IFAB

INSTITUTE FOR APPLIED **FIRE SAFETY RESEARCH**

ASKING - ANALYSING - ANSWERING

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High-pressure water mist systems and fire testing

Max Lakkonen
IFAB – Institute for Applied Fire Safety Research

ASKING - ANALYSING - ANSWERING

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Content of presentation

- IFAB
  - Company
  - Application fields
  - Services
- High-pressure water mist systems
  - History
  - Function and physics
- Fire testing of high-pressure water mist systems
  - Prescriptive tests (standards)
  - Engineered systems (special hazards)

IFAB

- IFAB – Institute of Applied Fire Safety Research *(**I**nstitute für **A**ngewandte **B**rand-schutz**f**orschung)*
  - Founded 2008
  - A private company, not academic although co-operating with Universities
  - Based in Berlin, Germany
  - Profiled to fire testing first, nowadays more focus to fire consulting rather than testing
  - Networked:
    - NFPA, IWMA, ITA-COSUF, SOLIT, UPTUN, EN45545, etc.

NFPA®

ITA COSUF
ITA Committee on Operational Safety of Underground Facilities

IWMA
International Water Mist Association

SOLIT
Safety of Life in Tunnels

SOLIT²

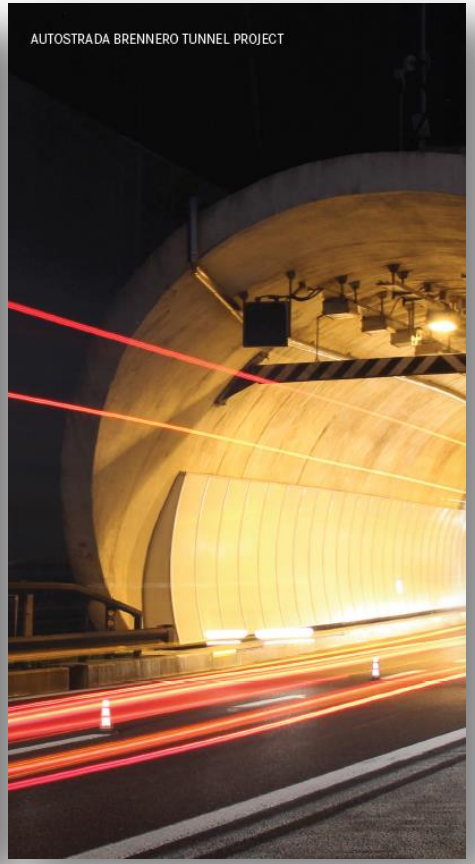
EUROPEAN NORM
EN

Application areas

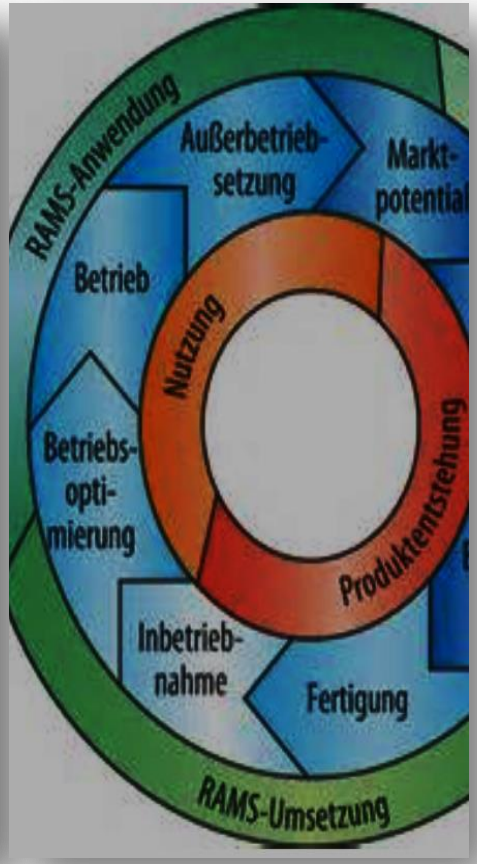
Buildings& Industrial

Rail

Tunnel& Metro

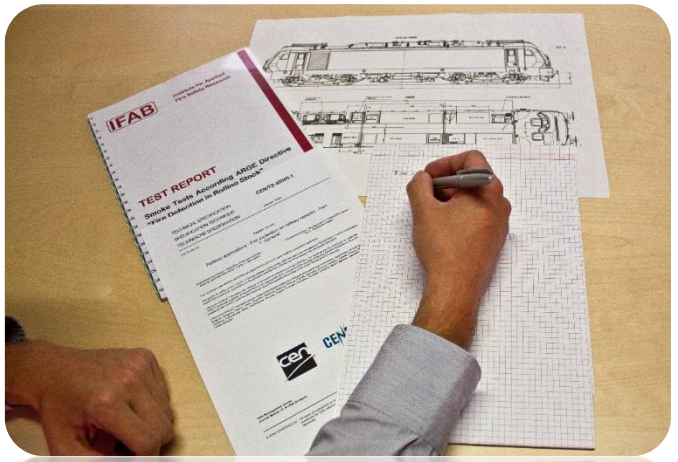


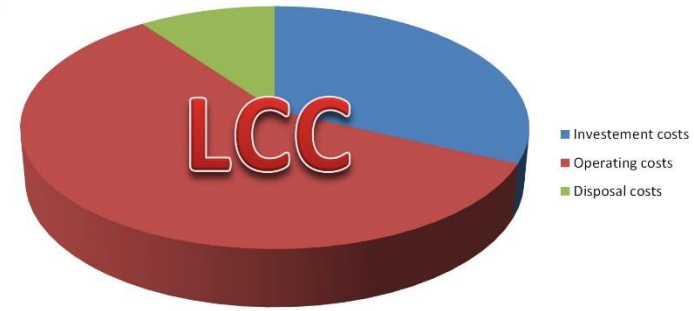
Reliability Engineering



IFAB services – Design&Consultancy

- Fire safety consulting
  - Risk analysis
  - Fire safety concepts
- Fire safety designs
  - Overall safety concepts
  - Fire fighting systems
- Special applications
  - High risk applications
- Trainings and 3rd party reviews
- Reliability engineering (RAMS)





IFAB services – Design&Consultancy

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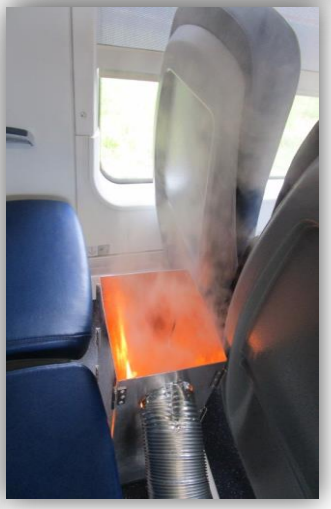
IFAB services – Fire&Smoke testing

