



INSTITUTE FOR APPLIED
FIRE SAFETY RESEARCH

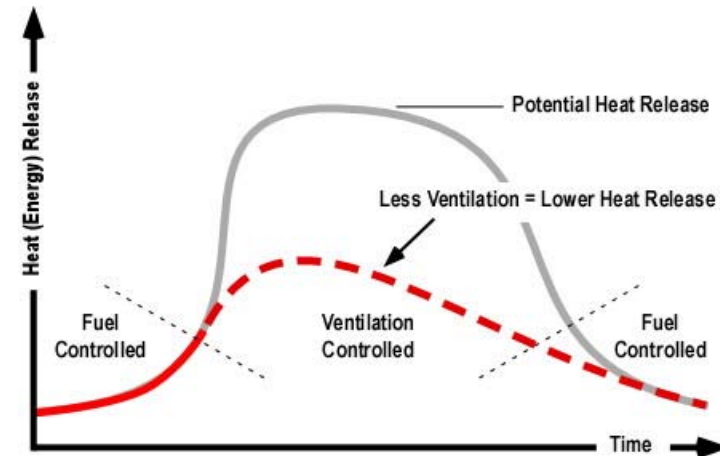
Protection of Tunnels with Water Mist Systems

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Managing Director



- Fire suppression Systems in Tunnels - Principles
- SOLIT² Full Scale Fire Tests
- Compensation with Water Mist Systems
- Case Study: New Tyne Crossing

- Fires in tunnels and underground stations can develop much faster than expected in the past.
- People do often not react as they are intended to do.
- Rescue services can not be considered as a support for people inside the tunnel (time!)
- Smoke caused the majority of fatalities in tunnel fires
- Time for fire fighters approach is significantly increased due to reduced visibility, temperature and radiation.
- Most larger tunnel fires are ventilation controlled fires.



- Two major “enemies”:
 - A. HGVs
 - Real fires and research programs have shown the severity of fires when HGVs are involved.
 - Design HRRs have changed from 30MW to 100+MW within a decade
 - B. Time
 - Fires can develop extremely fast



Higher Heat Release Rates than expected

	PIARC	French	NFPA	Tests	HRR estimates from real fires (MW)
Car	2.5 - 8	2.5 - 8	5	2.5 - 9	3 - 10
Van	15	15	-	-	-
Bus	20	20	20	29 - 34	36
HGV	20 - 30	30	20 - 30	15 - 203	300 - 400
Tanker	100	200	100	20 - 100	120 - 300



Spanish National Testing and Research Institute

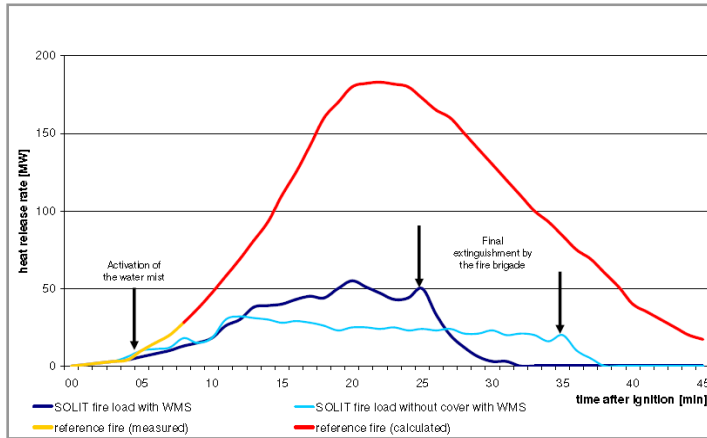


Notice! NFPA502 Edition 2008 has already increased fire sizes acco

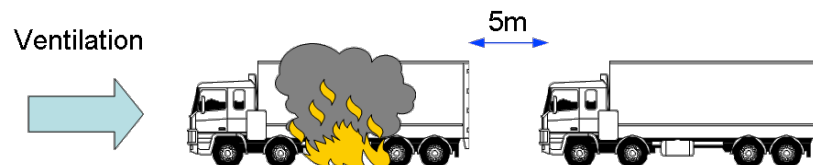
Table A.10.5.1 Fire Data for Typical Vehicles

Vehicles	Peak Fire Heat-Release Rates (MW)
Passenger car	5-10
Multiple passenger cars (2-4 vehicles)	10-20
Bus	20-30
Heavy goods truck	70-200
Tanker*	200-300

