

Het brandvermogen van een vrachtwagen in een gesprinklerde tunnel, bepaald uit volle schaal proeven

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**BENELUX
CHAPTER**



Heat Release Rates of a Heavy Goods Vehicle in a sprinklered tunnel, determined with full scale fire tests

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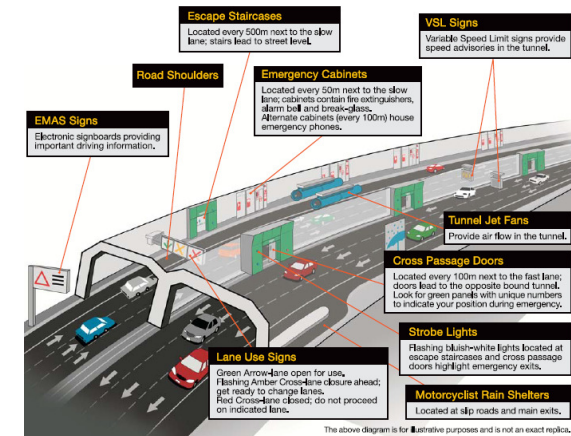


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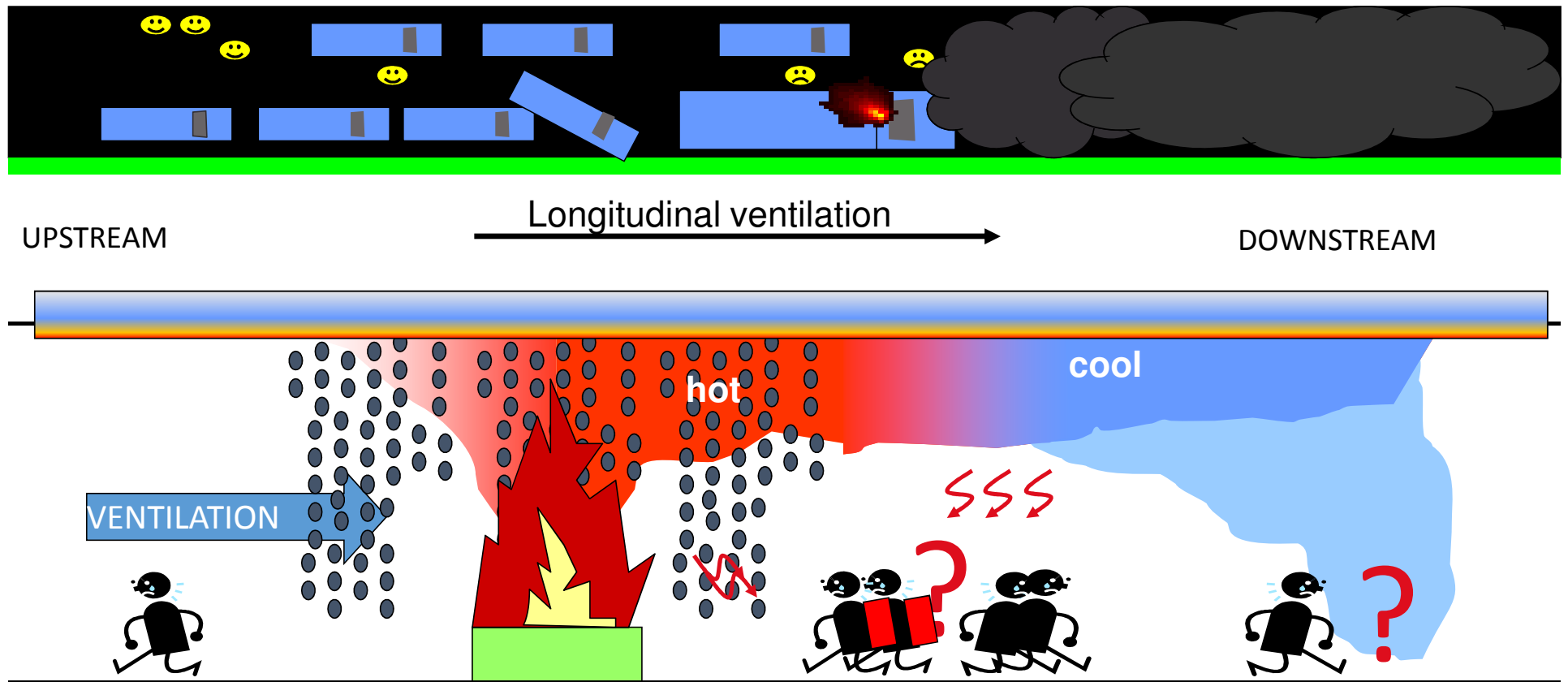