- Fire testing
  - Over 2000 tests carried out
    - Standard tests (OH, LH, Water mist, VdS)
    - Ad-Hoc test (project related, tunnels)

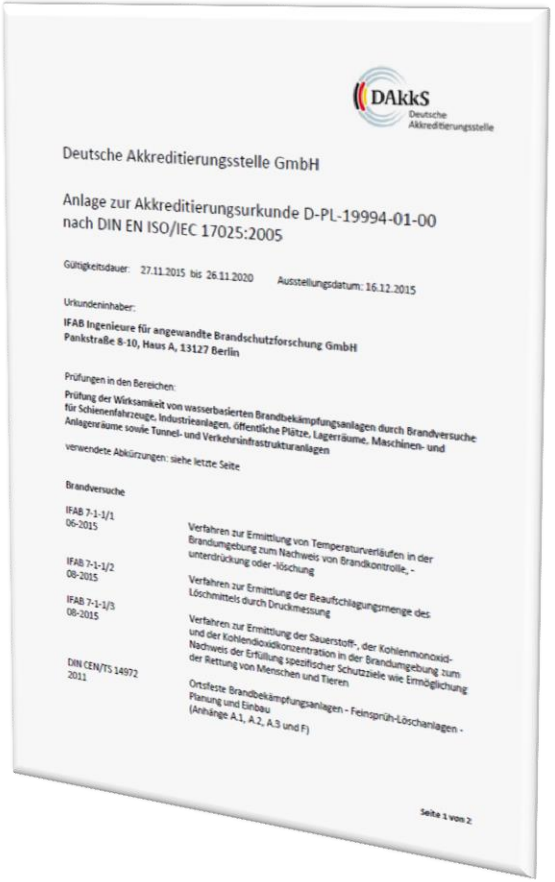
- Smoke testing
  - Over 500 tests carried out
    - Standard tests (ARGE)
    - Ad-hoc tests (tunnels)

IFAB services – Fire&Smoke testing



IFAB services – Fire&Smoke

- EN17025 accredited fire test laboratory



Deutsche Akkreditierungsstelle GmbH

Anlage zur Akkreditierungsurkunde D-PL-19994-01-00
nach DIN EN ISO/IEC 17025:2005

Gültigkeitsdauer: 27.11.2015 bis 26.11.2020 Ausstellungsdatum: 16.12.2015

Urkundeninhaber:

IFAB Ingenieure für angewandte Brandschutzforschung GmbH
Pankstraße 8-10, Haus A, 13127 Berlin

Prüfungen in den Bereichen:

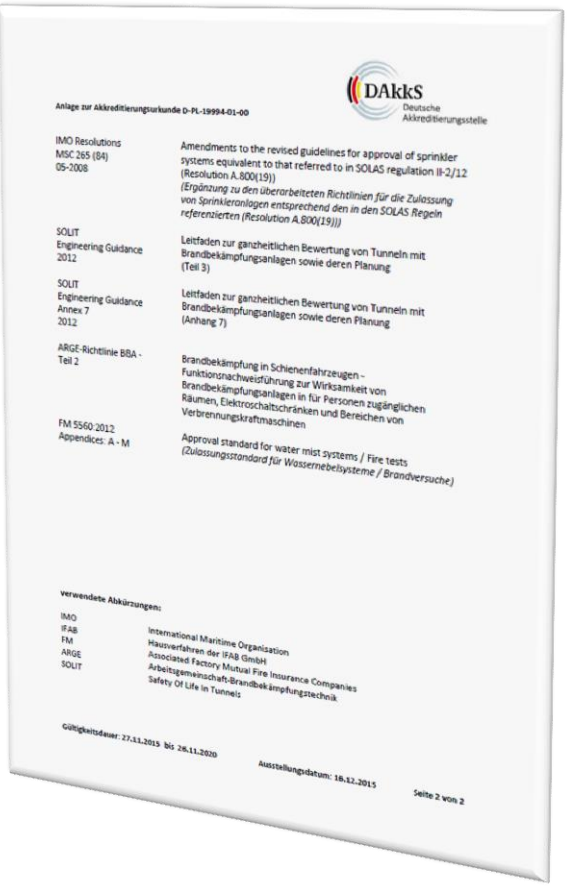
Prüfung der Wirksamkeit von wasserbasierten Brandbekämpfungsanlagen durch Brandversuche für Schienenfahrzeuge, Industrieanlagen, öffentliche Plätze, Lagerräume, Maschinen- und Anlagenräume sowie Tunnel- und Verkehrsinfrastrukturanlagen

verwendete Abkürzungen: siehe letzte Seite

Brandversuche

IFAB 7-1-1/1 06-2015	Verfahren zur Ermittlung von Temperaturverläufen in der Brandumgebung zum Nachweis von Brandkontrolle, -unterdrückung oder -löschung
IFAB 7-1-1/2 08-2015	Verfahren zur Ermittlung der Beaufschlagungsmenge des Löschmittels durch Druckmessung
IFAB 7-1-1/3 08-2015	Verfahren zur Ermittlung der Sauerstoff-, der Kohlenmonoxid- und der Kohlendioxidkonzentration in der Brandumgebung zum Nachweis der Erfüllung spezifischer Schutzziele wie Ermöglichung der Rettung von Menschen und Tieren
DIN CEN/TS 14972 2011	Ortsfeste Brandbekämpfungsanlagen - Feinsprüh-Löschanlagen - Planung und Einbau (Anhänge A.1, A.2, A.3 und F)

Seite 1 von 2



Anlage zur Akkreditierungsurkunde D-PL-19994-01-00

IMO Resolutions MSC 265 (84) 05-2008	Amendments to the revised guidelines for approval of sprinkler systems equivalent to that referred to in SOLAS regulation II-2/12 (Resolution A.800(19)) *(Ergänzung zu den überarbeiteten Richtlinien für die Zulassung von Sprinkleranlagen entsprechend den in den SOLAS Regeln referenzierten (Resolution A.800(19)))*
SOLIT Engineering Guidance 2012	Leitfaden zur ganzheitlichen Bewertung von Tunneln mit Brandbekämpfungsanlagen sowie deren Planung (Teil 3)
SOLIT Engineering Guidance Annex 7 2012	Leitfaden zur ganzheitlichen Bewertung von Tunneln mit Brandbekämpfungsanlagen sowie deren Planung (Anhang 7)
ARGE-Richtlinie BBA - Teil 2	Brandbekämpfung in Schienenfahrzeugen - Funktionsnachweisführung zur Wirksamkeit von Brandbekämpfungsanlagen in für Personen zugänglichen Räumen, Elektroschaltschränken und Bereichen von Verbrennungskraftmaschinen
FM 5560:2012 Appendices: A - M	Approval standard for water mist systems / Fire tests *(Zulassungsstandard für Wassernebelsysteme / Brandversuche)*