- Fire Suppression / Fire Fighting



- Protection of fire spread



IFAB

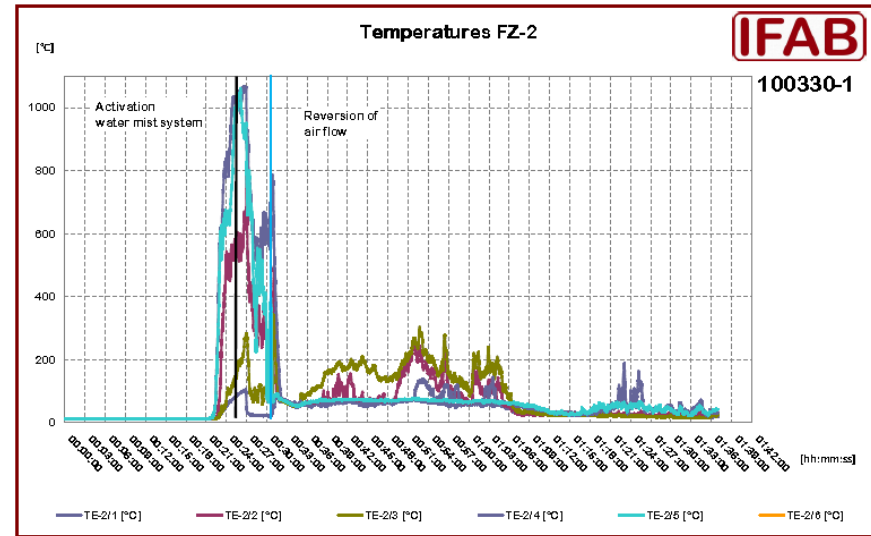
- Facilitate the approach of rescue services
- Increase the life safety for tunnel users



- Improving performance of ventilation systems
- Protection of tunnel structure
- Compensation of other safety measures within an integrated approach



- Cooling Effect
 - Small droplets are converted into steam
 - Enormous and rapid cooling
- Reduction of Radiant Heat
- Oxygene Depletion
 - Limited effect due to forced ventilation
 - Only necessary for fires with burnable liquids





FFFS Technologies for Tunnels

- Deluge
 - 6 – 12 l/m²/min.
 - Droplets above 1-2 mm
 - Used in Japan and Australia
 - No fire test above 30 MW known
- Foam (Premix or CAF)
 - Used in US
 - Some fire tests presented
- Water Mist
 - More than 100 full scale fire tests up to 200 MW
 - Used in France, UK, Spain, Italy, Russia
 - Approx. 20 % of water compared to Deluge



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SOLIT² Fire Tests



■ **Compensation of safety measures by FFFS**
Integration of FFFS into a holistic tunnel safety system

- Run time: 10/2010 – 02/2012
- Supported by the German ministry of economy and technology
- Budget: ~ 4 Mio €
- Large scale fire test program in 2011
- Workshop/Conference in 2011
- Scientific advisory board

Information at www.solit.info





FFFS, Project Manager

Engineering, Simulation, Compensation

Engineering, Simulation, Literature

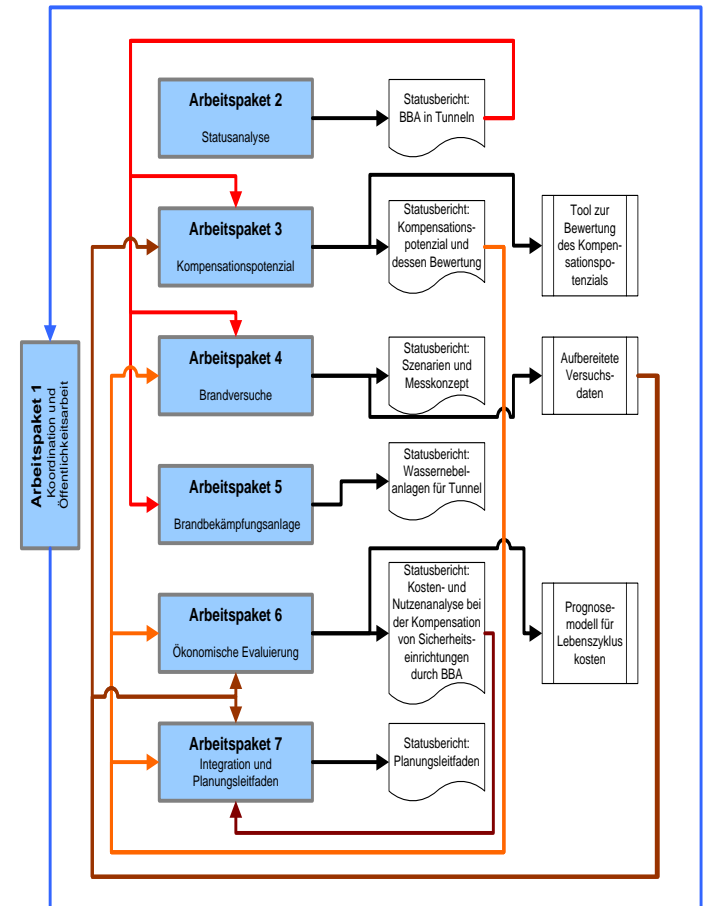
Economical Evaluation, Integration

Integration, Reliability, Guidance

Full Scale Fire Tests

Measurements, Data evaluation

- State of the art analysis
- Potential of Compensation
- Simulation
- Base data for risk analysis
- Effects of FFFS
- Economical Evaluation (LCC)
- Integration and Engineering Guidance





