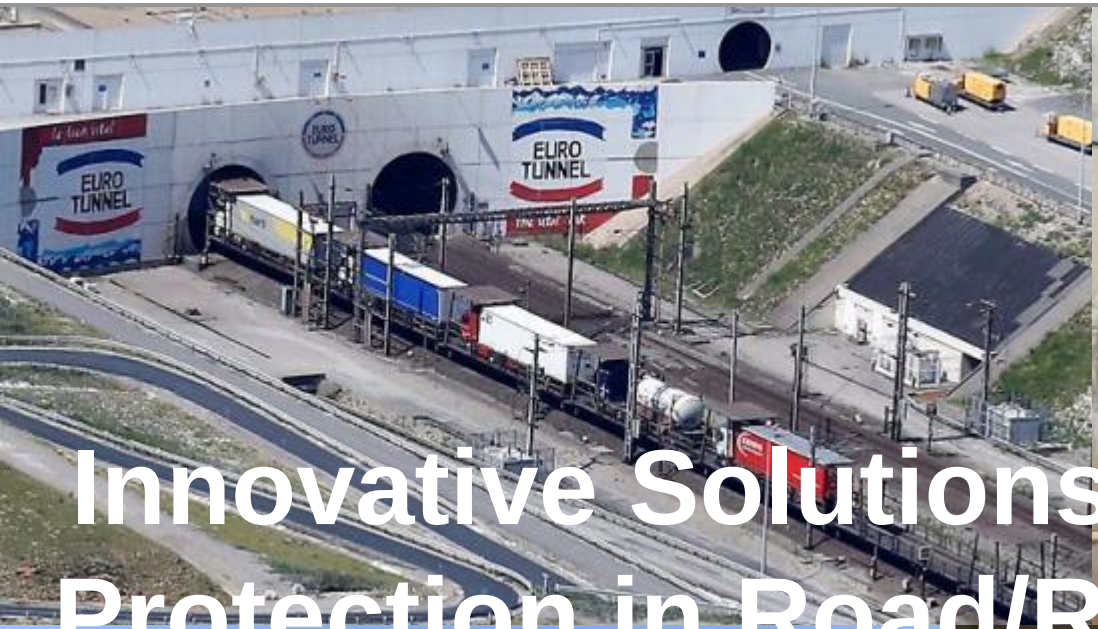
FOGTEC FIRE PROTECTION

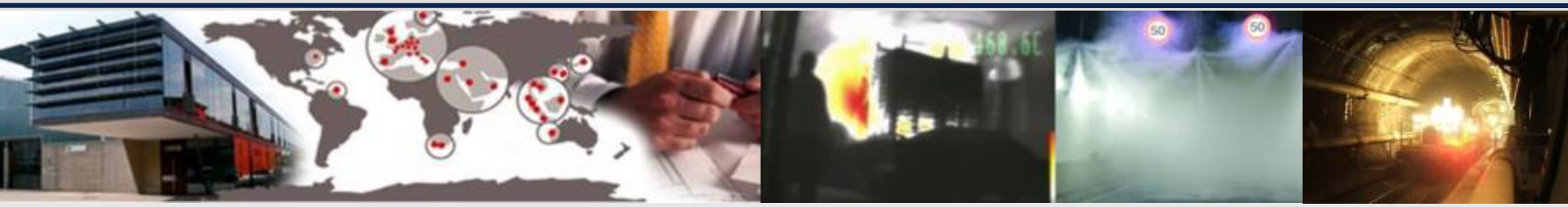


Innovative Solutions for Active Fire Protection in Road/Rail Tunnels and Underground Facilities

Roger – A. Dirksmeier, FOGTEC Fire Protection, Germany

Fire Protection Conference Tel Aviv, 4th of April 2016

FOGTEC tunnel systems



- **Services from consulting to comissioning**
  - **Fire fighting, detection and control systems**
  - **Fire tests**
  - **Reliability (RAMS) studies**
  - **References from installations in 5 countries**
- **Very active in international research projects**
- **Member of important working groups / standardisation**

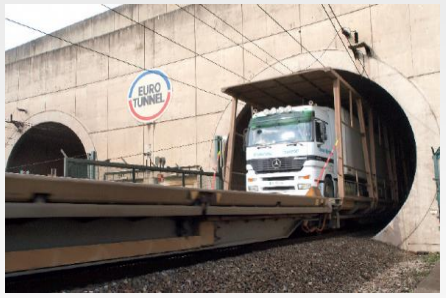
Full scale fire tests

Year	Country	Project/Program/Organisation	Project	Class A – HGV tests (up to)	Number of tests
2001	Hungary	Metro Budapest		10MW	5
2004	EU	UPTUN		30MW	60
2006	Germany	SOLIT – Safety of Life in Tunnels		100-200MW	55
2006	Spain	Madrid Bomberos		25-150MW	10
2006	Spain	Madrid Municipality – M30		150MW	3
2008	France	CSTB scaled tests		Scaled	
2010	UK	UK Highways Agency		100MW	20
2010	France	Eurotunnel		200MW	4
2011	Germany	SOLIT – Safety of Life in Tunnels		100-150MW	30
2011	Germany	Sprinkler reference tests		100MW	5
					187

Some large reference projects of FOGTEC

- **EUROTUNNEL (Channel tunnel)**
  - **2 rail tunnels**
  - **SAFE stations (4 pcs)**
- **TYNE TUNNEL SYSTEM**
  - **2 road tunnels**
- **DARTFORD TUNNELS**
  - **2 road tunnels**



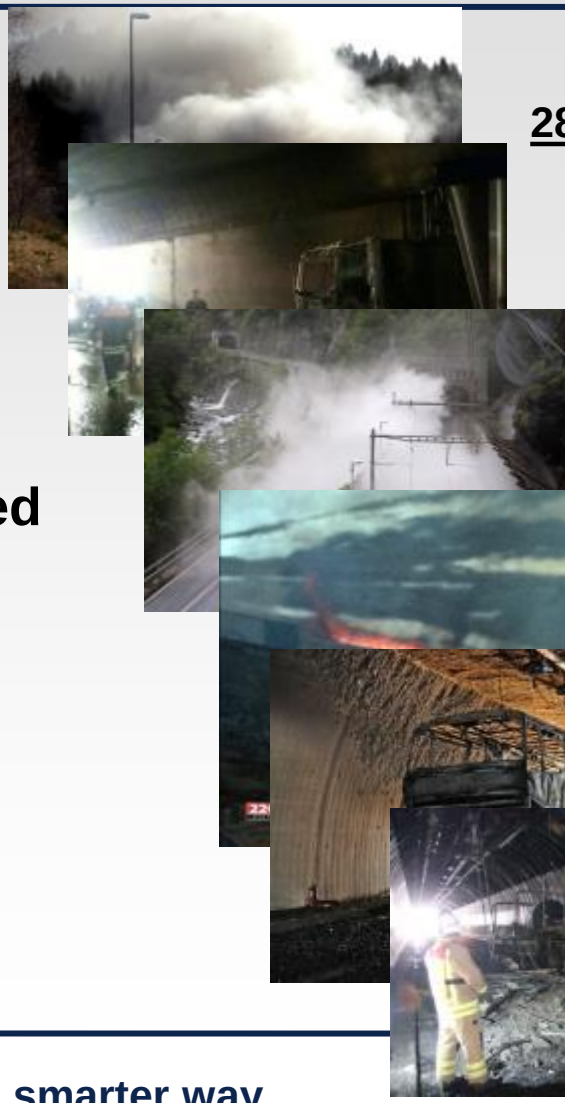




FOGTEC FIRE PROTECTION

FIXED FIRE FIGHTING SYSTEM TO TUNNELS?

Fixed fire fighting systems to tunnels – Why needed?

- **Why?**
  - Fires do happen
- **Why?**
  - Problems occur when HGVs (trucks) or busses get involved
- **Why?**
  - Improving life safety
  - Safety of fire services
  - Asset (tunnel) protection



OSLO
28.3.2011 (again in June)

