=1) at different locations by using a conventional mathematical model described in CEN/TS 45545-2 combined with a pragmatic simulation tool for distribution of the toxic gas in a volume described in WP4

$$\mathrm{CIT}(t) = \frac{0.51\mathrm{m}^3 \times \mathrm{Am}^2}{\mathrm{Vm}^3 \times \mathrm{k}(t)} \times \sum_{i=1}^{i=8} \frac{c_i\ (t)\mathrm{mgm}^{-3}}{C_i\mathrm{mgm}^{-3}}$$

- ci (t) is the concentration of the gas i in function of the time,
- Ci is the Critical Concentration of the gas I,
- K(t) is the dilution coefficient predicted by the simulation tool of the gas distribution described in the WP4
- V is the dilution
- A is the burning surface area of the products in a train

Classification of toxicity effect of gas (WP6) from Small scale test results

- FSE approach
  - Prediction of the toxic effect by combining the fire growth prediction with the smoke movement and atmospheric dispersion simulation base on the modelling tools

conclusions

- FSE is a complement to normal prescriptive rules and cannot replace every tests on elements

- FSE is more flexible than prescriptive approach

- TRANSFEU will permit to develop this methodology based on a robust method for the fire toxicity evaluation

Thank you for your kind attention !

More information on:
www.transfeu.eu