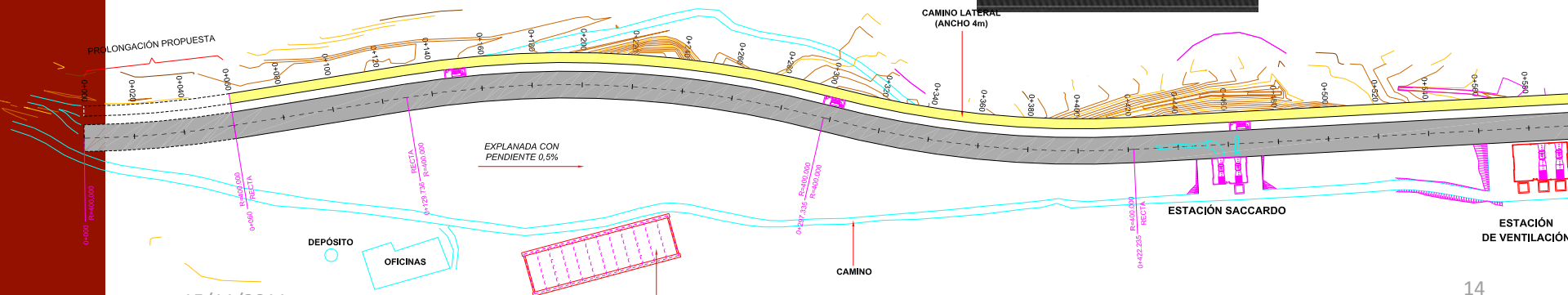
TEST SITE

San Pedro des Anes

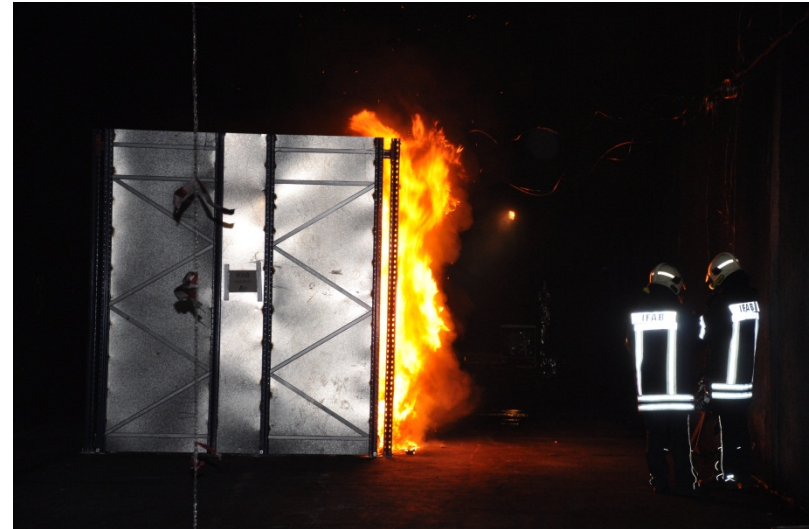
Next City: Oviedo; Gijon

Airport: Asturias (OVD)

Length: 600 m

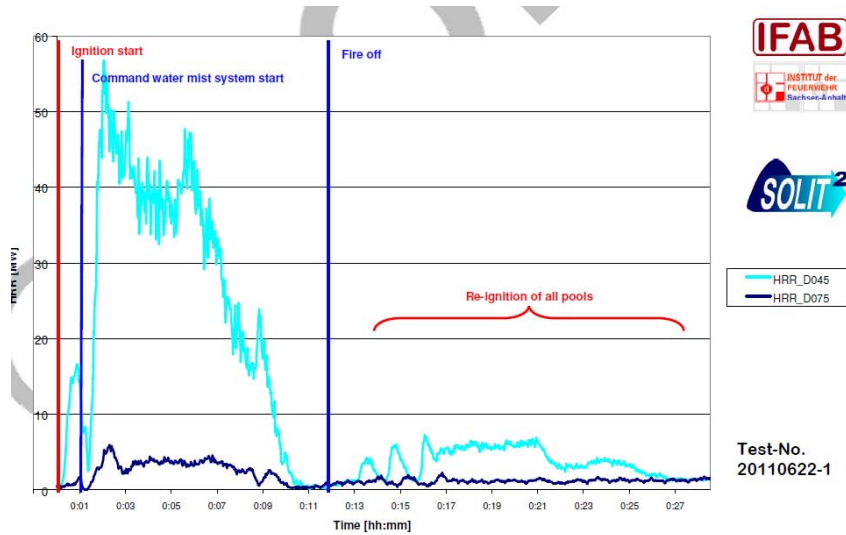


- HGV Fire tests with Longitudinal and Semi-transversal Ventilation
- 30, 50 and 100 MW Pool Fire tests with various ventilation conditions
- Study of the influence of FFFS on ventilation and vice versa