HAMBURG
31.3.2011

SIMPLON Tunnel
11.6.2011

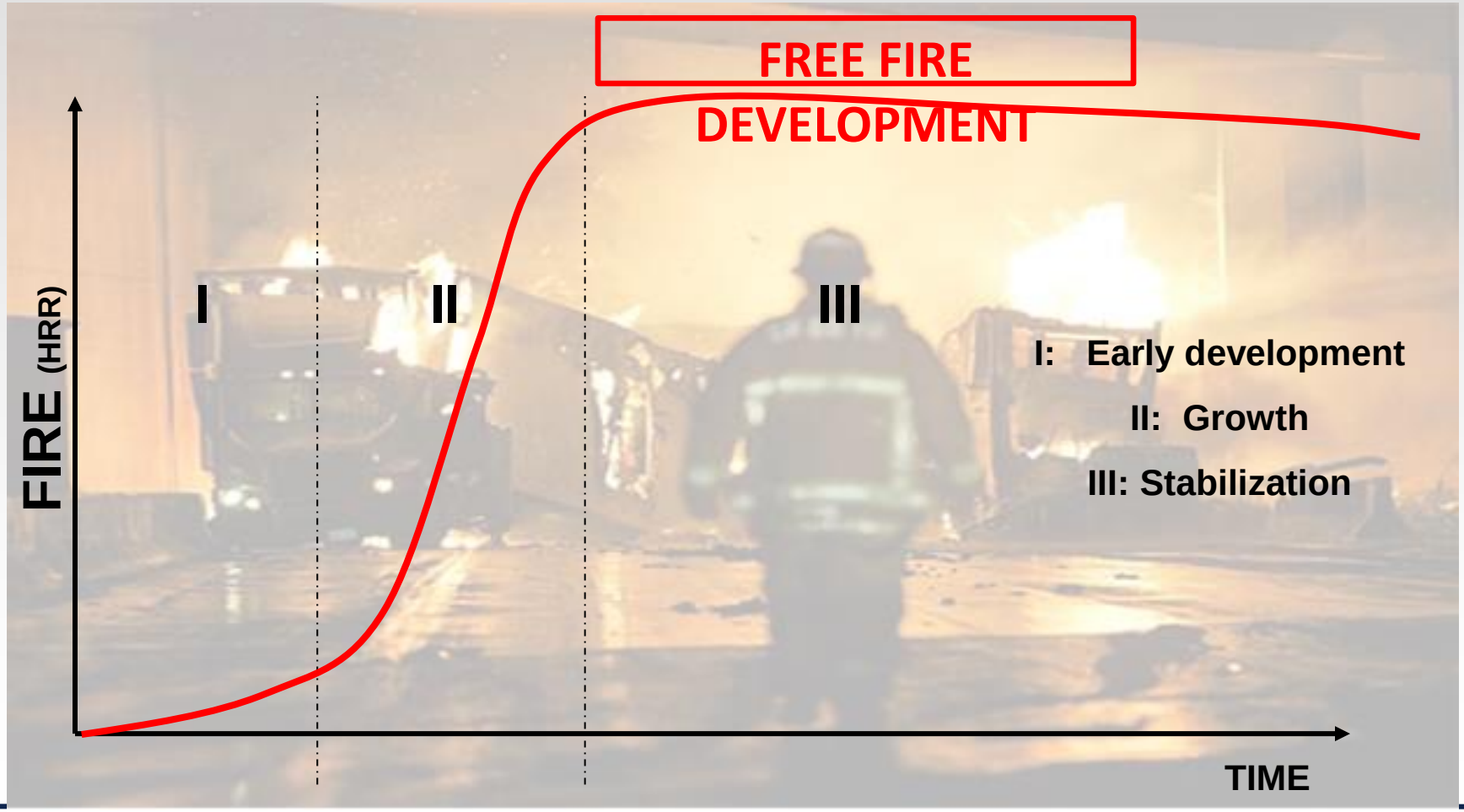
Bergen
16.6.2011

Zurich
19.6.2011

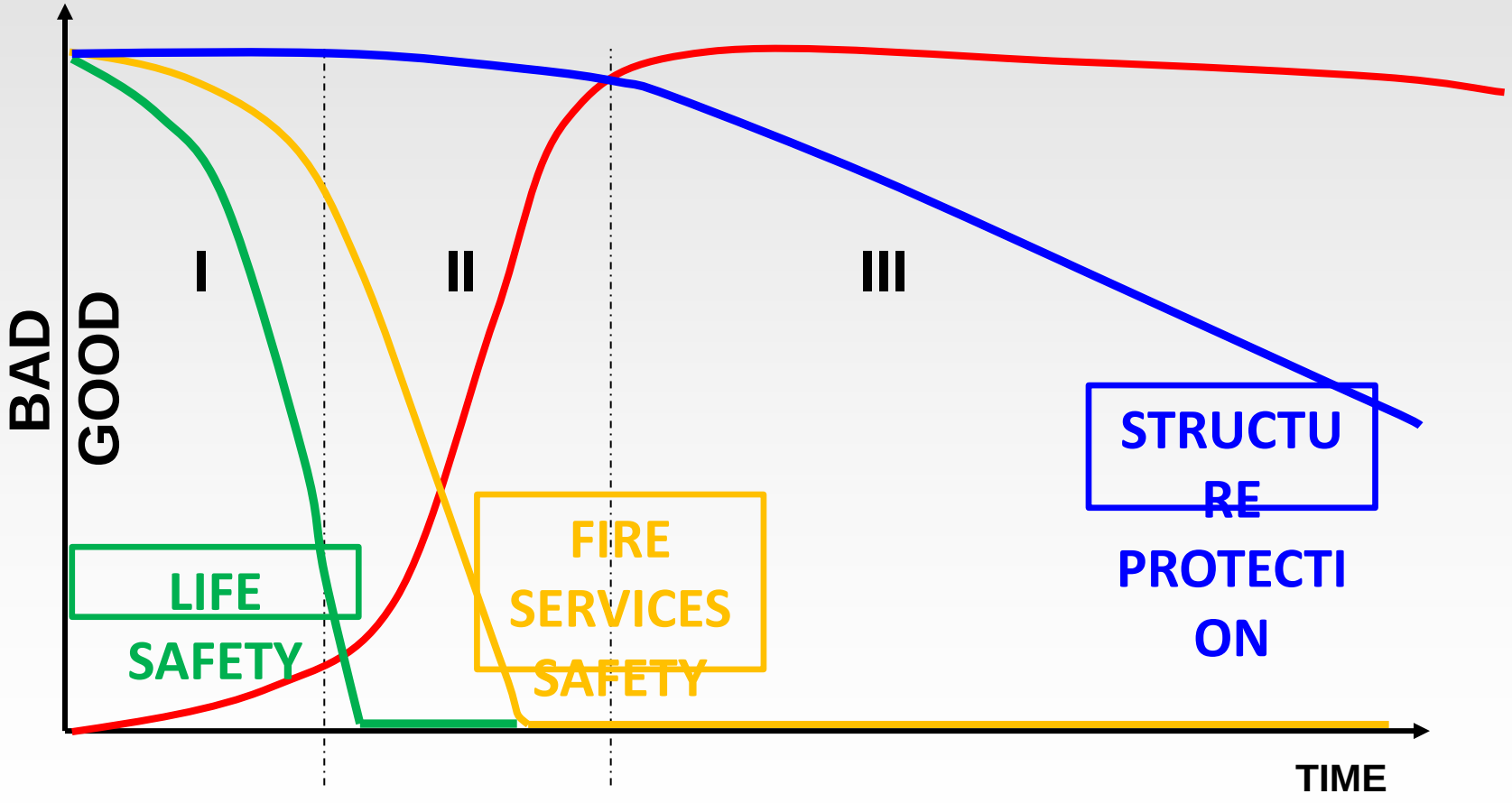
Brynglas
26.7.2011

Fixed fire fighting systems to tunnels – Why needed?

Tunnel fires – Free development



Tunnel fires – Life, fire services and tunnel structure safety



Main enemies to fight – Time & Fire size?

LIFE SAFETY

- Time typically up 4-10 minutes / HRR up to 10-20MW
  - Depends on ventilation, fire scenario, tunnel design, location
  - Smoke (toxic gases, visibility), temperatures and radiant heat are main problems

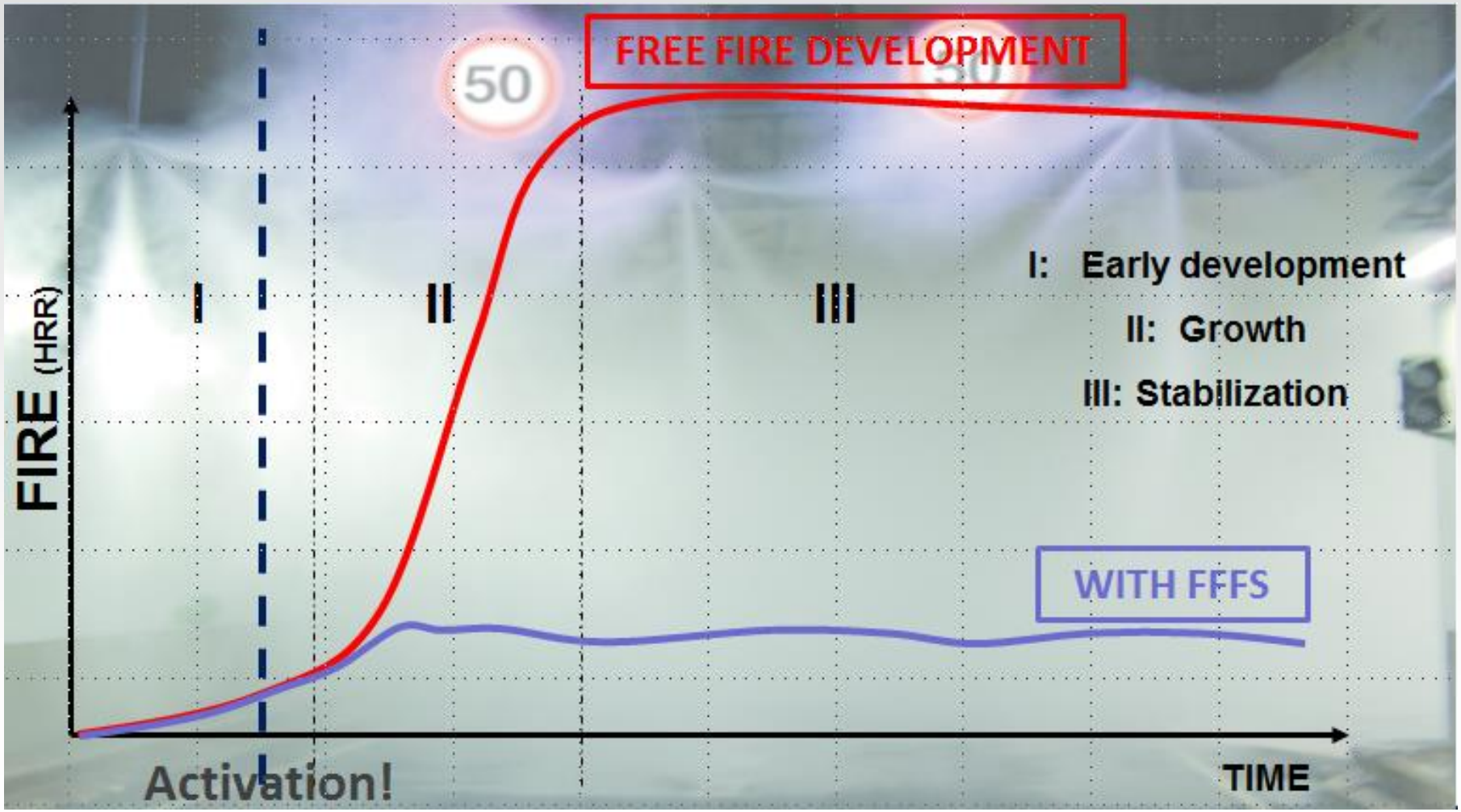
FIRE SERVICES SAFETY

- Time typically up to 10-20 minutes / HRR up to 20-40MW
  - Depends on ventilation, fire scenario, tunnel design
  - Smoke (visibility) and escpecially radiant heat are main problems

STRUCTURE INTEGRITY

- Strongly dependent on structure protection and fire scenario
  - Damages occur immediately, level of damages is related to time / temperature
  - Different design curves ISO/RWS/HC/RABT

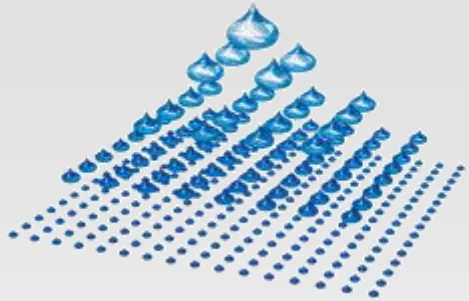
Tunnel fires – Fire fighting systems (FFFS)



FIXED FIRE FIGHTING SYSTEMS BACKGROUND

FOGTEC (FOG = small droplets) “Smarter way of fire fighing“

- **Applying high-pressure system to generate small droplet sprays that have been noticed to extremely effective fire fighting method (big surface area)**



=> 1 liter of water has 20m2 surface are with 100µm droplets

Works by COOLING:

- **Energy absorption of 1 liter of water:**
  - **2257 kJ by transition from liquid to gas**

=> No other agent with such heat absorption effect!