Tunnel fire safety

- Tunnel fires can pose a threat to:
 - Life safety (tunnel users and fire brigade)
 - Structural safety/property protection (lining)
- Measures are taken to mitigate these risks:
 - detection
 - ventilation
 - fire protection
 - suppression



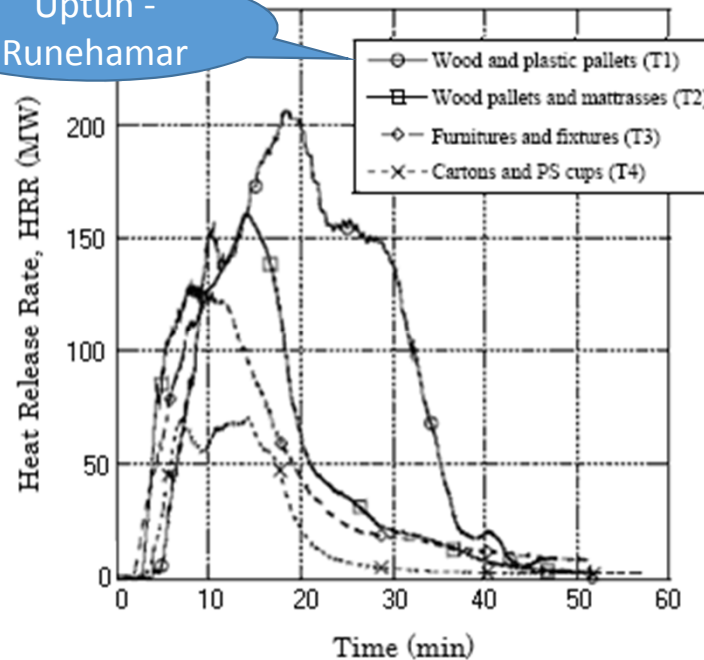
Mitigating effects of deluge system



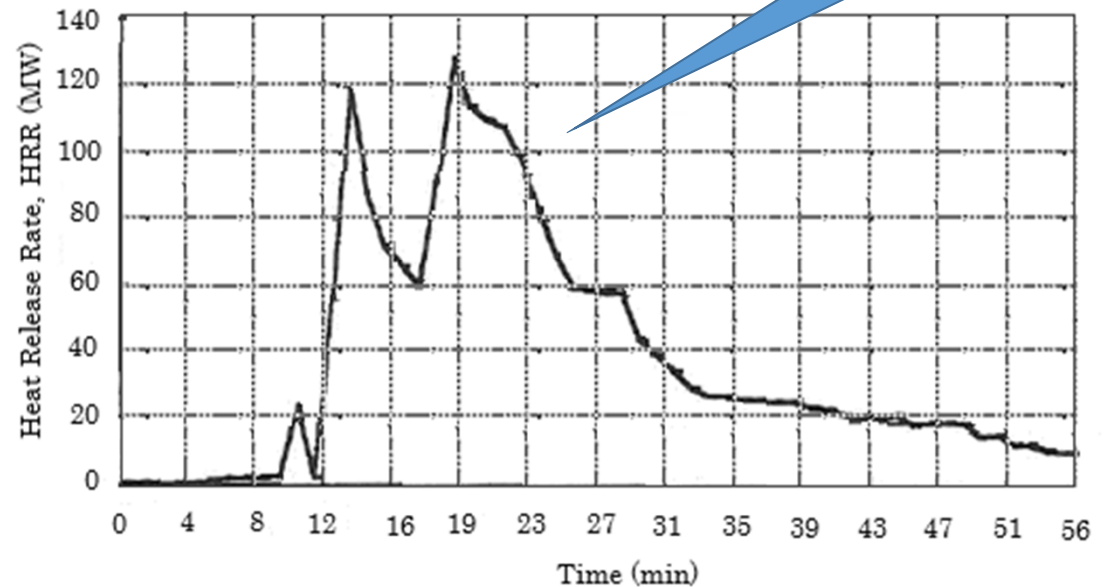
Design fires without suppression

- Car: 5 MW to 10 MW
- Heavy goods truck: 70 MW to 200 MW
- Bus: 20 MW to 30 MW
- Tanker: 200 MW to 300 MW

Uptun -
Runehamar



Eureka