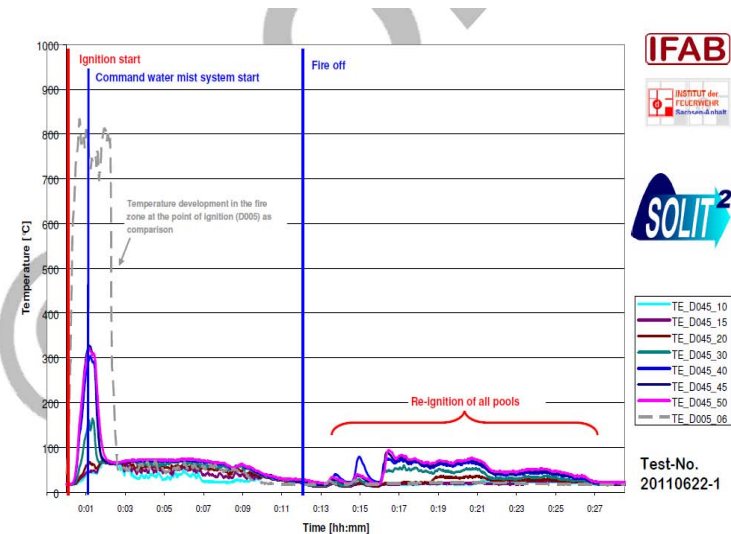


- Interaction with the Fire Brigades Approach
- Cooperation with the Hamburg and Elbtunnel Fire Brigade
- Workshop with life fire test in the tunnel

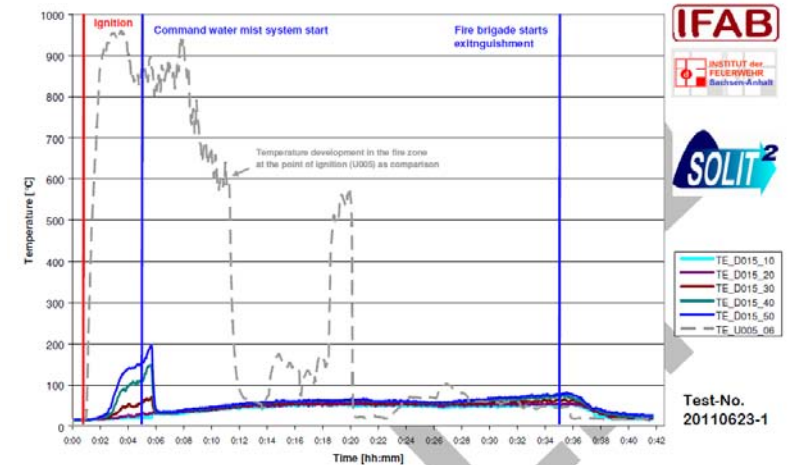
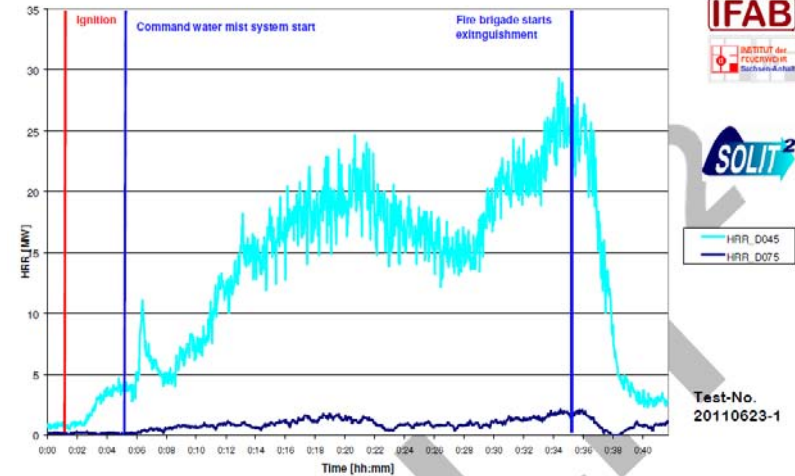




- Class B fires with 30, 60 and 100 MW
- Diesel
- Fires were extinguished



- Potential fire load up to 180 MW
- Covered and uncovered
- Target objects at downstream





Compensatory Effects

Compensation means to achieve the same level of safety by other measures.