Verwendete Abkürzungen:

IMO	International Maritime Organisation
IFAB	Hausverfahren der IFAB GmbH
FM	Associated Factory Mutual Fire Insurance Companies
ARGE	Arbeitsgemeinschaft-Brandbekämpfungstechnik
SOLIT	Safety Of Life in Tunnels

Gültigkeitsdauer: 27.11.2015 bis 26.11.2020 Ausstellungsdatum: 16.12.2015

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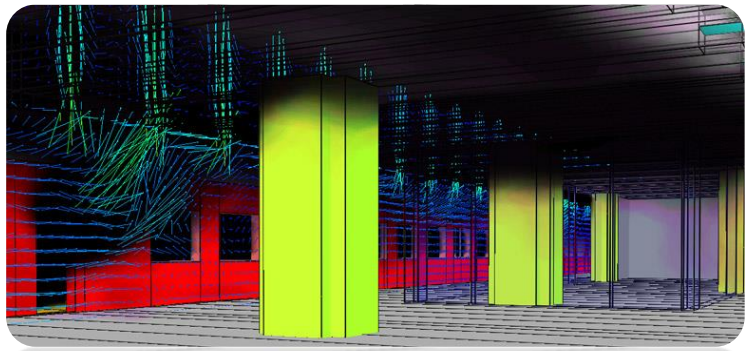
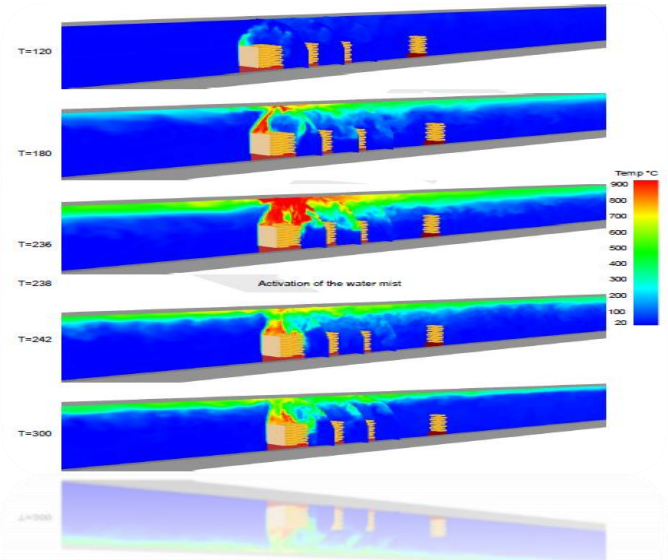
IFAB services – Simulations

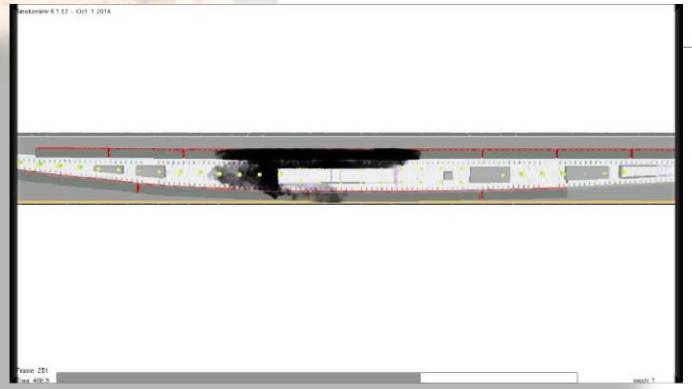
- Fire simulations
- Smoke simulations
- Ventilation simulations
- Evacuation simulations

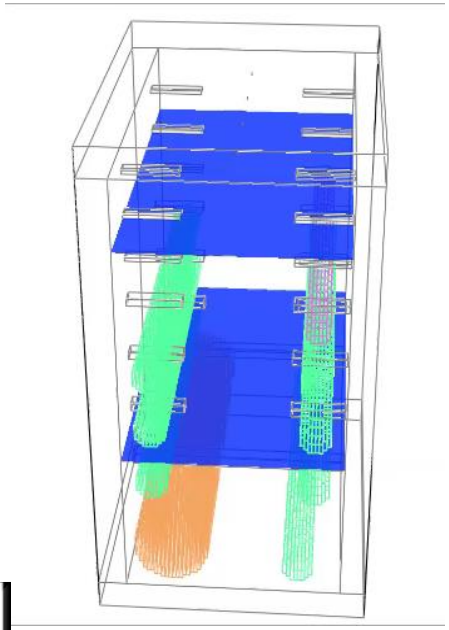


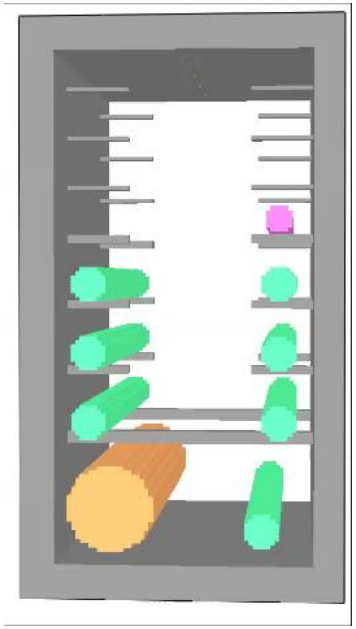
=> Models with full scale validation!!



IFAB services – Simulations







References

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Water mist fire fighting

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History of water mist

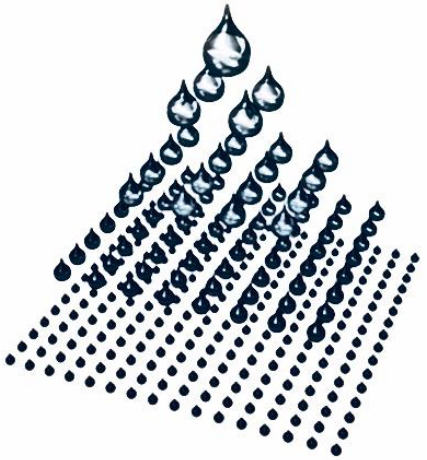
- Water mist systems were used during before second world war
- After HALON was invented, water mist was forgotten
- Restart became early 90's after HALON was banned
- Within last 25 years water mist systems have been industrialised

1970's

2010's

Definition of water mist

- According to NFPA / EN:
  - Droplets smaller than 1000µm (Dv99)
  - Actually much smaller due to sprinkler lobby
- Water mist classes (old NFPA750)
  - Class 1: <150µm
- Pressure levels
  - Low-, medium- and high-pressure