Works by INERTING locally

=> 1 liter of water will be 1640 liters of vapor!

Fixed fire fighting systems to tunnels – PIARC, NFPA, UPTUN

- **Safety of tunnel users**
  - Temperature, toxic gases, tenability

- **Minimizing fire spread**
  - Next truck (target) 5m downstream, no ignition

- **Safety of first responders (access)**
  - Radian heat, smoke production, temperatures

- **Improving performance of ventilation**

- **Limiting structural damages**

FOGTEC FIRE PROTECTION

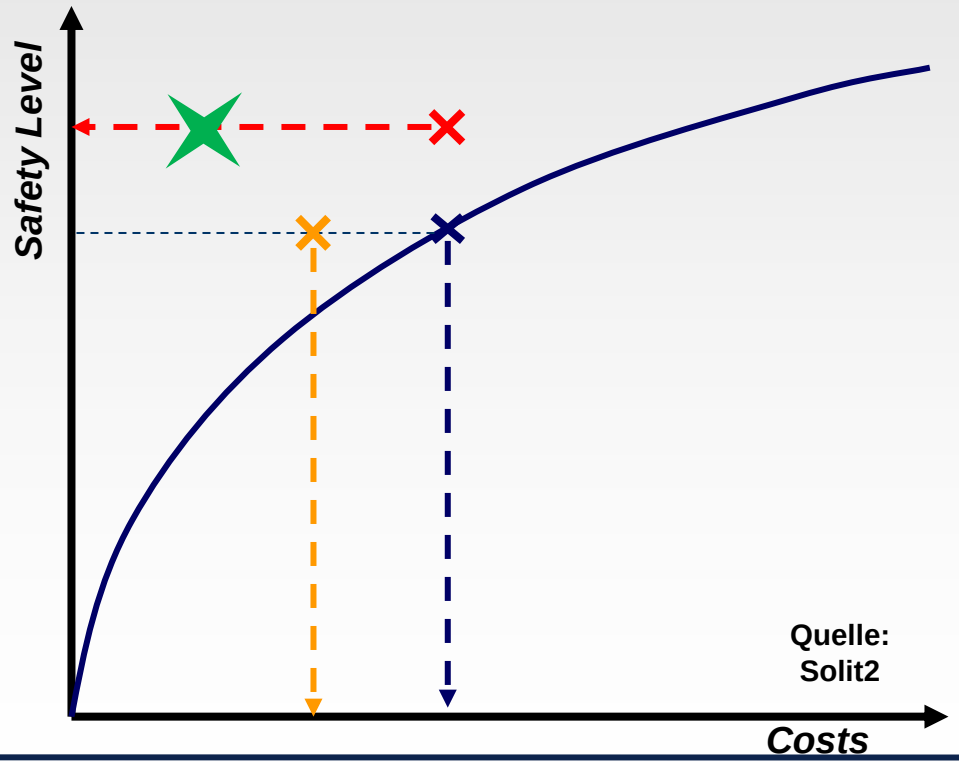
SOLIT2 RESEARCH PROJECT – FUTURE OF TUNNEL FIRE SAFETY

FOGTEC FIRE PROTECTION · STUVA · BUNG Beratende Ingenieure · RUB · TÜV SÜD · IFAB · INSTITUT der FEUERWEHR Sachsen-Anhalt

bast · ADAC · Freistaat Thüringen Innenministerium · TÜVRheinland®

Changing from Current Status to holistic approach!

Since a lot of years FOGTEC is realizing, what approved research projects now confirmed (e.g. SOLIT 2):



Increasing Safety Level→ higher costs

Increasing Safety Level → same costs

Same Safety Level → lower cost

Smart Concepts Scenario

FOGTEC® FIRE PROTECTION

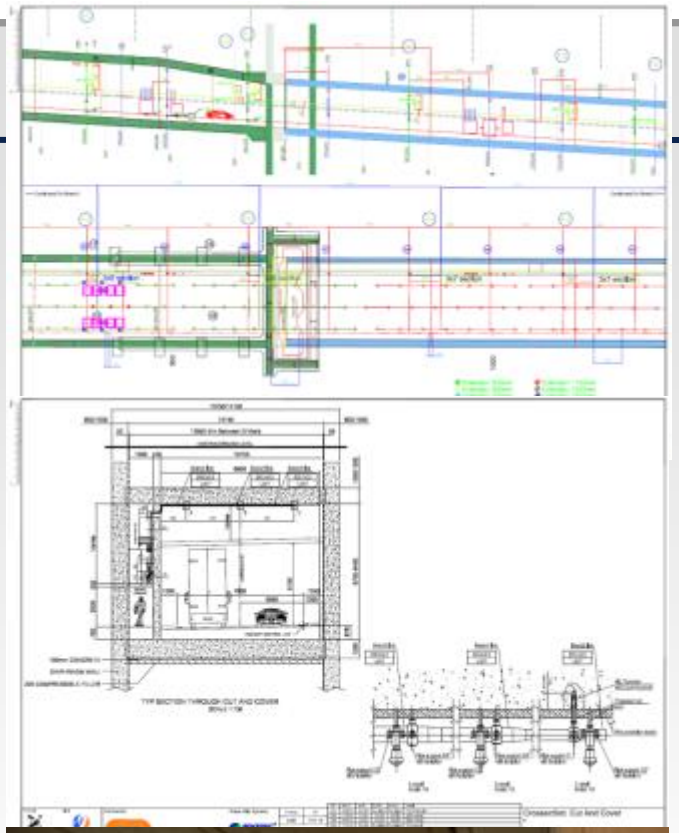
CASE STUDY – TYNE TUNNELS

Tyne Tunnels

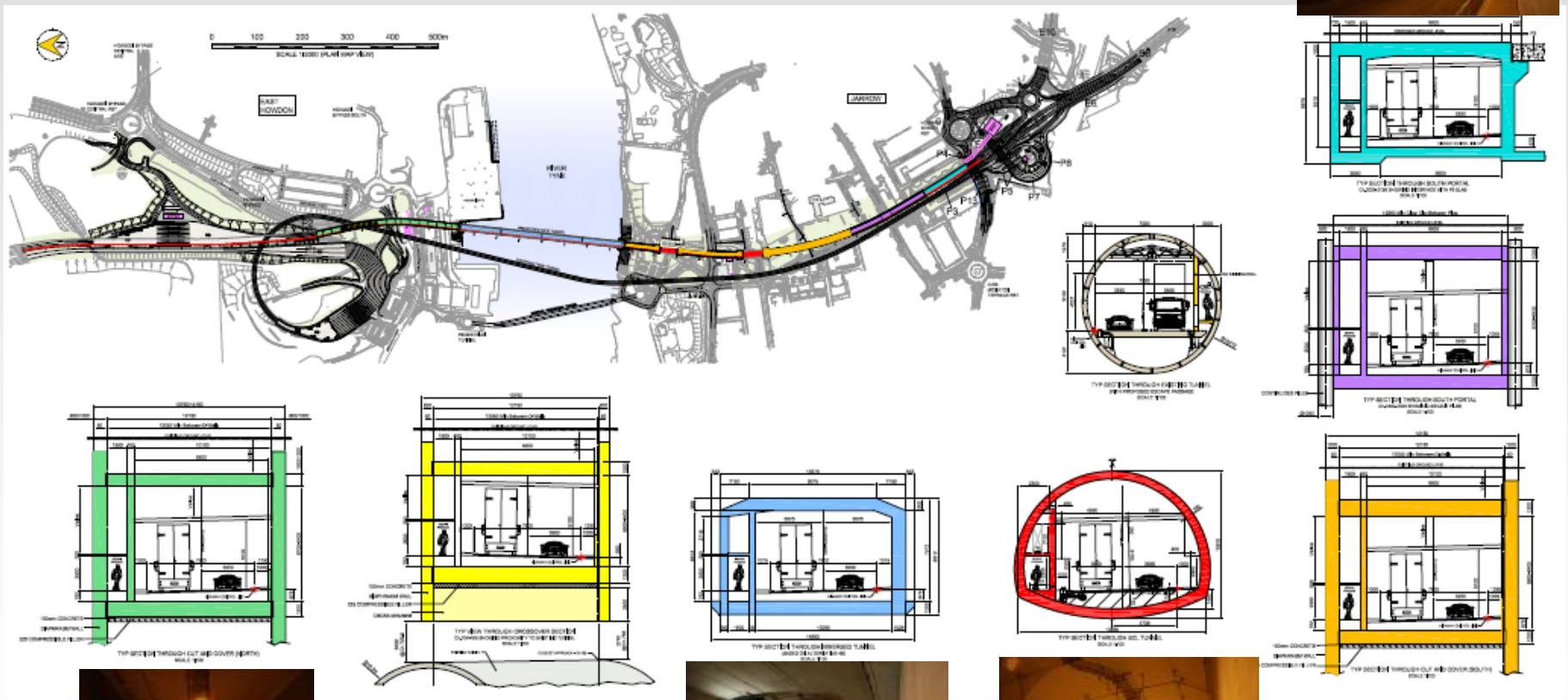
- Location in Newcastle, UK. Tunnels go under river Tyne.
- Two tunnels (approx 1,5km):
  - Existing tunnel built 1967
  - New tunnel opened 2011
- Traffic amount 38 000 vehichles per day
- Several different tunneling methods / cross-sections
- Very modern tunnel (new tunnel)
- Very important for operator and surrounding society