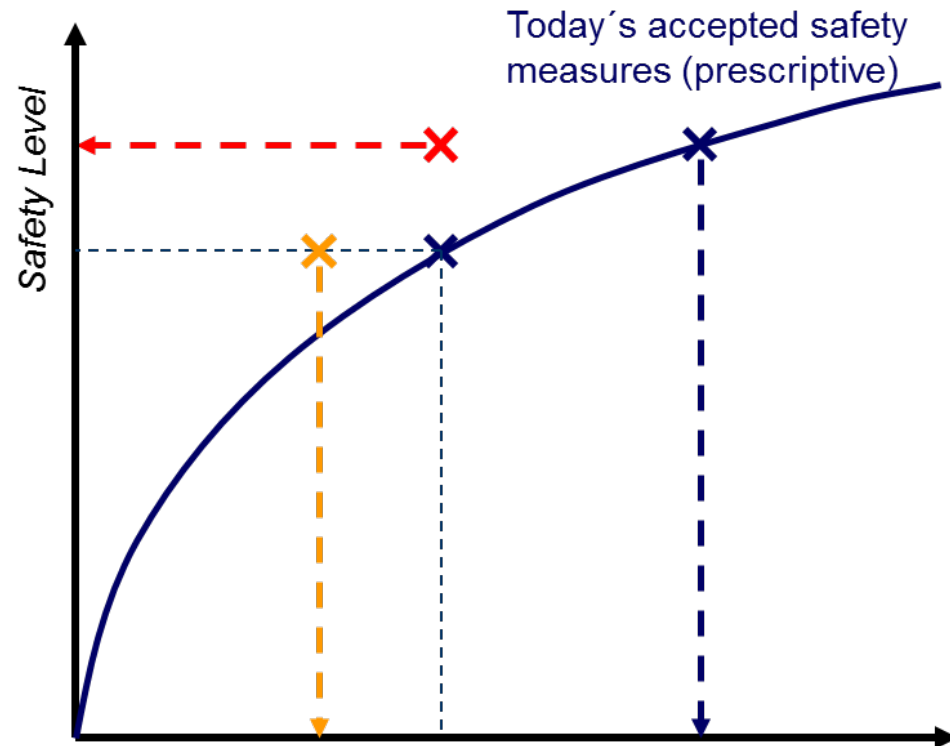
Compensation requires a proof of equal level of safety

Compensation requires equal reliability

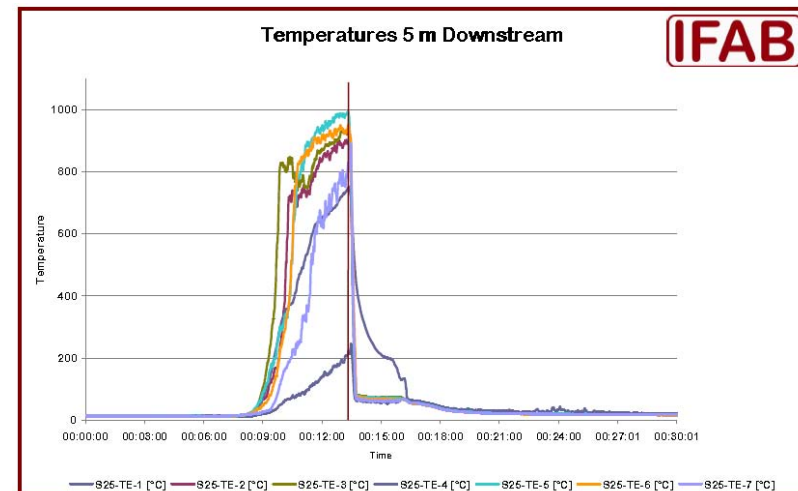
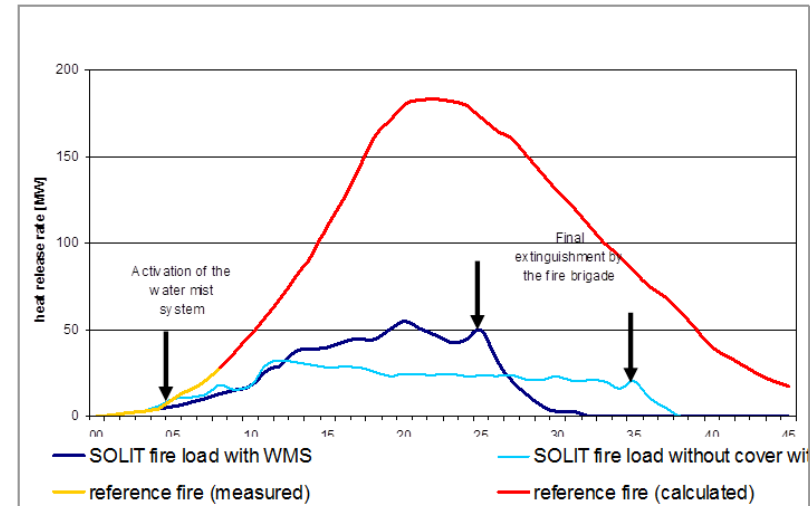
Compensation should be based on LCC evaluation

Compensation requires a holistic performance based tunnel safety concept

- Design fires for tunnel safety systems are usually increased to 100 MW (at least)
- New design fires and other data for upgrade and new projects
- Space & Power
- Costs
- Design