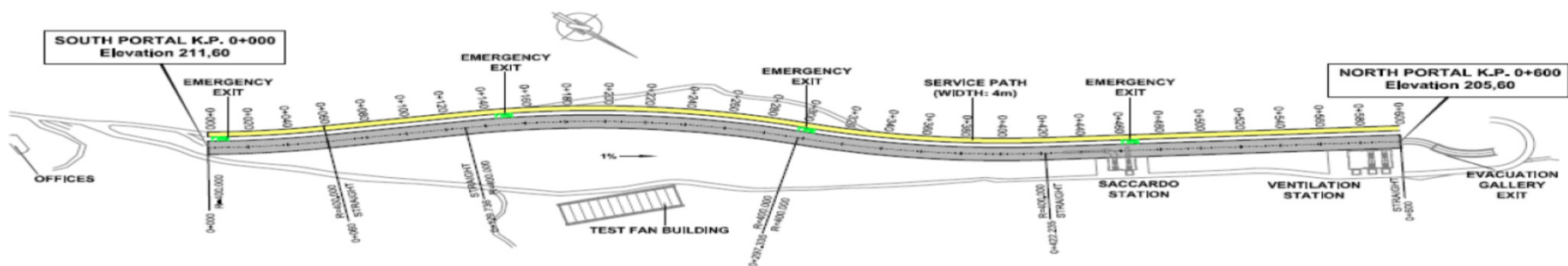
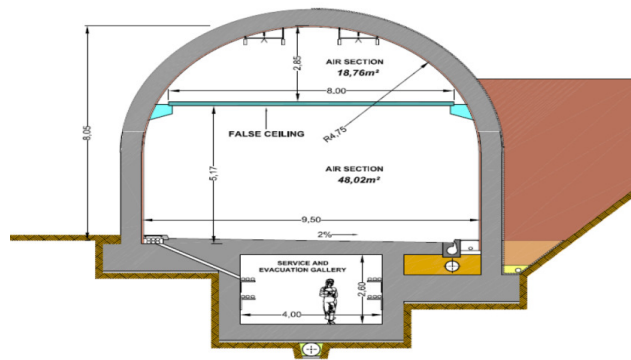
Singapore Fire Test Programme

- In 2011, LTA Singapore commissioned Effectis to conduct a fire test programme with deluge sprinkler system in ventilated (3 m/s) road tunnel
- Objectives:
 - Investigate effect of suppression on heat release rate
 - Investigate effect of fire suppression system on tunnel velocity: reduce risk of vehicle fire spread
 - Acquire information on appropriate design parameters (e.g. nozzle type, discharge density and activation time)
- A total of 7 large scale test conducted