Tyne tunnels – Design Parameters

- Section length: 25 meters
- Number of sections: 60 (new) + 68 (existing)
- Activation: 3 sections simultaneously
- Total pump capacity: 3250l/min
- Maximum pressure: 140bar
- Design basis: SOLIT fire tests
- Engineering basis: UPTUN Engineering guideline – Report R251



Tyne tunnels - Design



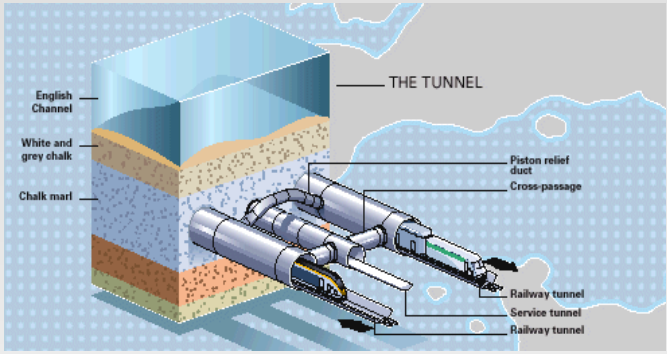
FOGTEC® FIRE PROTECTION

CASE STUDY – EUROTUNNEL SAFE PROJECT

EUROTUNNEL

EUROTUNNEL (Channel tunnel) :

- Two rail tunnels and one service tunnel, length of tunnels is ~50km
- About 3300 employees in total
- Average traffic per day:
  - 21 000 passangers
  - 5250 cars and 150 busses
  - 2500 trucks
  - 27 000 tons of freight
- Short crossing time: 35 minutes
- Very reliable and independent on weather
- Environmental friendly



Eurotunnel – Major fires

- **1996:**
  - **Tunnel damaged on 400m distance (concrete from 0,4m to 0,02m), tracks replaced 500m, 800m of catenary/cooling pipes replaced, signaling equipment damaged for 1500m, 4 escape doors replaced.**
  - **Train burned with the distance of 400m with trucks on board.**
  - **Loss of traffic 1996, -60% (5mths)**

- **2008:**
  - **Tunnel damaged for over 650m distance, over 1000°C temperature, almost whole train 800m as well as trucks damaged.**
  - **Fire lasted 16 hours**
  - **Loss of traffic -50% (4mths)**

=> Financial impact of fires very high and additionally loss of positive image

Eurotunnel – Major fires

PROJECT SAFE

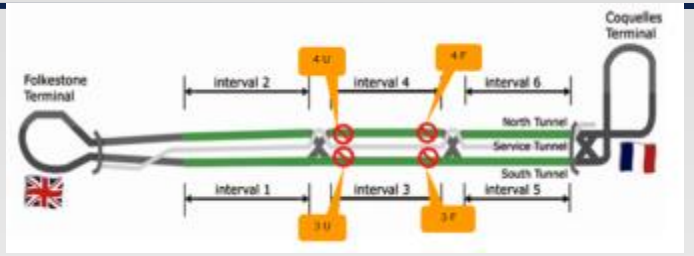
EUROTUNNEL: SAFE project background

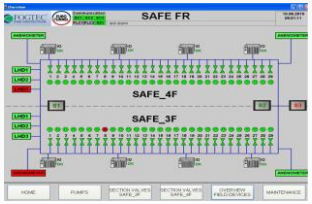
- Eurotunnel could not suffer anymore such fire incident
- SAFE project to further improve fire safety:
  - Developed for HGV fires (main hazard similar than in road tunnels)
  - No major modifications to infrastructure
  - Short recovery time after fire
  - Full RAMS studies and high design availability for FFFS (99.98%)
- Several technologies were considered. Only high-pressure water mist was seen suitable for the purpose

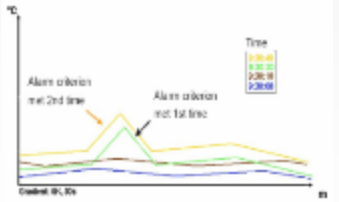
EUROTUNNEL: SAFE project

SAFE stations are installed to 2 locations along the tunnel (4 SAFE stations in total)

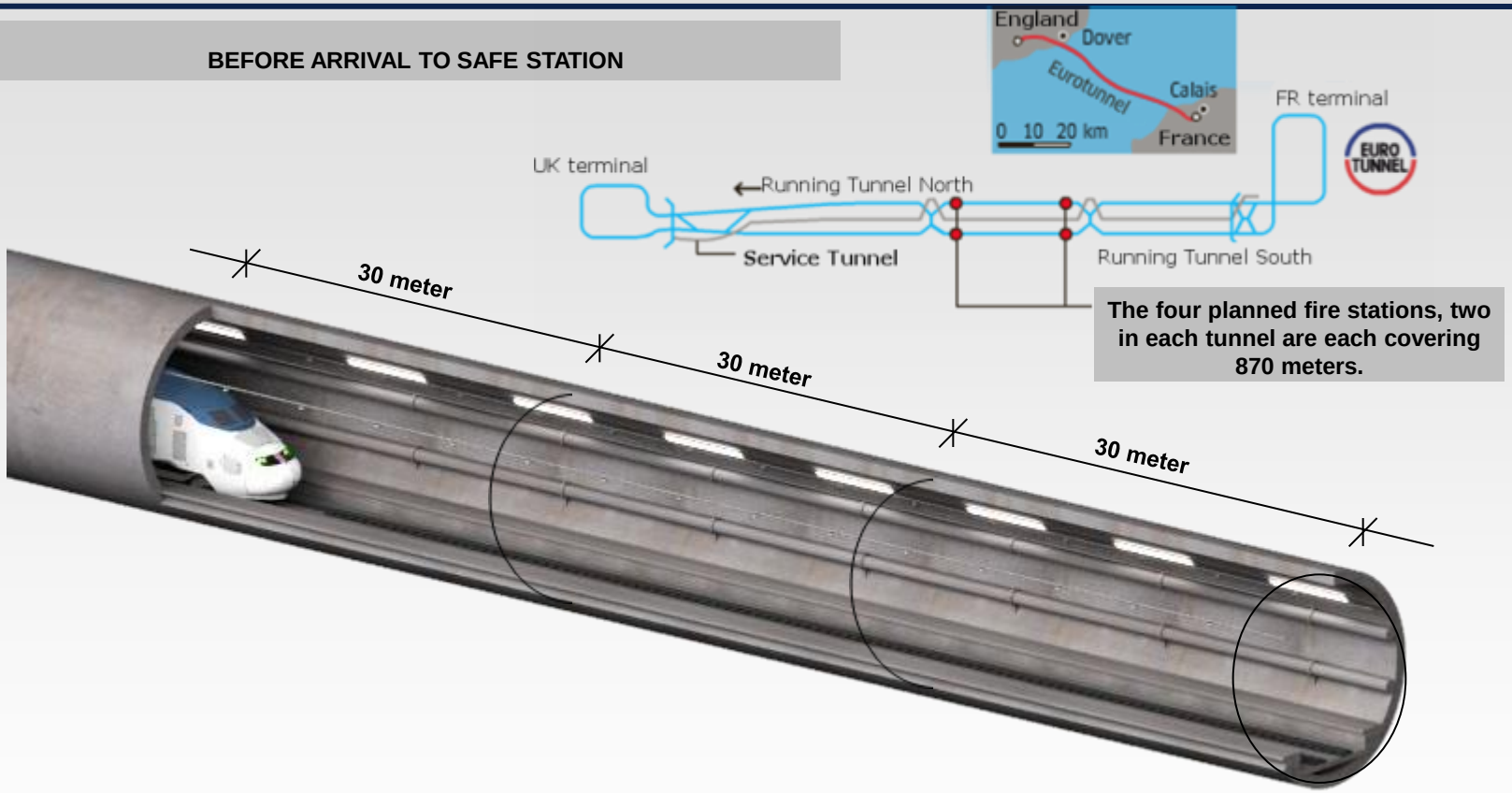
- Meant for shuttles carrying trucks
- All SAFE station are 870m
- Fire protection sections is 30m and 3 of them are activated simultaneously
- SAFE station includes additionally:
  - Integrated fire detection/ localisation system
  - Control/SCADA system
  - Video surveillance system