- For FFFS water mist systems are considered
- HRR will be limited by FFFS
- Smoke production rate will be limited
- Cooling effect will reduce the smoke volume
- Further effects for people, fire brigade and structures



IFAB

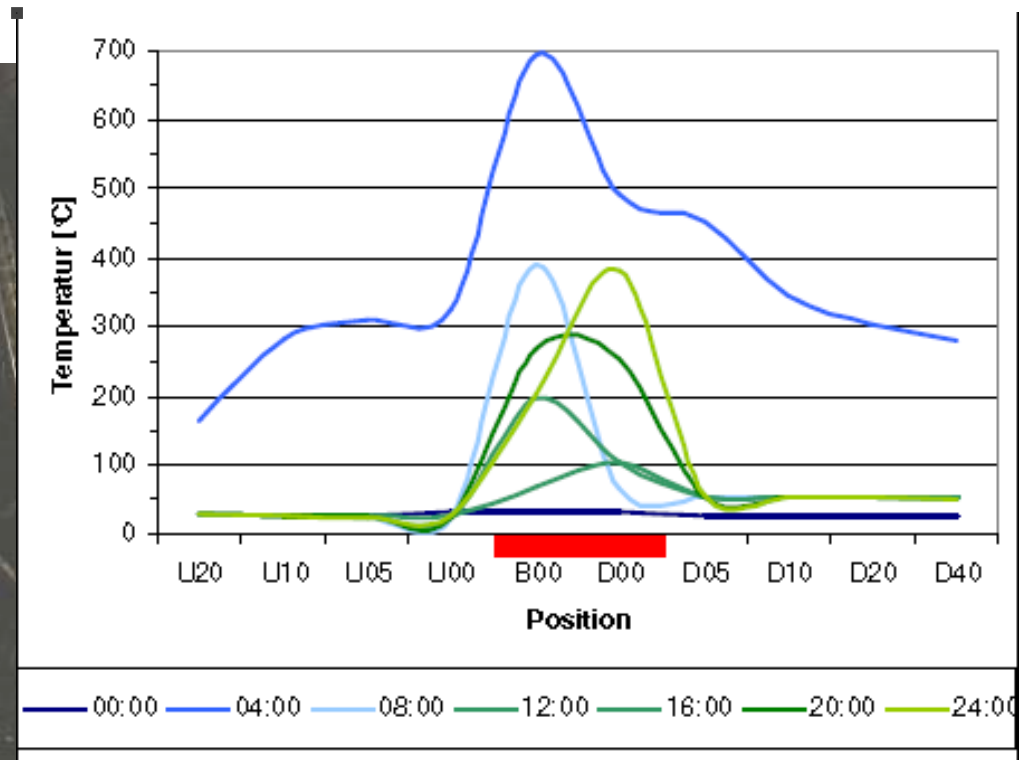
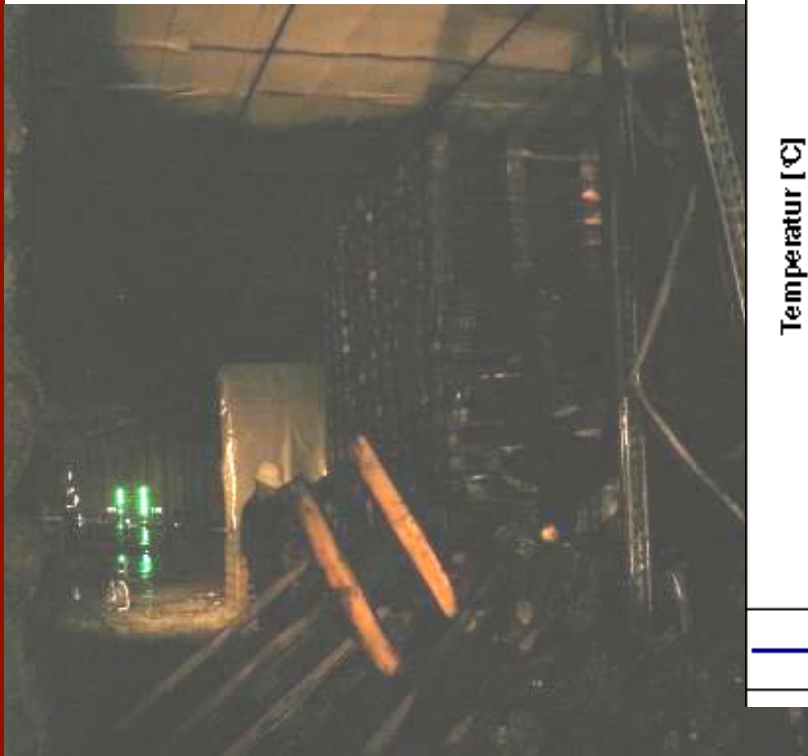


- Still good visibility through water mist
- Increased capacity of the smoke extraction or longitudinal ventilation by 70%.
- Further infos: www.solit.info