Fire fighting principles and water mist

- Combustion triangle

Fire fighting principles and water

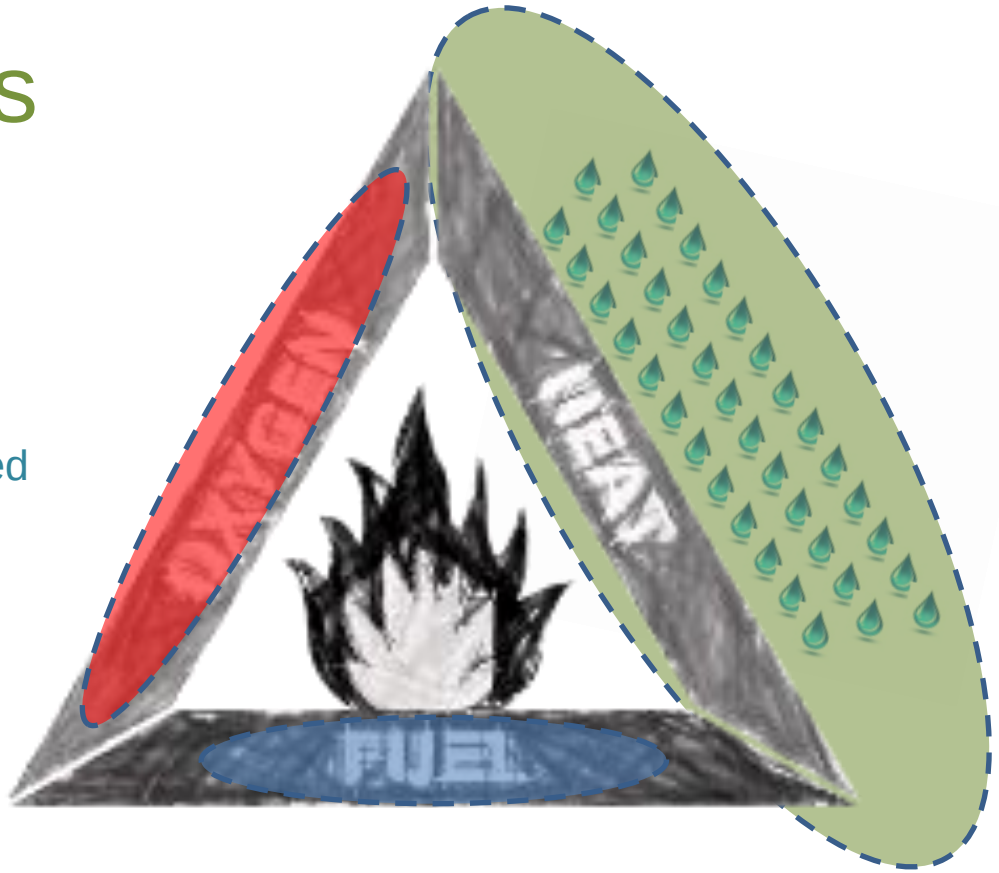
- Sprinkler / deluge systems
  - Large droplets
  - High flow rates
  - Low momentum

Fire fighting principles and water

- Gaseous systems
  - Removing/ replacing oxyggen

Fire fighting principles and water

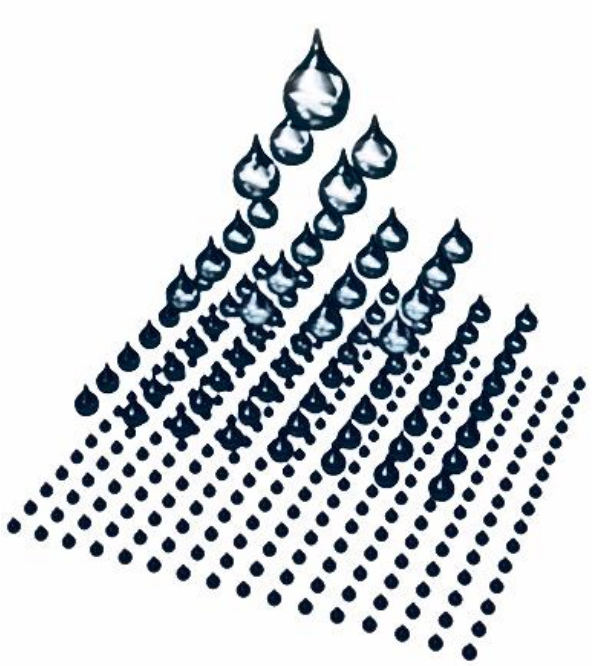
- Water mist systems
  - Primary effect is cooling
  - Additionally also local inerting
  - Minor effect by fule isolation (limited applications)



What are the benefits of water mist?