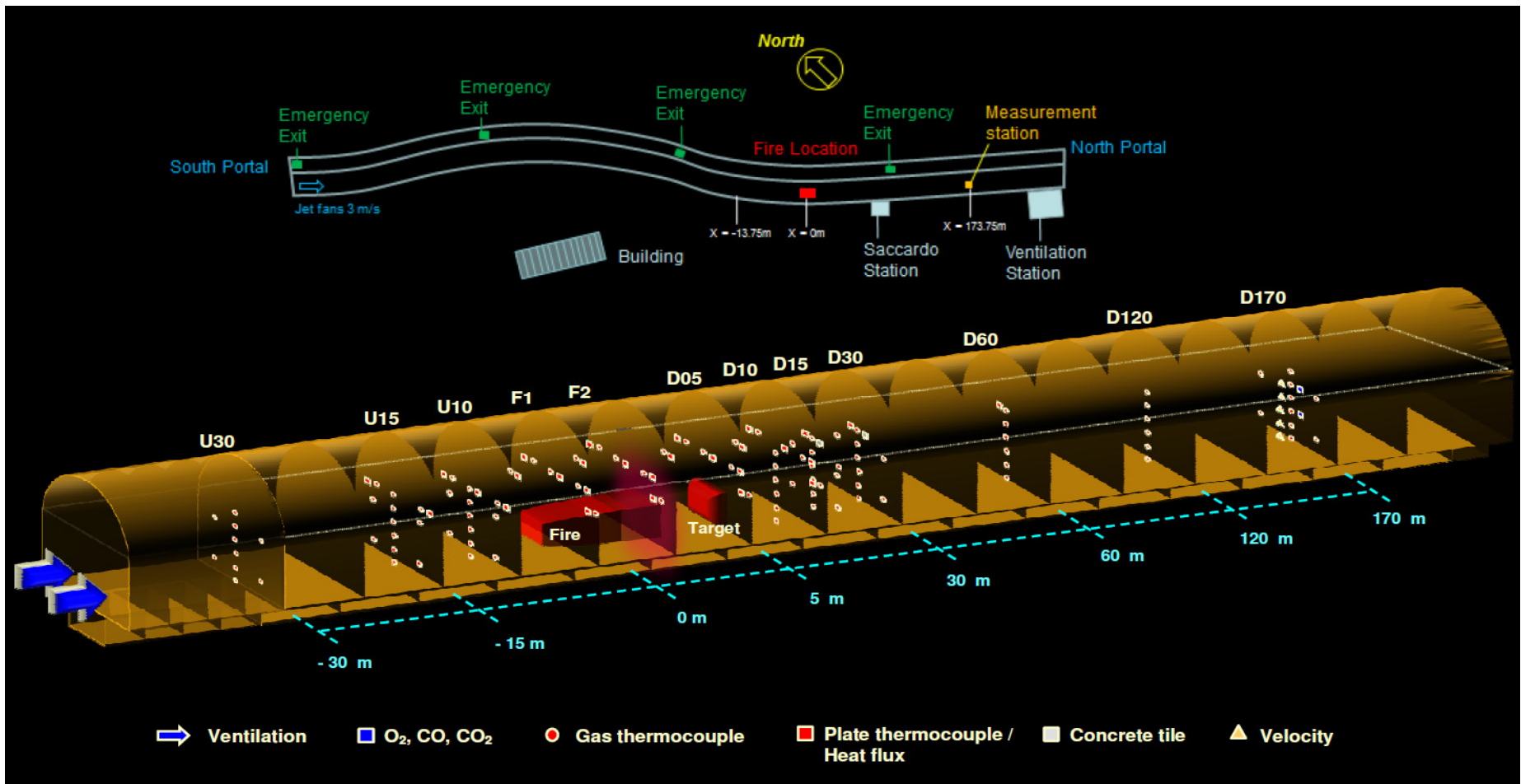
This
presentation

Large scale fire tests - Test tunnel

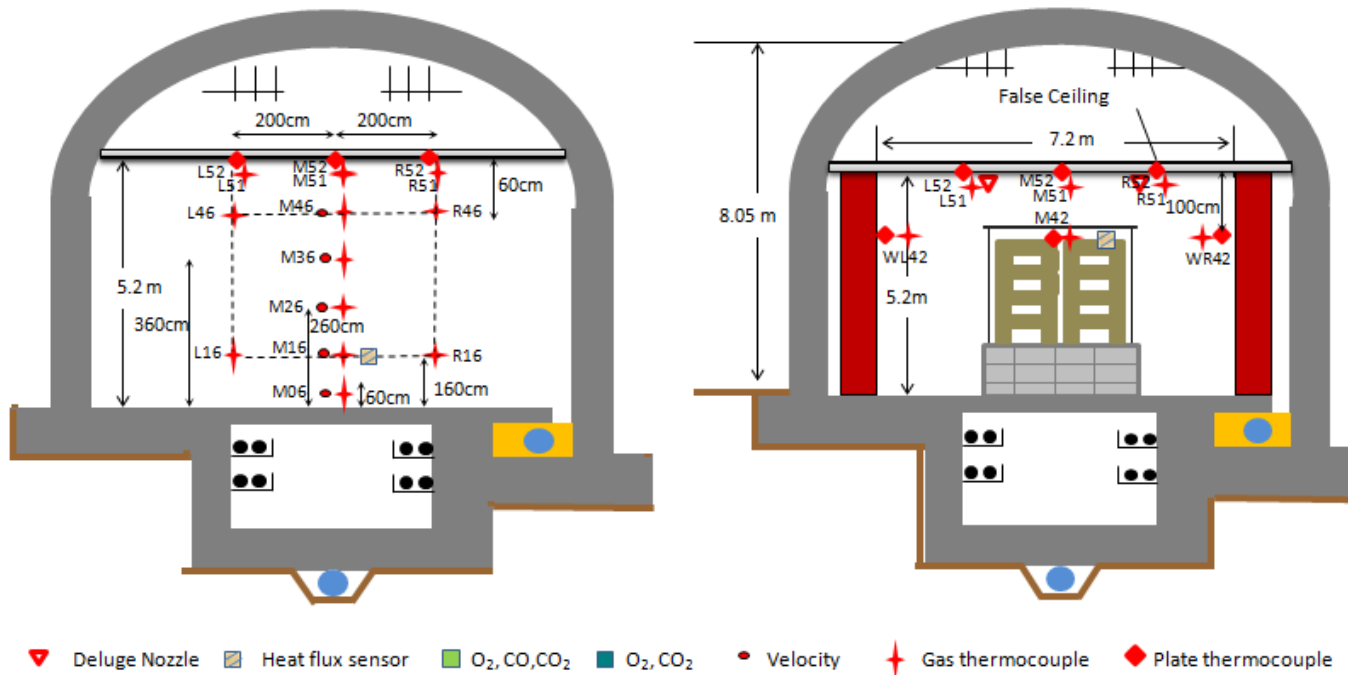
- Tunnel Safety Testing, Pola de Siero, Spain
- 600m long test tunnel
- 5.2m high
- 7.2-9.5m wide