- Reality: Fire brigades need up to 30 minutes to reach the place of incident!
- Fire spread (even for Class B truck fires) can be observed within
- Rescues services can not be considered as assistance for the self rescue procedures.
- Timing problem is often ignored and unsolved.
- Some tunnels operate their own fire brigades (such as Elbtunnel (Hamburg), MontBlanc). Costs per year and fire fighter: not less than 200.000 €/man)

- Area of high temperatures is limited
- Time of temperature is limited
- Absolut temperature is limited



- Compensation requires a proof of a equal level of safety
- This includes a similar reliability of the systems (eg. MTBF)
- Holistic tunnel safety concepts require also RAMS (Reliability, Availability, Maintainability and Safety) and LCC (Life Cycle Costs) analyses.
- Hardly used for conventional fire protection systems
- Common usage e.g. for rolling stock, cars, planes, etc.

E.g.: Decision to install a FFFS into New Tyne Crossing was fully based on a economic base.



SOLIT² Workshop

Pre-Announcement:

2nd Conference on Fire Suppression in Tunnels

- Fire Suppression Systems in Tunnels
- Compensation of Safety Measures
- Integration of FFFS

19.06. – 20.06.2012 in BERLIN

More informations within the next weeks at
www.solit.info

Or send a short email to contact@solit.info



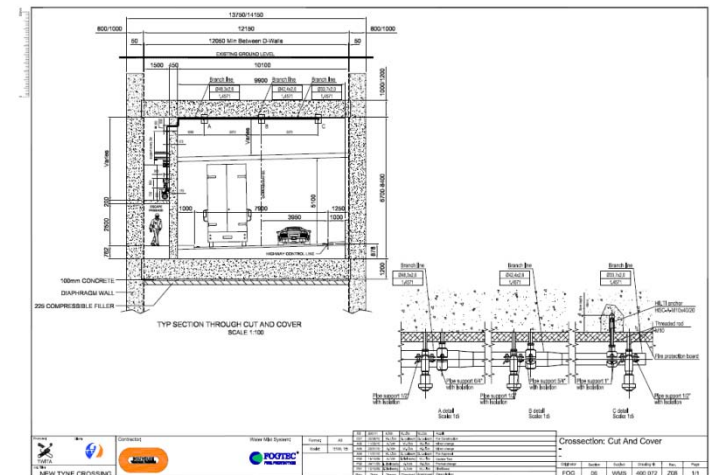
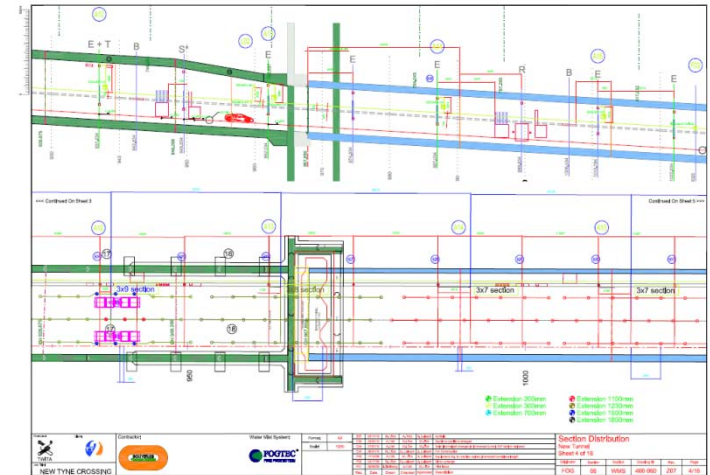