- Superior cooling
  - Reaction surface per 1 liter of water

Droplet Diameter	
0,100mm ⇒	2m²
0,100mm ⇒	20m²
0,010 mm ⇒	200m²

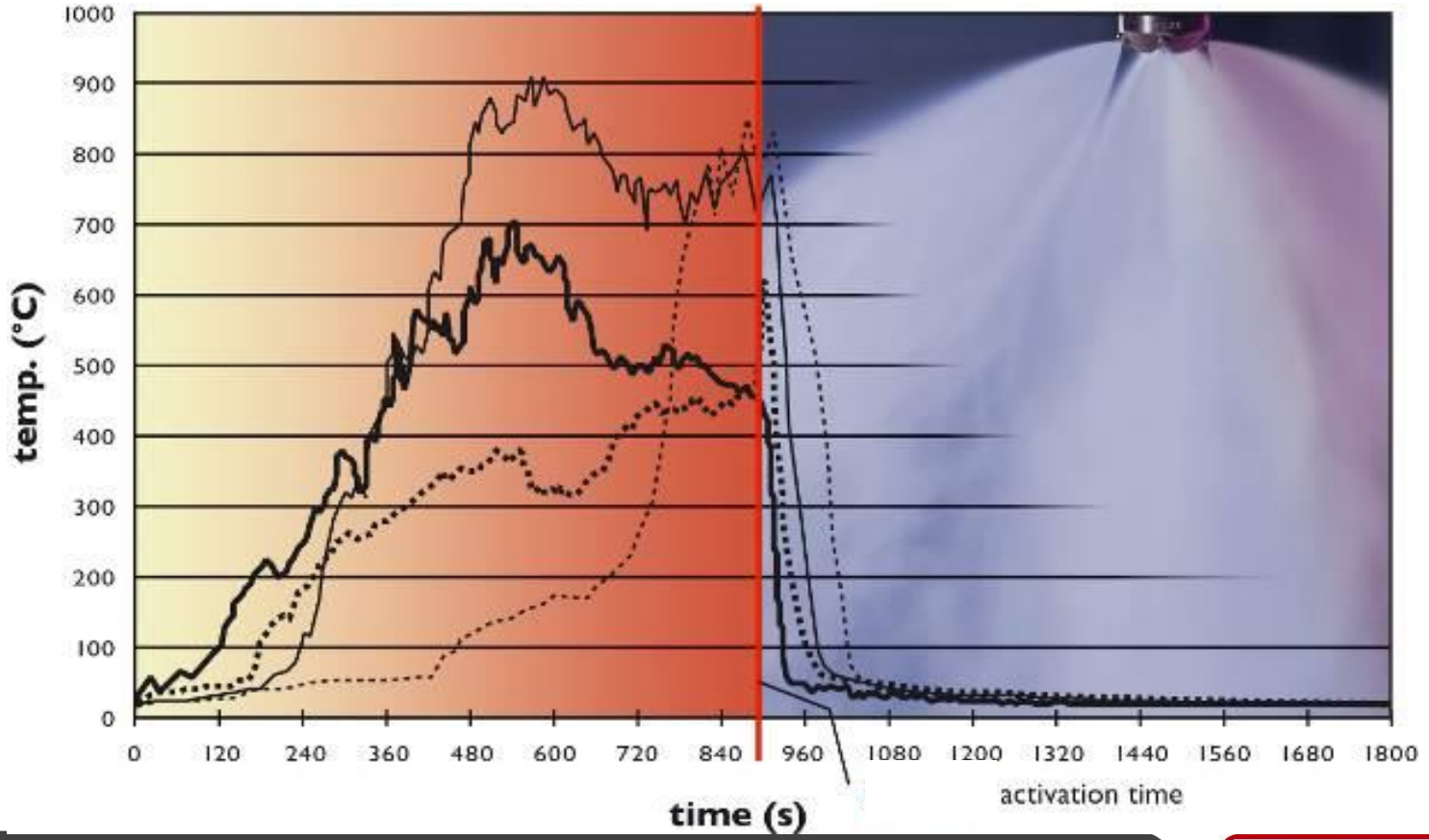


  - 335 kJ heating from 20°C to 100°C
  - 2257 kJ by transition from liquid to gas

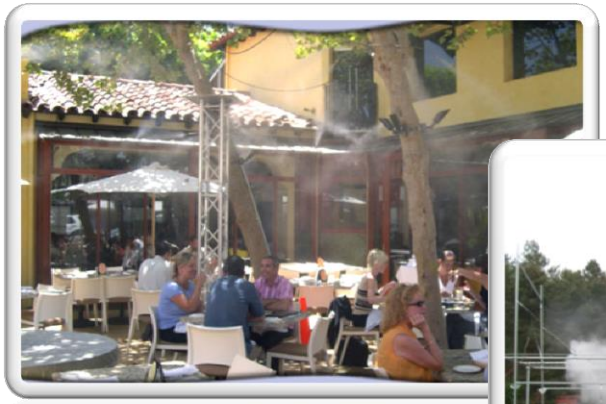
=> Highest of all known agents in the world !

What are the benefits of water mist?

- Superior cooling



What are the benefits of water mist?



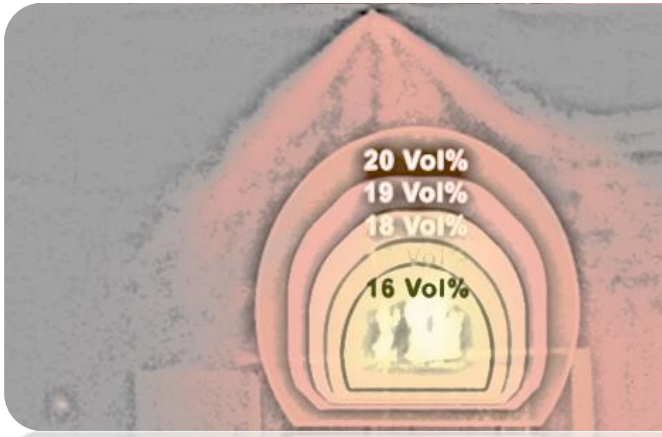
Cooling
10kW

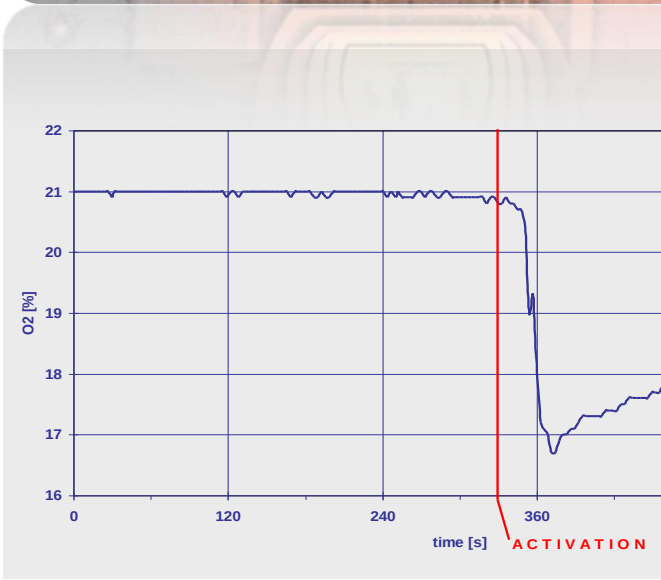
Coolling
5000kW

Cooling
50 000kW

What are the benefits of water mist?

- "Suffocating" (local interting)
  - Volume expansion is from 1 liter (liquid) to 1650 liters (gaseous) when evaporated
  - Note! Oxygen level is lowered only locally.





High-pressure water mist testing and fire testing

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Verification process

- “Prescriptive standards”
  - Examples: LH, OH risks
  - Straight forward following the standards

Verification process

- “Performance based approach“

1. risk analysis
2. fire safety concepts
3. **proof of evidence**
    - expertise
    - simulation
    - **fire testing**
4. engineering design
5. implementation planning
6. expertise/assessment (commissioning)

Examples of real verification tests

1. Cable tunnel
2. Transformer (room protection)
3. Conveyer belt
4. Printing unit

=> All typical “special“ applications where water mist is very competitive technology