Test set-up: instrumentation



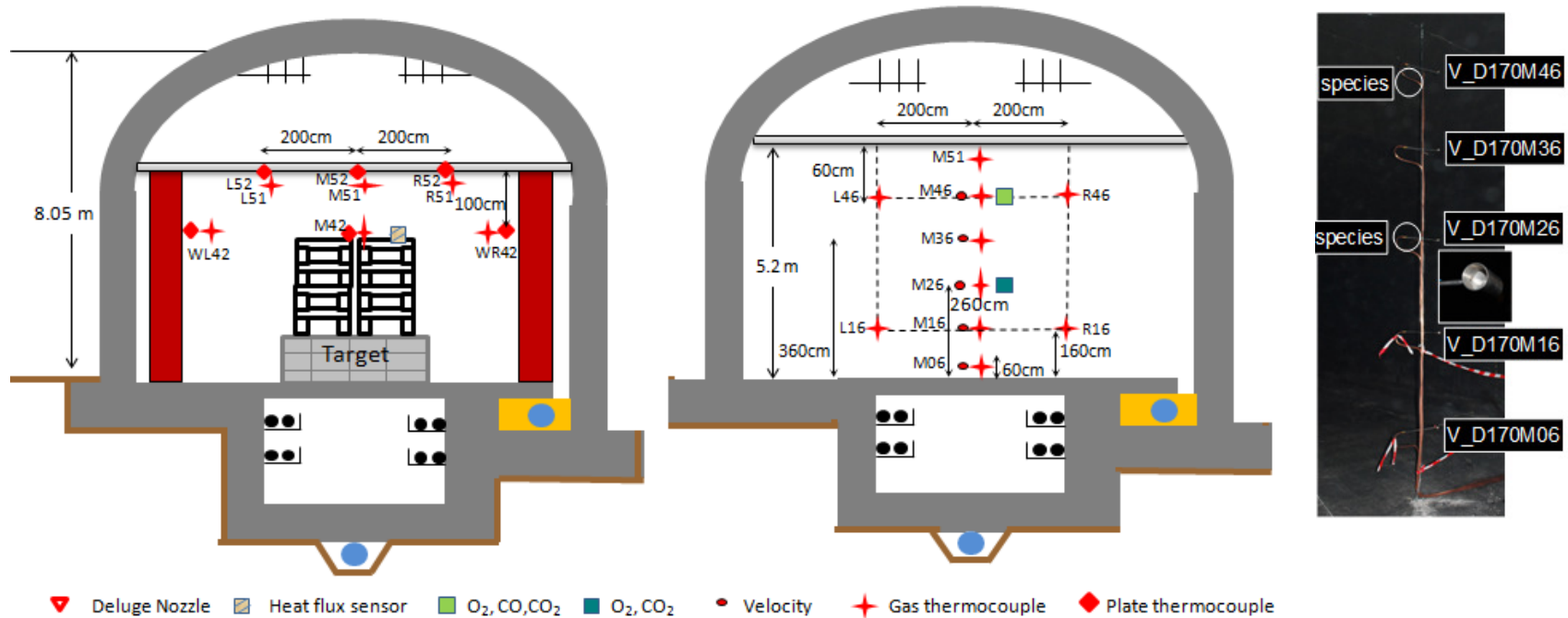
Test set-up: instrumentation upstream



U10 Location X = -13.75 m

Fire Location X = 0 m

Test set-up: instrumentation downstream



D5 Location X = 8.75m

D170 Location X = 173.75m

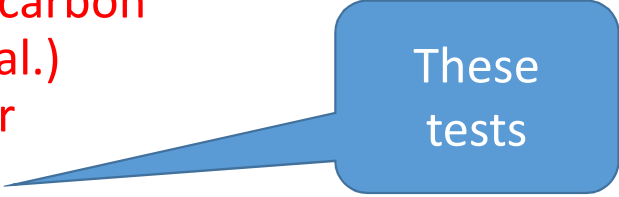
Test set-up: measurement heat release rate

Methods:

- Mass loss rate: not possible due to weight of water
- Oxygen depletion:
 - Oxygen only
 - Oxygen + carbon dioxide
 - Oxygen + carbon dioxide + carbon monoxide (Dlugogorski et. al.) (includes influence of water vapor): most accurate

Measurements 170 m downstream:

- Velocities
- Temperatures
- Gas concentrations : O₂, CO₂, CO
- Relative humidity



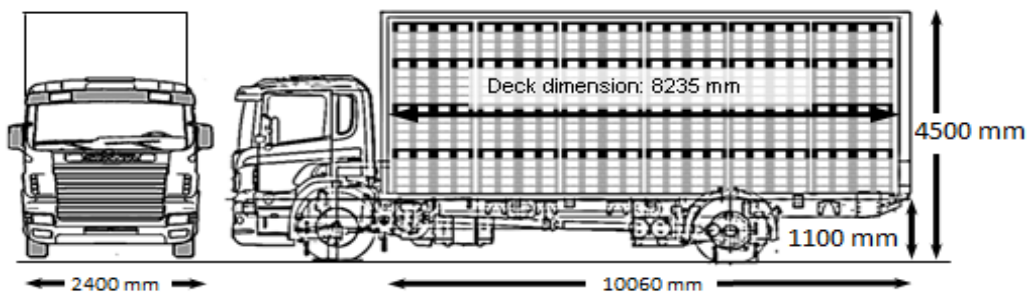
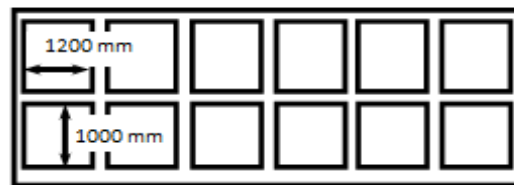
These tests