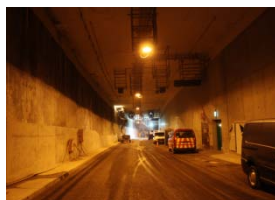
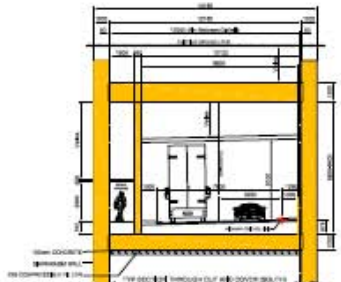
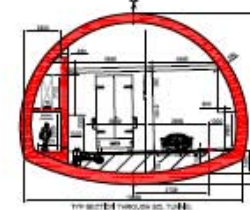
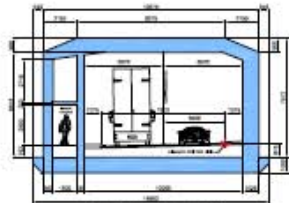
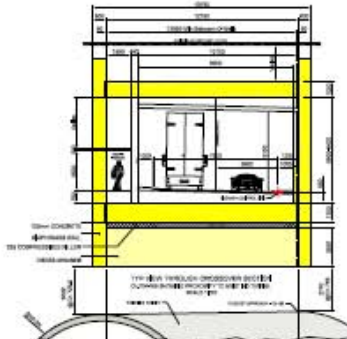
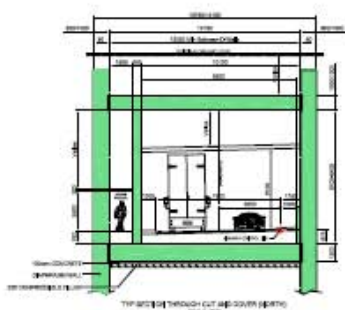
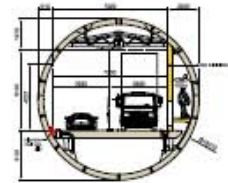
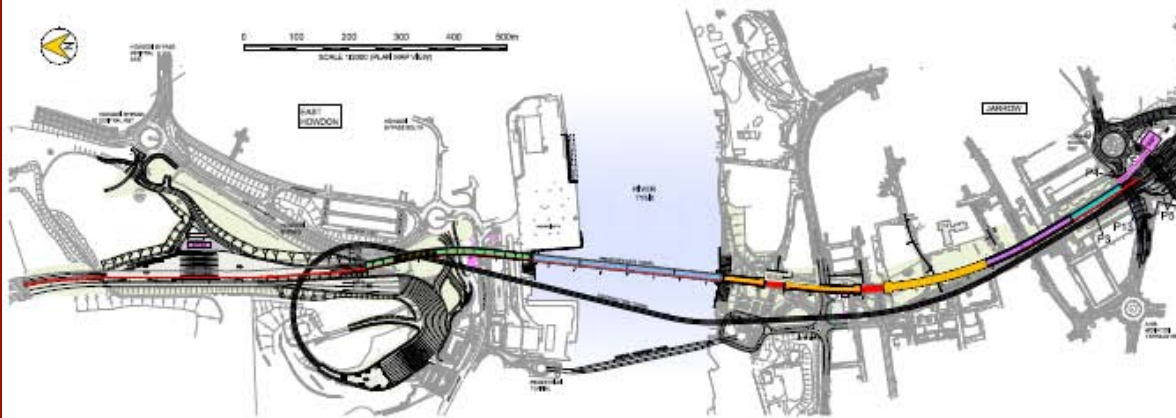
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Case Study: New Tyne Crossing

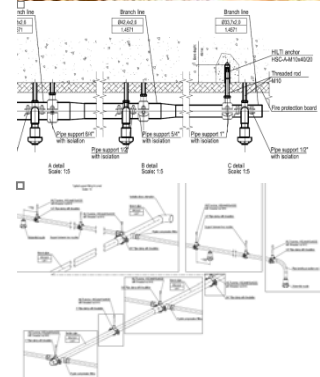


- Section length: 25 meters
- Number of sections: 60 (new) + 68 (existing)
- Activation: 3 sections simultaneously
- Total pump capacity: 3250l/min
- Maximum pressure: 140bar
- Design basis: SOLIT fire tests
- Engineering basis: UPTUN Engineering guideline – Report R251

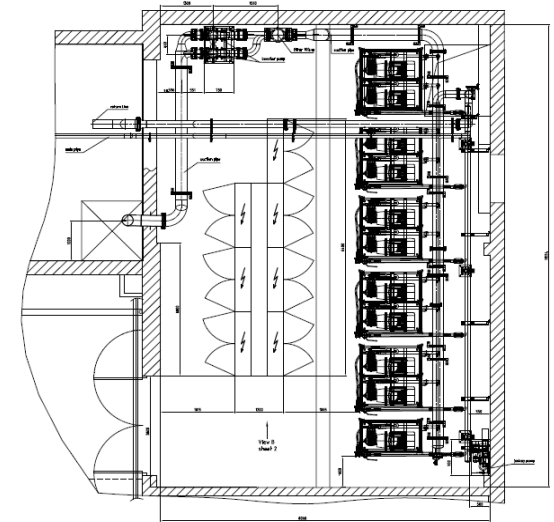




- Mechanical and hydraulic design:
 - Main pipes DN50 and DN100
 - Section pipes (primary) DN17
 - Minimum pipe quality: AISI316 (lifetime / standards)
 - Pipe connections mainly in welding (lifetime / standards)
 - Main aspects:
 - Proper hydraulic design (worst case scenario)
 - High level of prefabrication (detailed design)
 - Quality control
 - Testing



- Jockey pump unit with self-cleaning filter for the pre-pressure of wet main pipes
- Booster pump unit (redundant pumps) with main filter
- HP pump sets
 - Each set 600l/min@140bar
 - Follows UPTUN R251 Engineering guidance:
 - Direct coupling, one motor per pump,
 - all pumps have individual safety valve, etc.
- Pump control cabinet
 - Many service / monitoring functions of critical components





Thank you for your kind attention !

Further information: Stefan Kratzmeir
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Consulting – Testing - Training

www.ifab-fire.com