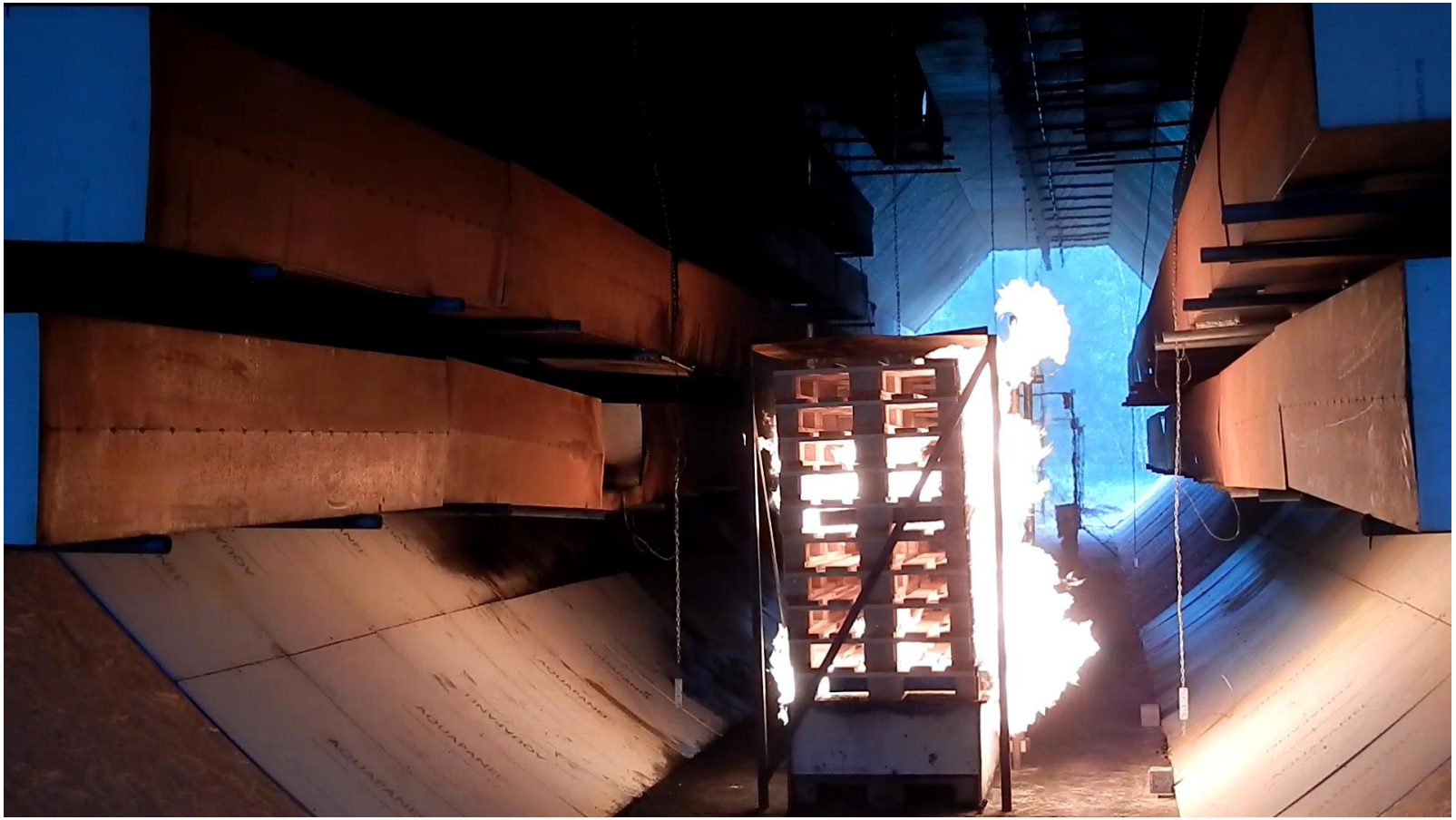
1. Cable tunnel

1. Cable tunnel

Test Set Up

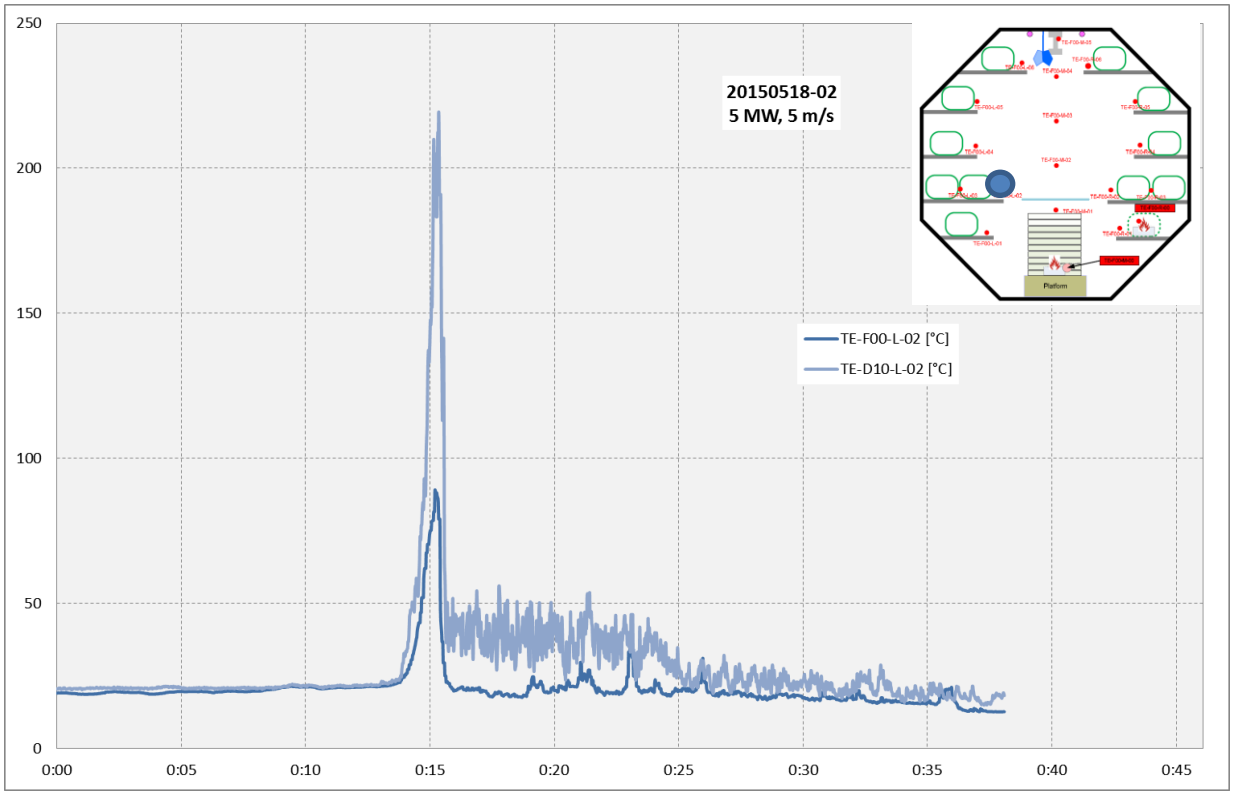
diameter 6 m, length 70 m

1. Cable tunnel



1. Cable tunnel

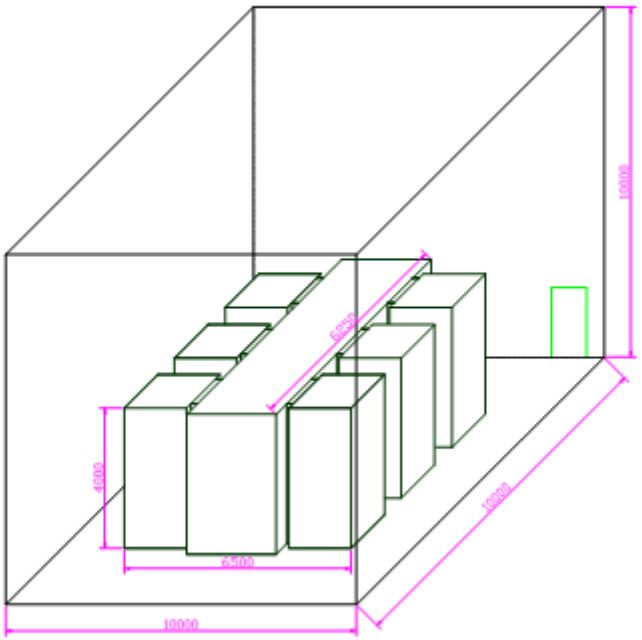
Test Results



2. Transformer (room protection)

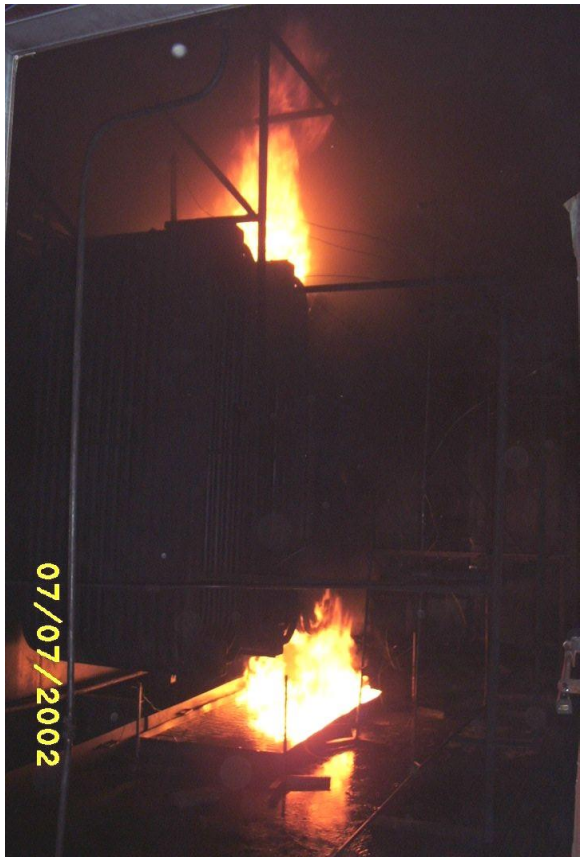
2. Transformer (room protection)

Test Set Up



2. Transformer (room protection)

Fire Load



class B, pool and flowing fires

2. Transformer (room protection)

Test Results **extinguishment**

Pos	Test No.	nozzle type	Q_{total} l/min.		Type	extinguishment min:sec
1	V1	DK 8-01	83,52		open pool	06:28
	05.07.2002				1000X2000	
	room					
2	V2	DK 8-01	83,52		hidden pool	07:06
	05.07.2002				1000X2000	
	room					
6	V6	DK 8-01	83,52		hidden pool	~07:00
	10.07.2002				1000X2000	
	room					
8	V8	DK 8-02	83,52		open pool	07:18
	12.07.2002					
	room		83,52			
9	V9	DK 8-02	83,52		open pool	02:21
	12.07.2002				300 x 2300	
	room		83,52			