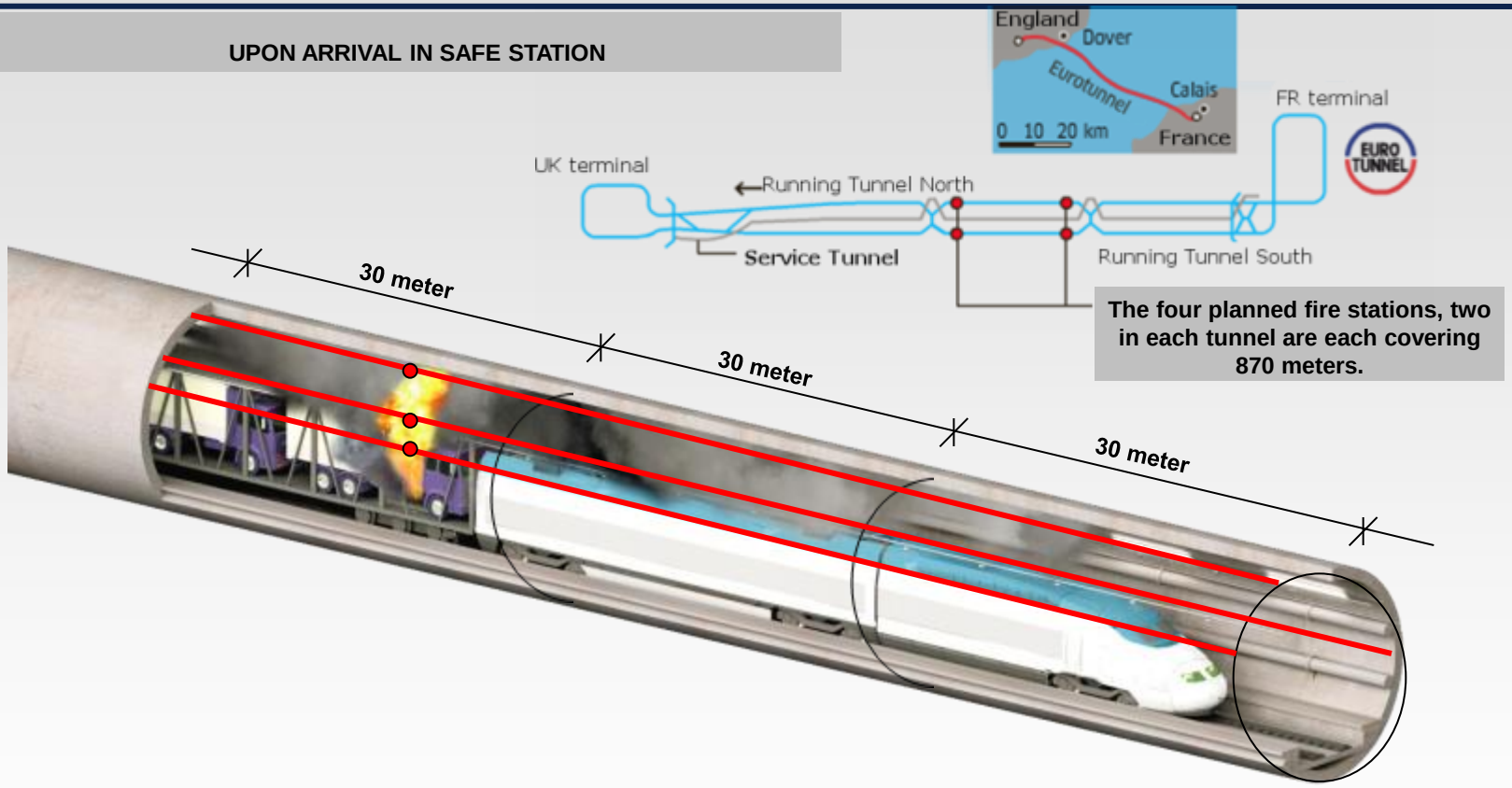


BEFORE ARRIVAL TO SAFE STATION



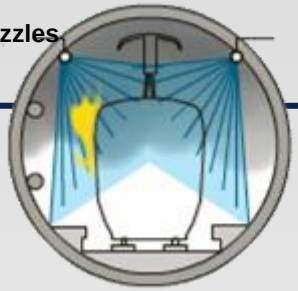
The four planned fire stations, two in each tunnel are each covering 870 meters.

UPON ARRIVAL IN SAFE STATION



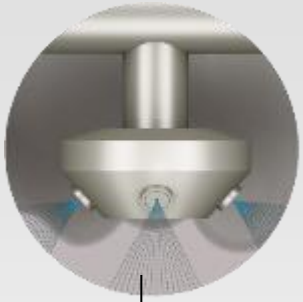
The four planned fire stations, two in each tunnel are each covering 870 meters.

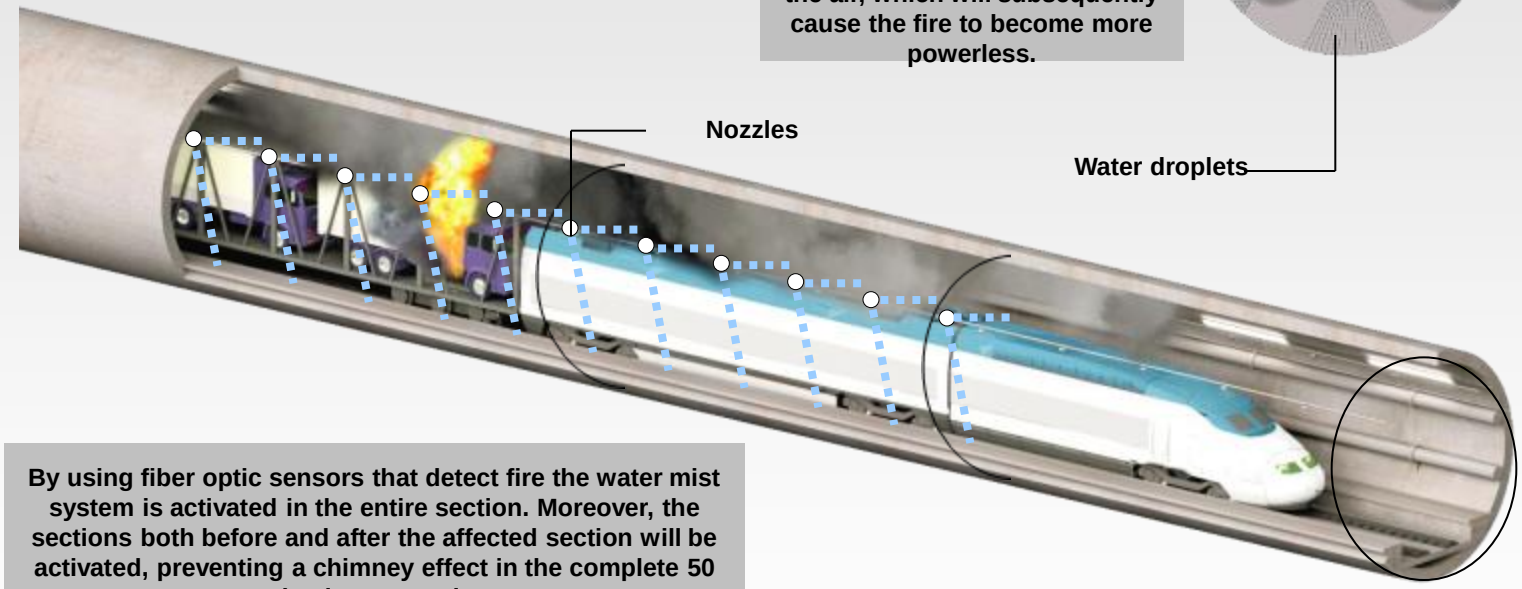
The nozzles of the water mist system are placed on the tunnel ceiling on each side of the train at a distance of three meters. In total there are 600 nozzles installed in each fire station.



When the microscopic water droplets reach the flames, they instantly evaporate and lower the flame temperatures.

The steam displaces the oxygen in the air, which will subsequently cause the fire to become more powerless.





The Water mist system has been tested under real conditions in a test-tunnel similar to the Channel Tunnel which had shown the capability to reduce the temperature from 900°C to 250°C in less than three minutes.

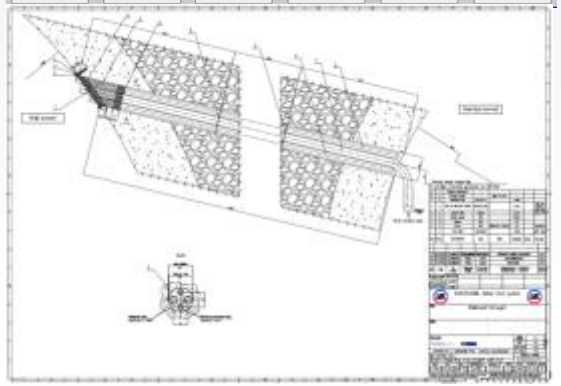
low-pressure sprinkler systems the droplets from high pressure water mist system of FOGTEC are microscopic. This means that they easily evaporate when the mist comes close to the fire. The evaporation increases the water volume and thus replaces the oxygen in the air near the fire source.

By using fiber optic sensors that detect fire the water mist system is activated in the entire section. Moreover, the sections both before and after the affected section will be activated, preventing a chimney effect in the complete 50 km long tunnel.

PROJECT SAFE - IMPLEMENTATION

PROJECT SAFE – Challenges

- **Implementing the tested system to real tunnels**
  - Very limited installation times (slots) available for rail tunnels
  - Reaching the installation areas (long distances)
- **Full integration in the Eurotunnel safety concept**
  - Integration of control systems
  - Integration of operating protocols
- **Very challenging design aspects**
  - Material tolerance against possible high temperatures before activation
  - Harsh environment
  - Extreme high availability 99.98% (proper RAMS studies) => Robust and maintenance free components

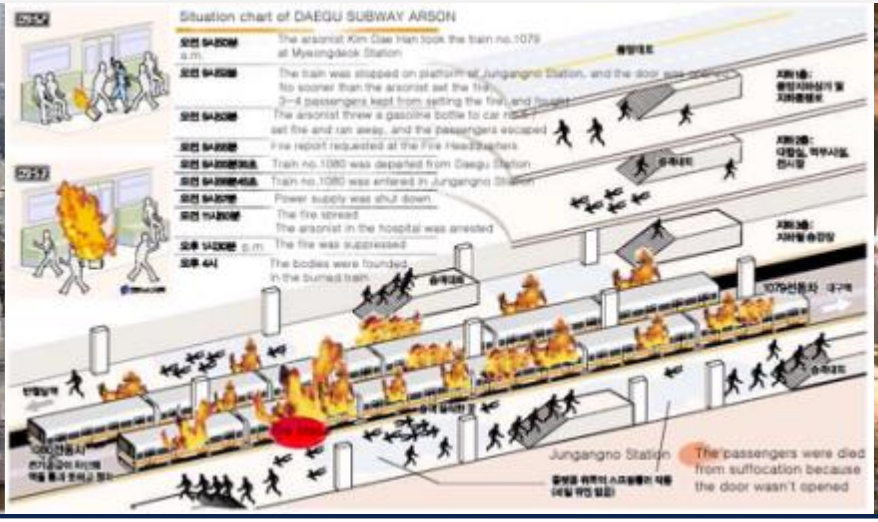


Eurotunnel installation

Tests with installation have shown:

- No negative effects with 25kV catenary and activated water mist
- Visibility for fire services and evacuation is sufficient
- Water mist will be equally spready to activation area and ventilation has very minor effect to water distribution
- Integration of water mist system locally to fire detection and control system has worked succesfully, integration to RCC under work
- Eurotunnel very satisfied for the system

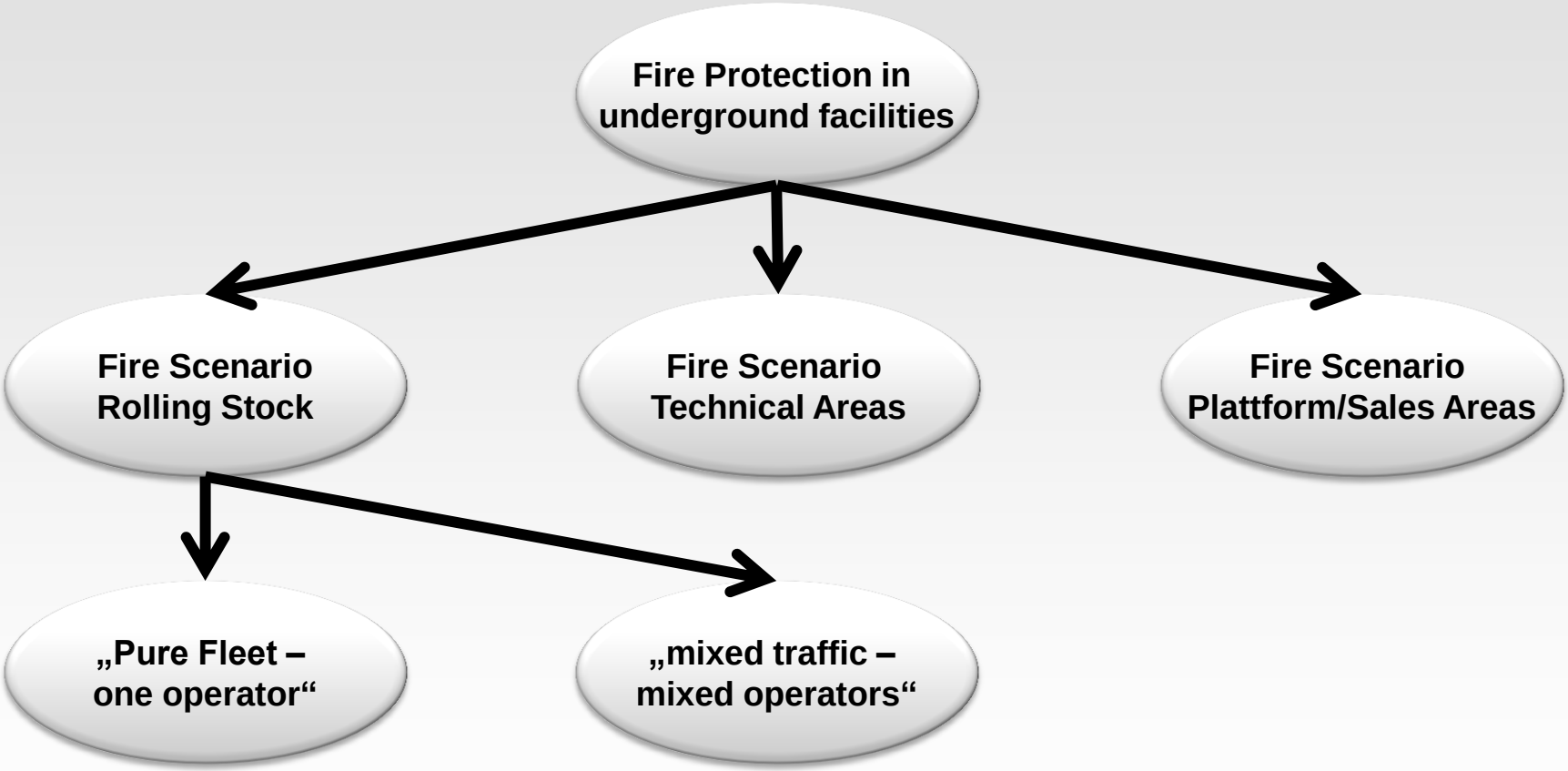
Underground Facilities for Public Transportation Systems



Case Study

On-Board-Fire Suppression System Affects Infrastructure Requirements

What means *Smart Concepts*?

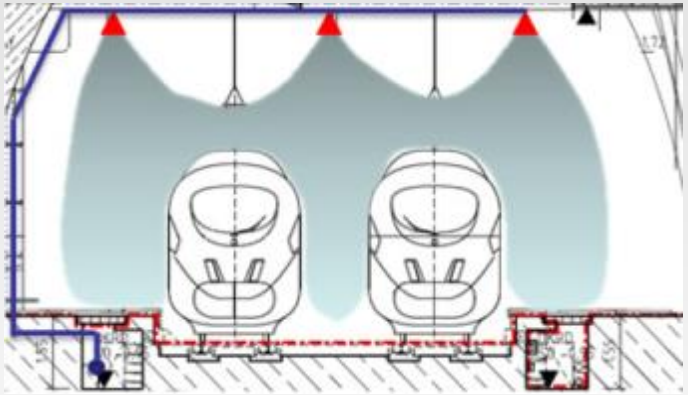


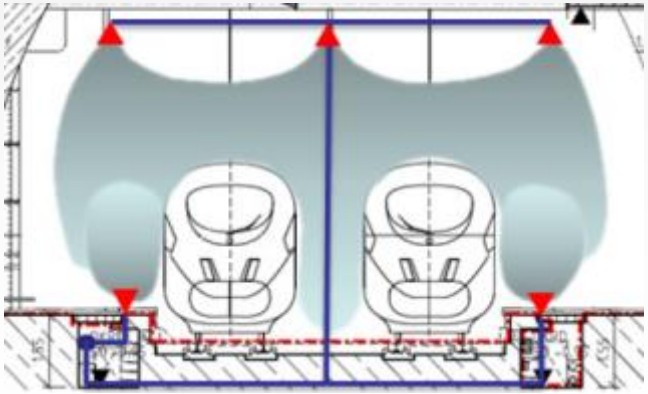
Application Specific Concept Development