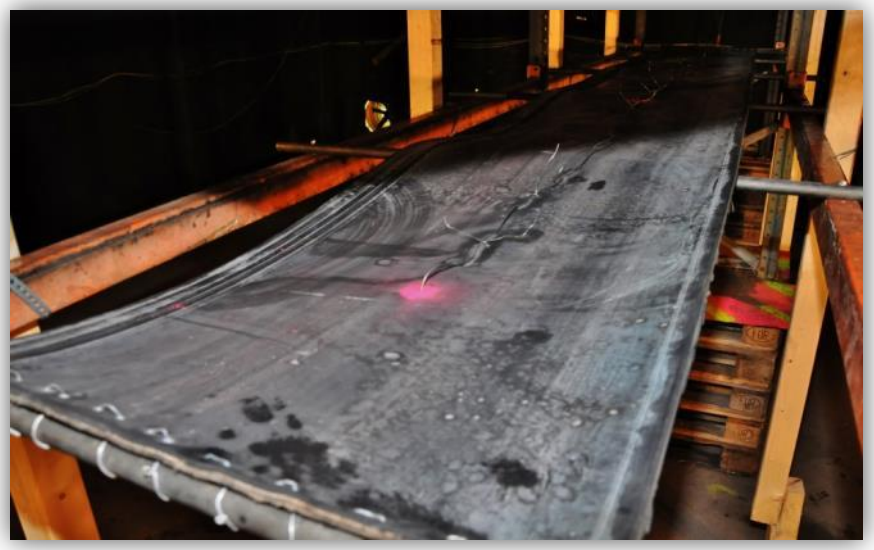
3. Conveyor belt

3. Conveyor belt

Test Set Up

3. Conveyor belt

Fire Load

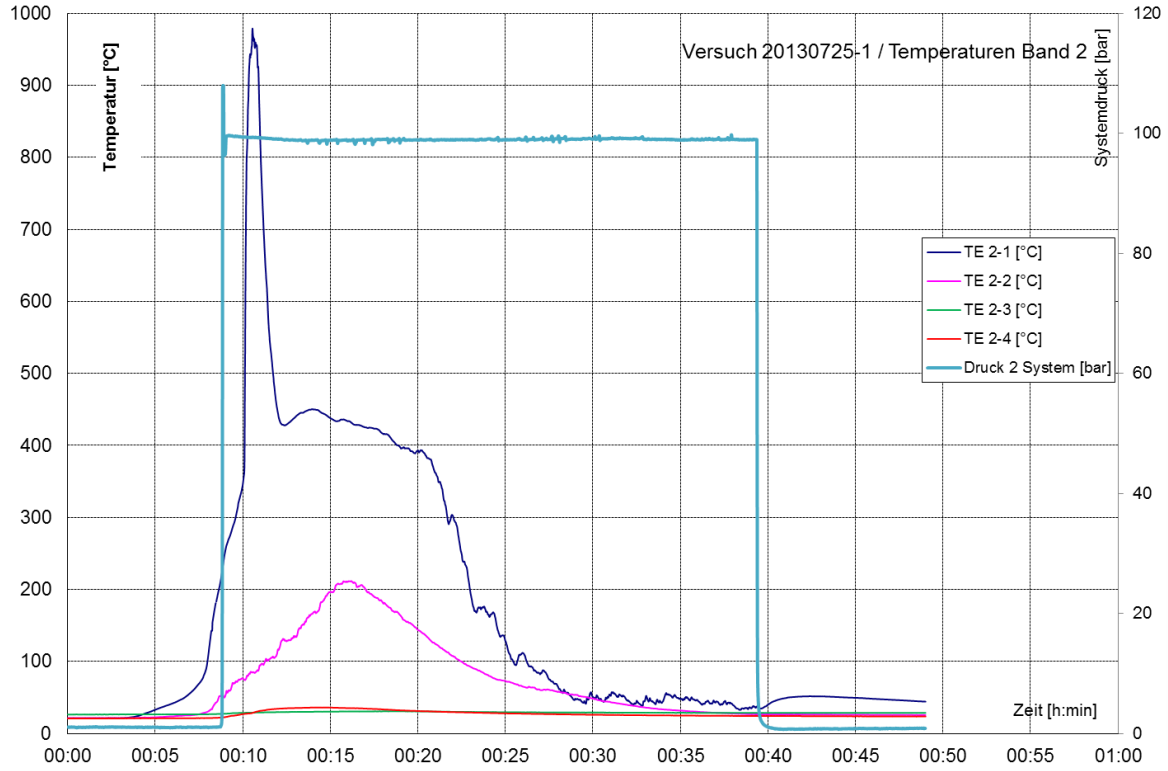


rubber belt, not fire retardant

3. Conveyor belt

Test Results

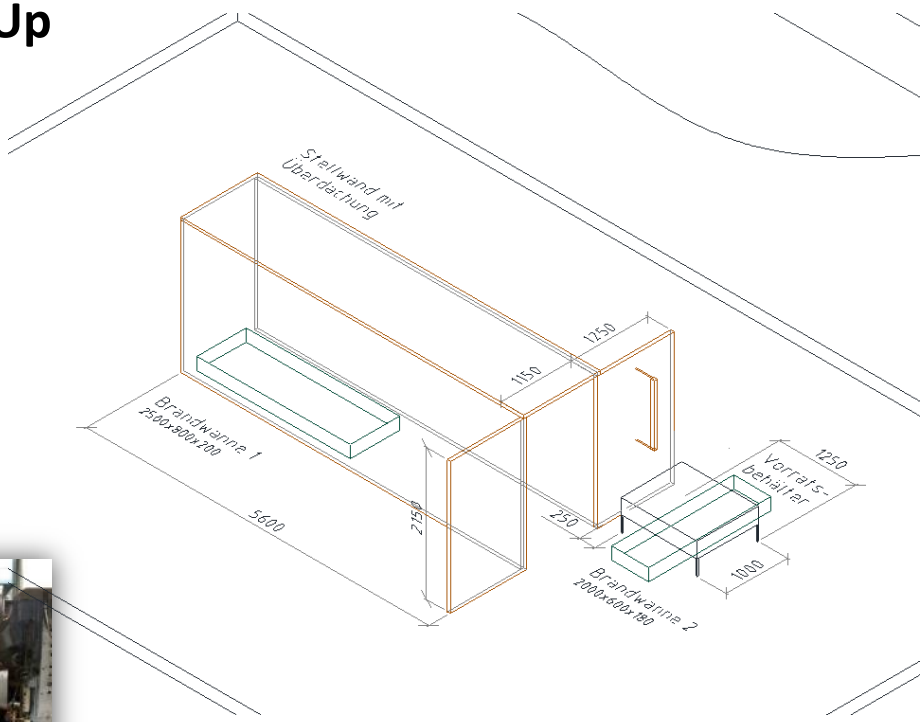
extinguishment



4. Printing unit

4. Printing unit

Test Set Up



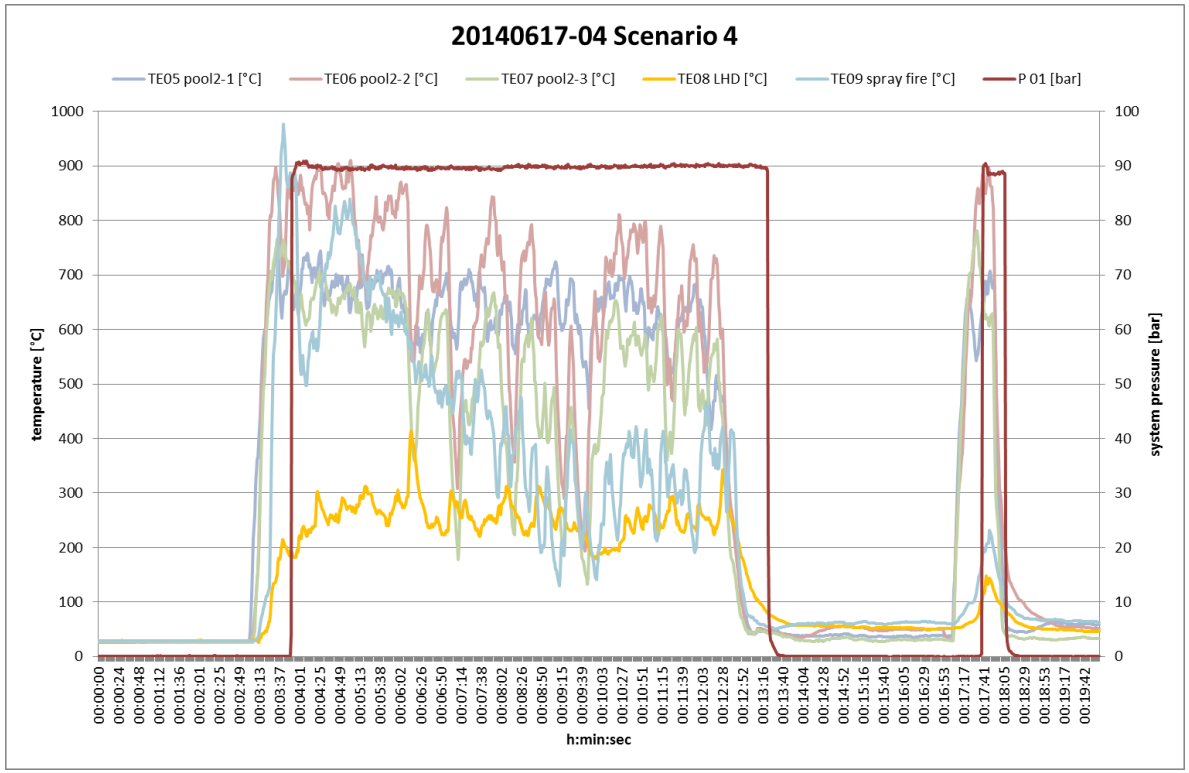
4. Printing unit

Fire Load

class B, pool and spray fires, toluene and heating oil (heptane)

4. Printing unit

Test Results **extinguishment**



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