Application Specific Concept Development

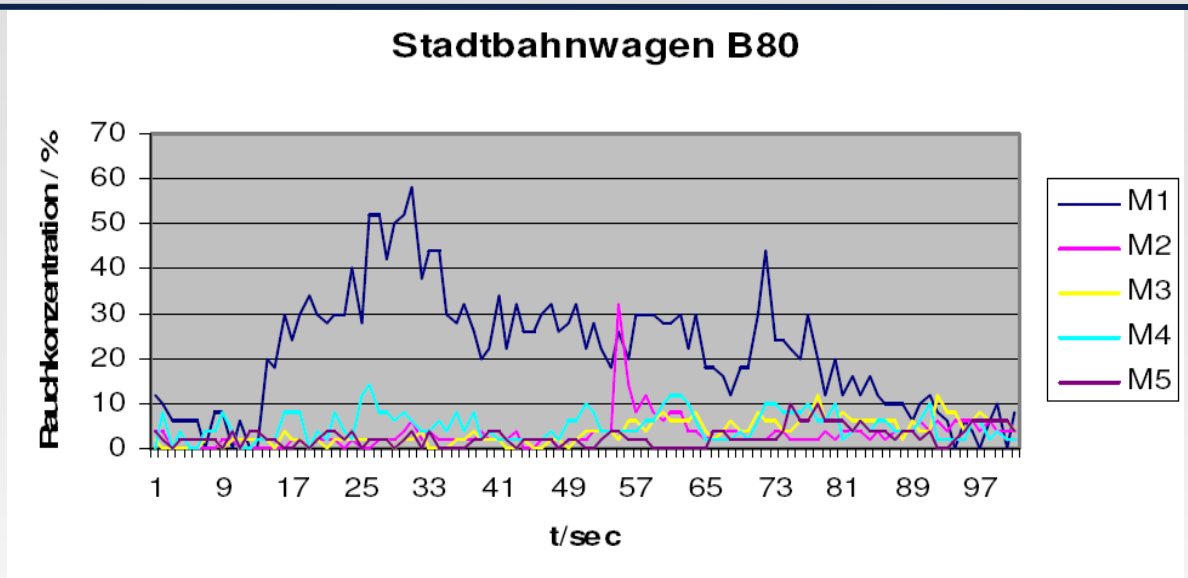
Pure Fleet – One Operator

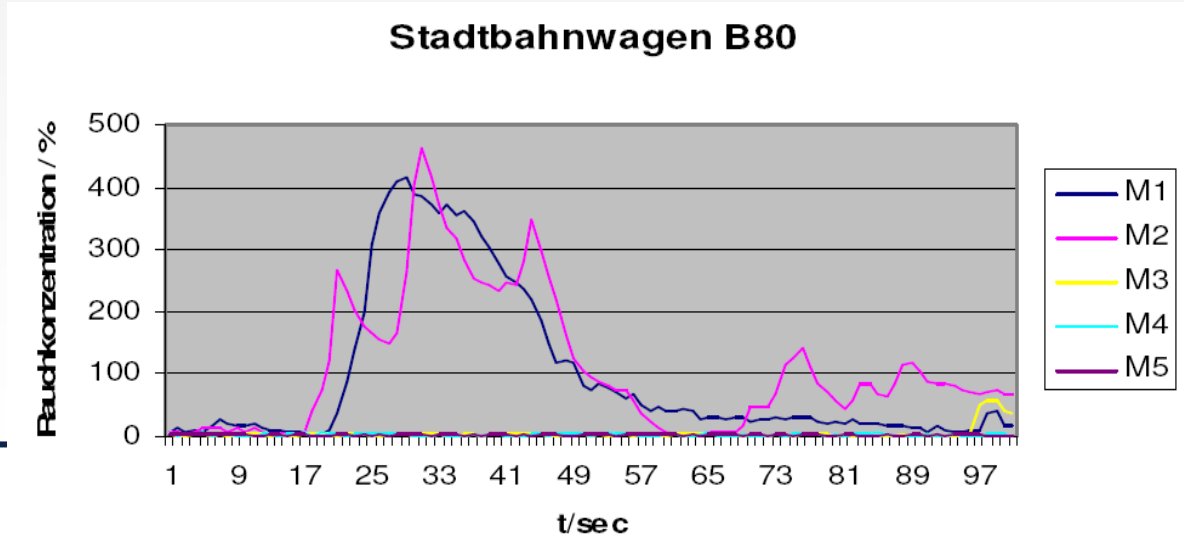
Mixed Traffic – Mixed Operators



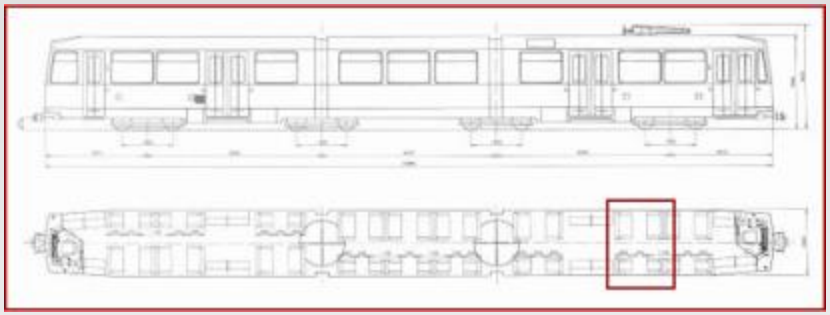


FOGTEC - Smart Concept – Case Study Phase 1

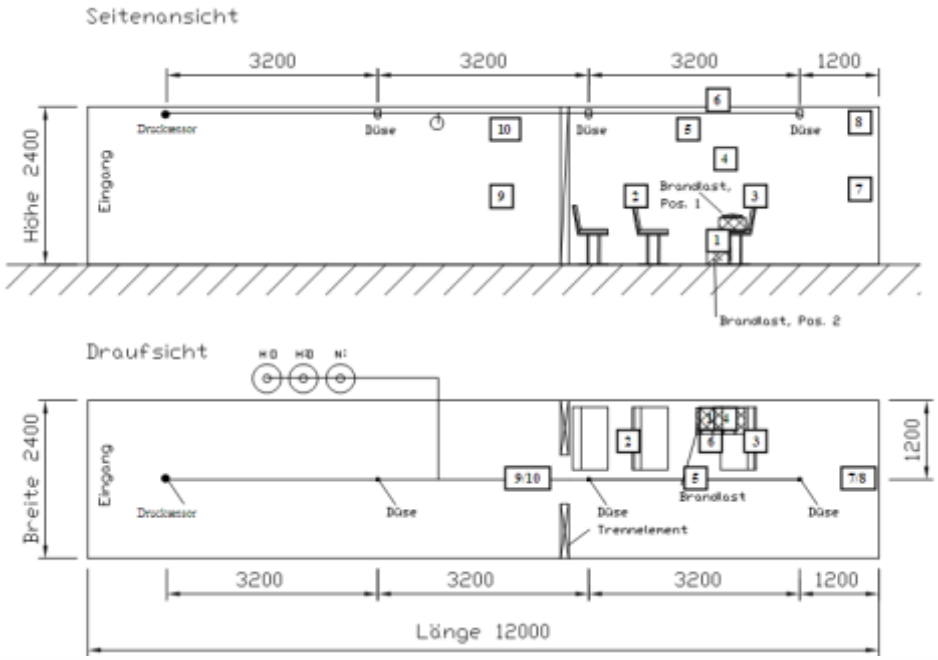


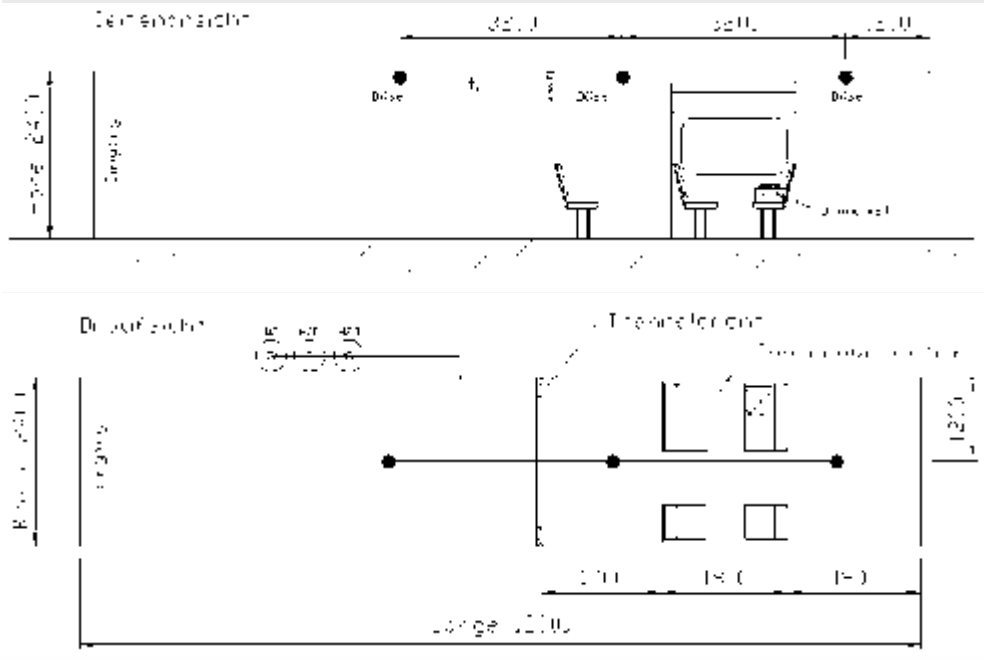


FOGTEC - Smart Concept – Case Study Phase 2



Transfer from reality to test mock-up





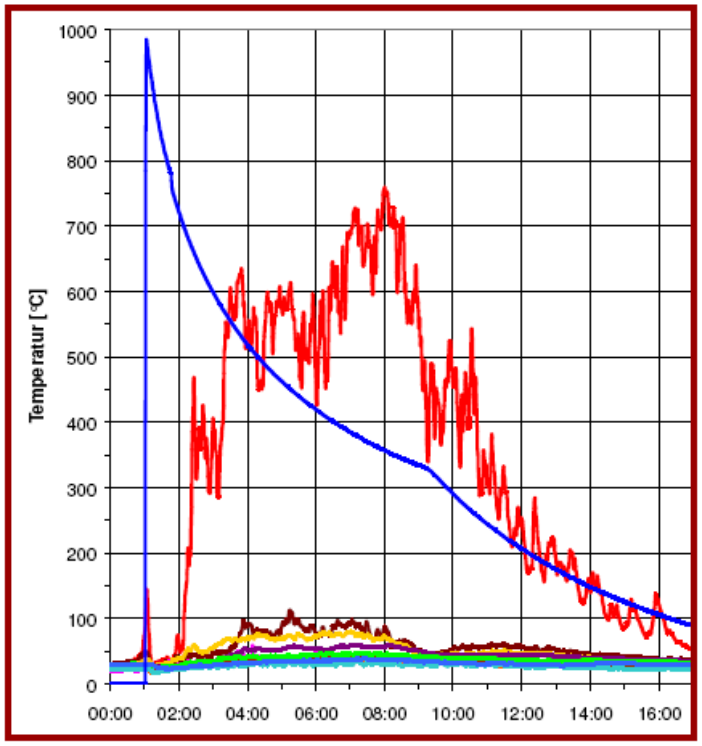
FOGTEC - Smart Concept – Case Study Phase 2

Full Scale Fire Test with Activation of FOGTEC System

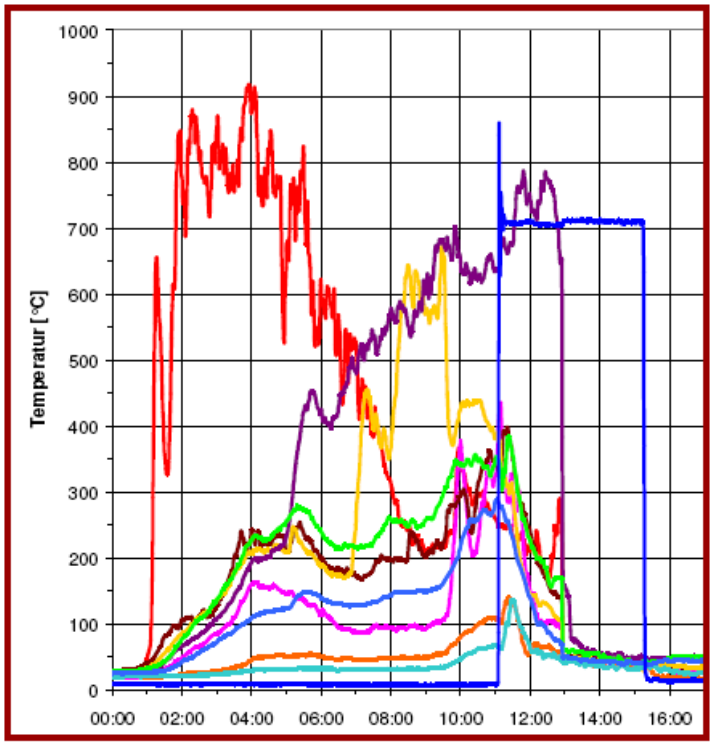
Full Scale Fire Test without Activation of FOGTEC System

FOGTEC - Smart Concept – Case Study Phase 2

Comparison with and without system (cushion on seats)

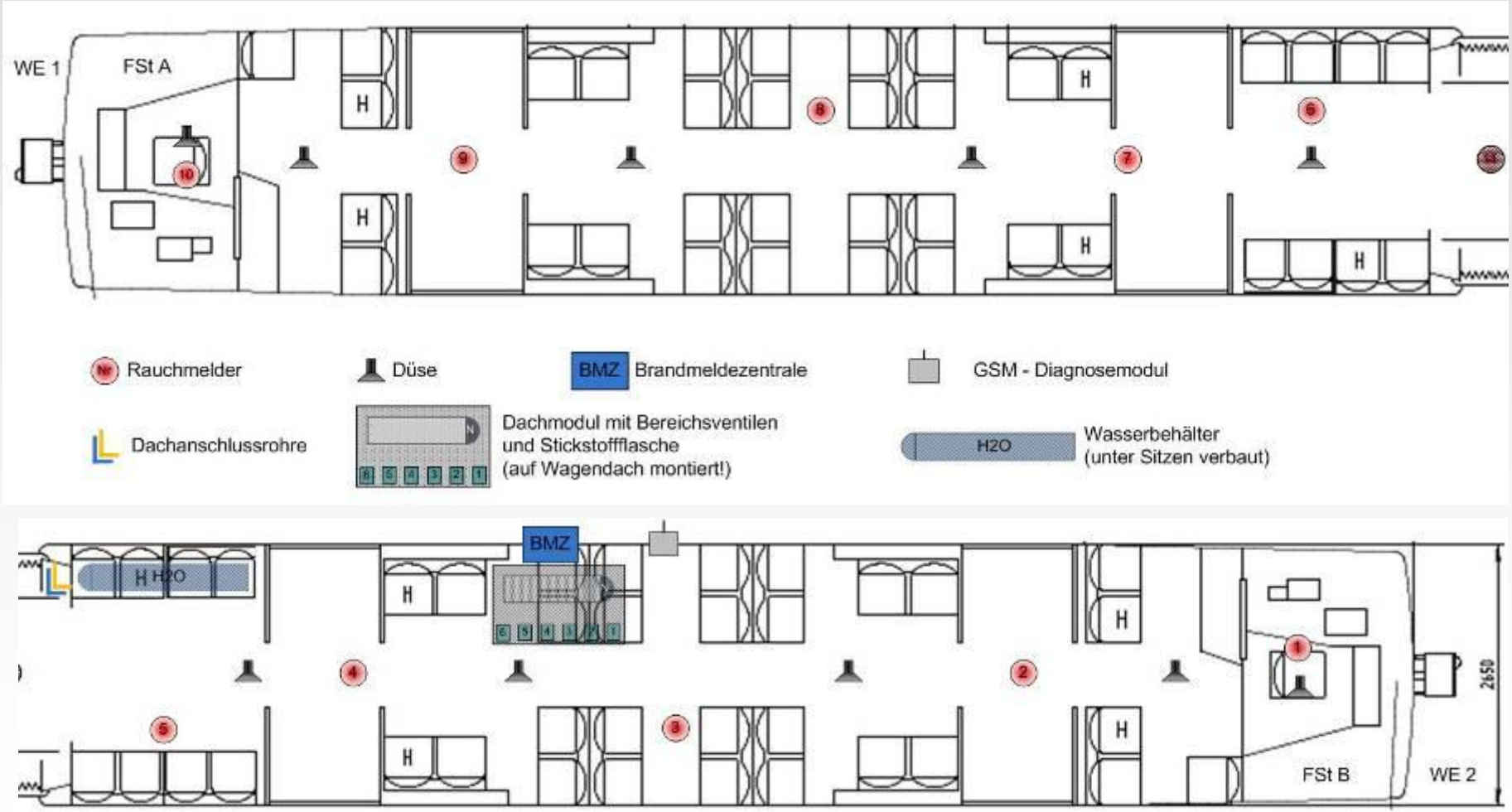


With activated FOGTEC System



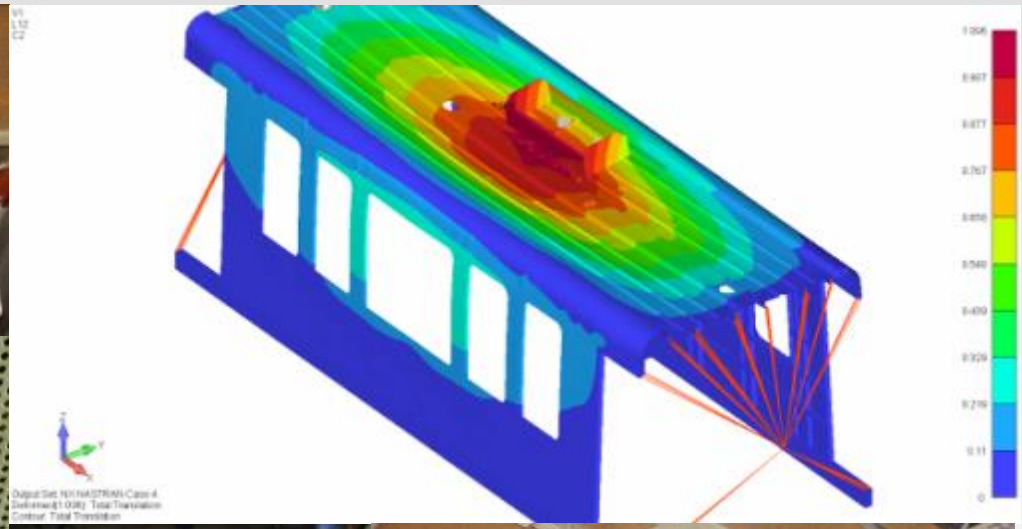
Without activated FOGTEC System

FOGTEC - Smart Concept – Case Study Phase 3



FOGTEC - Smart Concept – Case Study Phase 3









FOGTEC - Smart Concept – Case Study Phase 4

Approval Assessment done by IFAB and TÜV Nord

IFAB Institut für angewandte Brandschutzforschung

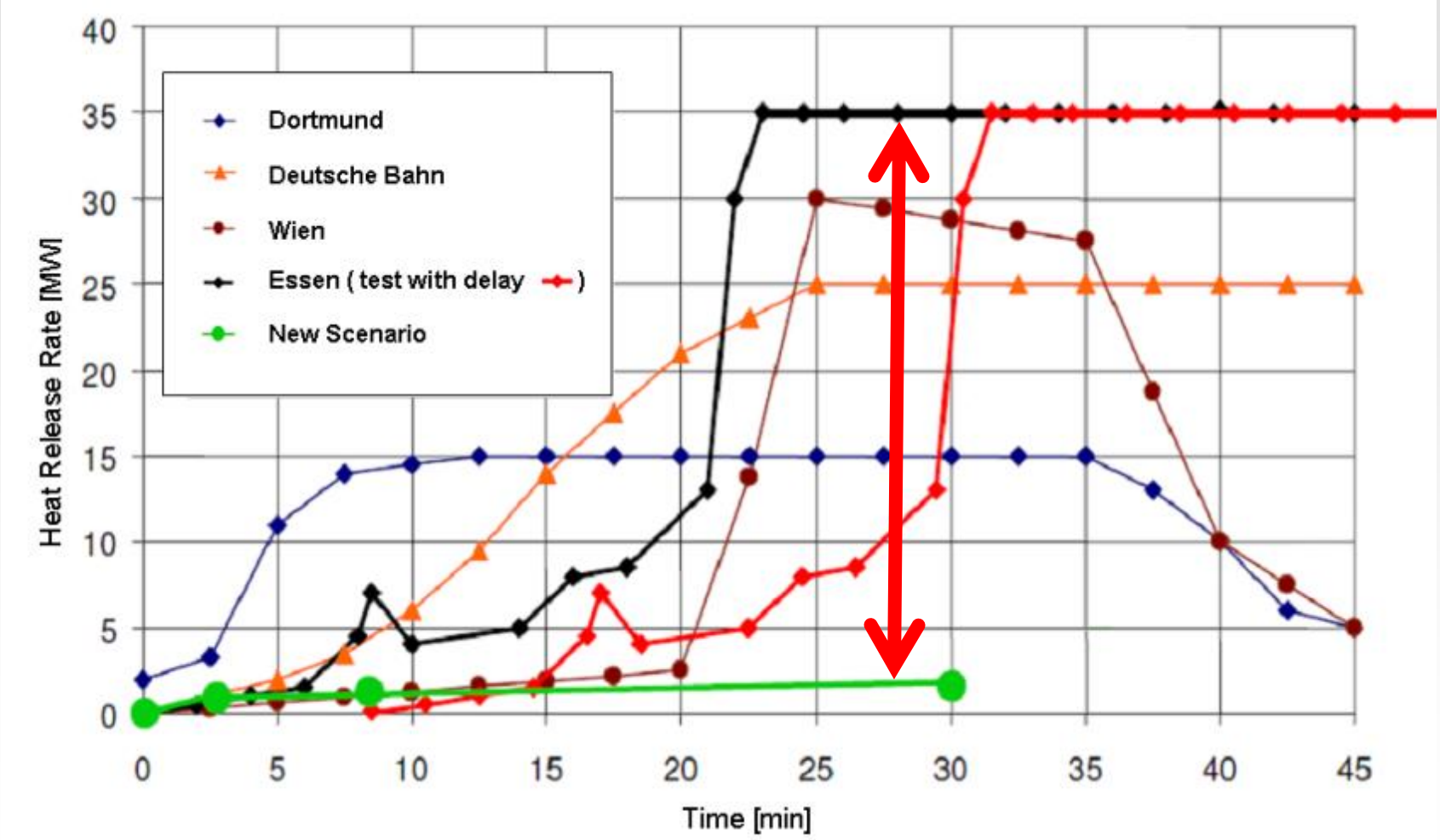
Versuchsdokumentation

Hochdruck-Wassernebel in Stadtbahnwagen

Brandversuche zur Beurteilung der Brandentwick-

Dokument: 08-BV04-02
Datum: 25.05.2009
Version: 01

After all the fire and approval tests…a new scenario…



What does it mean?

During the study done with the city of Essen in Germany, the result show an

- **decrease in investment by 89%**
- **increase in safety**
- **decrease in amount of needed energy**
- **increase in attractivity!**

Attractivity?

Yes, caused by smaller smoke extraction systems, other materials than normally required…

NFPA 130 is moving right…first standard taking care about…

Annex G On-board Fire Suppression System

G.1 On-board fire suppression systems (e.g., mist systems), while relatively new in the passenger rail and fixed guideway industry have been successfully used on a number of passenger rail and diesel powered light rail systems outside of the United States. The applications for this type of system can range from protection of diesel engine compartments to the interior of passenger rail vehicles. The use of a fire suppression system may save lives in the incident vehicle during a fire condition; minimize damage to the train, tunnel and the station which it has entered; reduce or eliminate potential use of station sprinklers; reduce or eliminate the need for downstands; significantly reduce the impact of designing for fire emergencies on station architecture; reduce tunnel ventilation capacities by approximately 40 percent; reduce the number and/or diameter of emergency ventilation fans at each end of each station and within the tunnels, thus reducing structure sizes; decrease shaft airflow cross section areas by approximately 40 percent; and decrease tunnel ventilation shaft portal areas that correspond to the required fans sizes/velocities. When considering the addition of a fire suppression system, several design challenges should be met by the rail vehicle manufacturer. These challenges include the type of extinguishing medium used, which all must be approved by the AHJ the size and number of medium canisters and where on the vehicle to place them for easy access for maintenance; the resultant increased energy consumption caused by the increase in weight of the suppression system; the maintenance intervals; the cost of the system; the testing and commissioning of the system; and the cost and difficulties associated with retrofitting vehicles.

NFPA® 130

Standard for
Fixed Guideway Transit and
Passenger Rail Systems

2014 Edition

Q & A

Thank you very much for your kind attention !