Test set-up: fuel load

- Based on allowed traffic in Singapore tunnels
- 228 wooden (80%) and plastic (20% pallets)
- Covered (metal sheet + tarpaulin)

Fuel Load on HGV
consist of 2 type of
pallets

182 wood pallets
46 plastic pallets



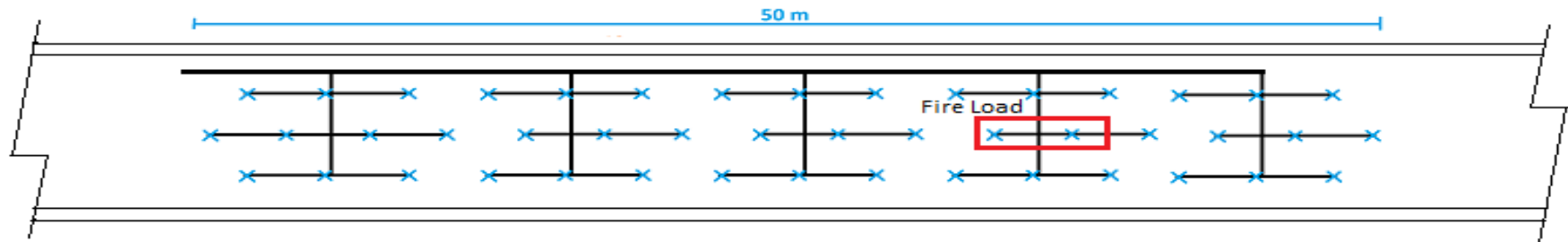
Target: fire spread



Ignition



Test set-up: deluge system



Max. installed system length: 50m
 Sections: 2 x 25m
 Max. no. of spray nozzles: 46
 Deluge system (open nozzles)
 Designed for 8-12mm/min
 Designed for 9m²/nozzle

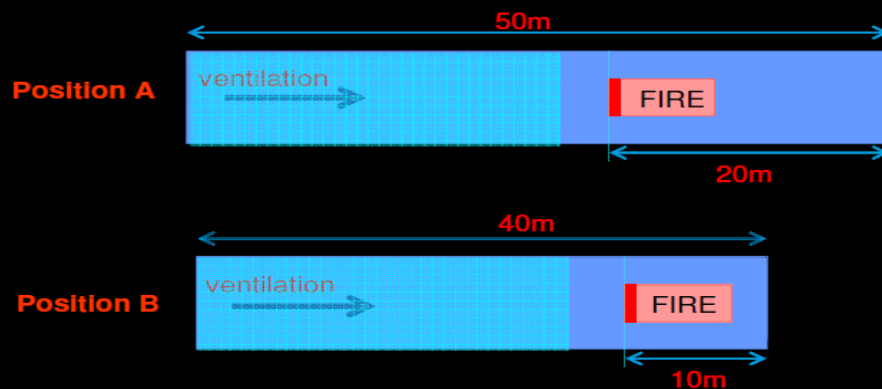


Standard Directional 180°



Fire test program – Test schedule

Test	Test description (variation)	Discharge density (mm/min)	Nozzle type	Activation time (min)	Fuel load in zone
1	Base case	12	Directional 180° spray nozzle	4	Position A
2	Low suppression	8	Directional 180° spray nozzle	4	Position A
3	Nozzle	12	Pendant standard spray nozzle	4	Position A
4	Nozzle*	12	Pendant standard spray nozzle	4	Position A
5	Reduced cooling	12	Pendant standard spray nozzle	4	Position B
6	Late activation	12	Pendant standard spray nozzle	8	Position A
7	Unsuppressed	-	-	-	Position A



Nozzle Specifications:

- K-factor: 80 lpm/bar^{0.5}
- Operating pressure: 1-2 bar, 8-12mm/min

Detection

- Gas thermocouples on ceiling level is measured
- "Detection" is defined as 60 °C gas temperature

System activation

- Fixed time after "Detection": 4 min

Fire test program – VIDEO





00:16



02:40 (just after detection)

Test 1



05:48



06:40 (just after activation)

Test 7



10:32



22:16



Remains fire load after fire test



Remains fire load after fire test



03:47



07:41



08:39



10:41



13:27



14:21



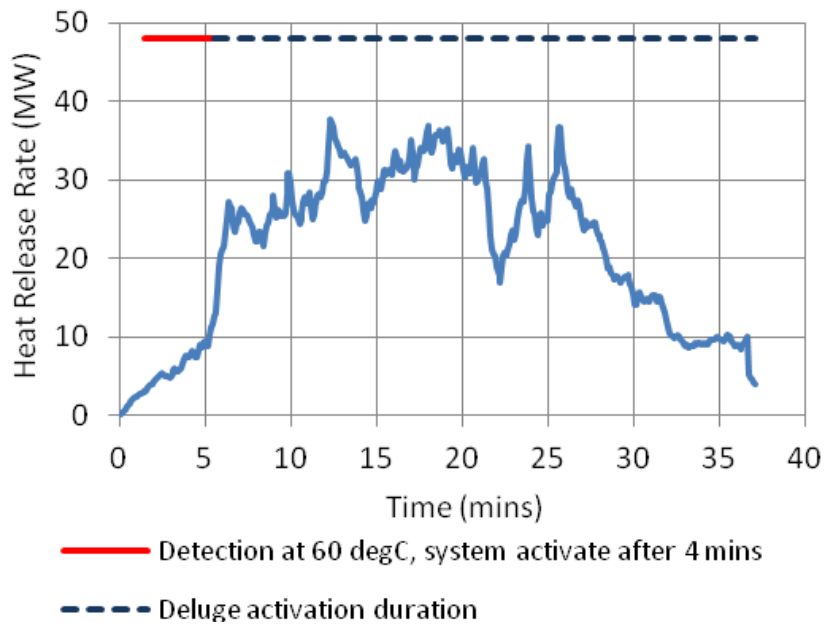
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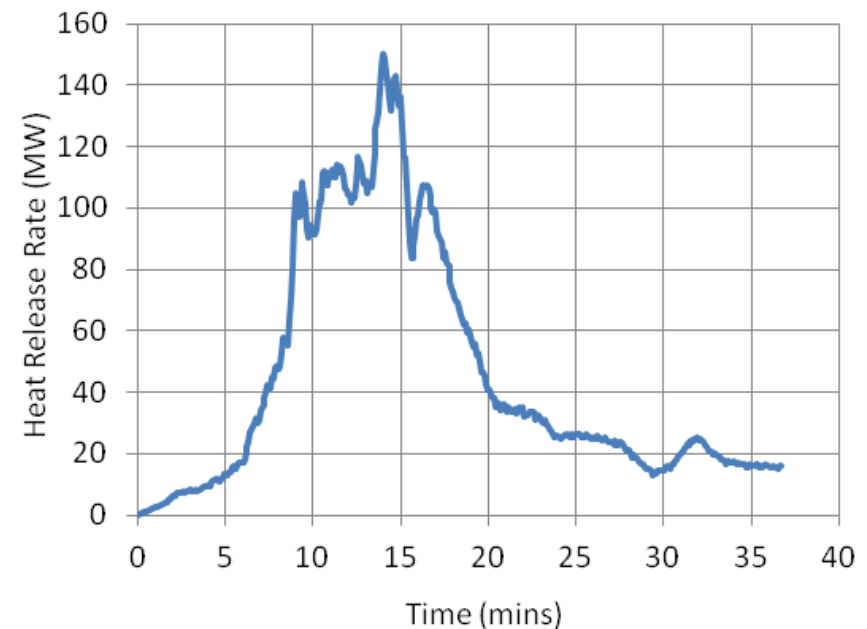
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Test results: HRR Test 1 vs Test 7

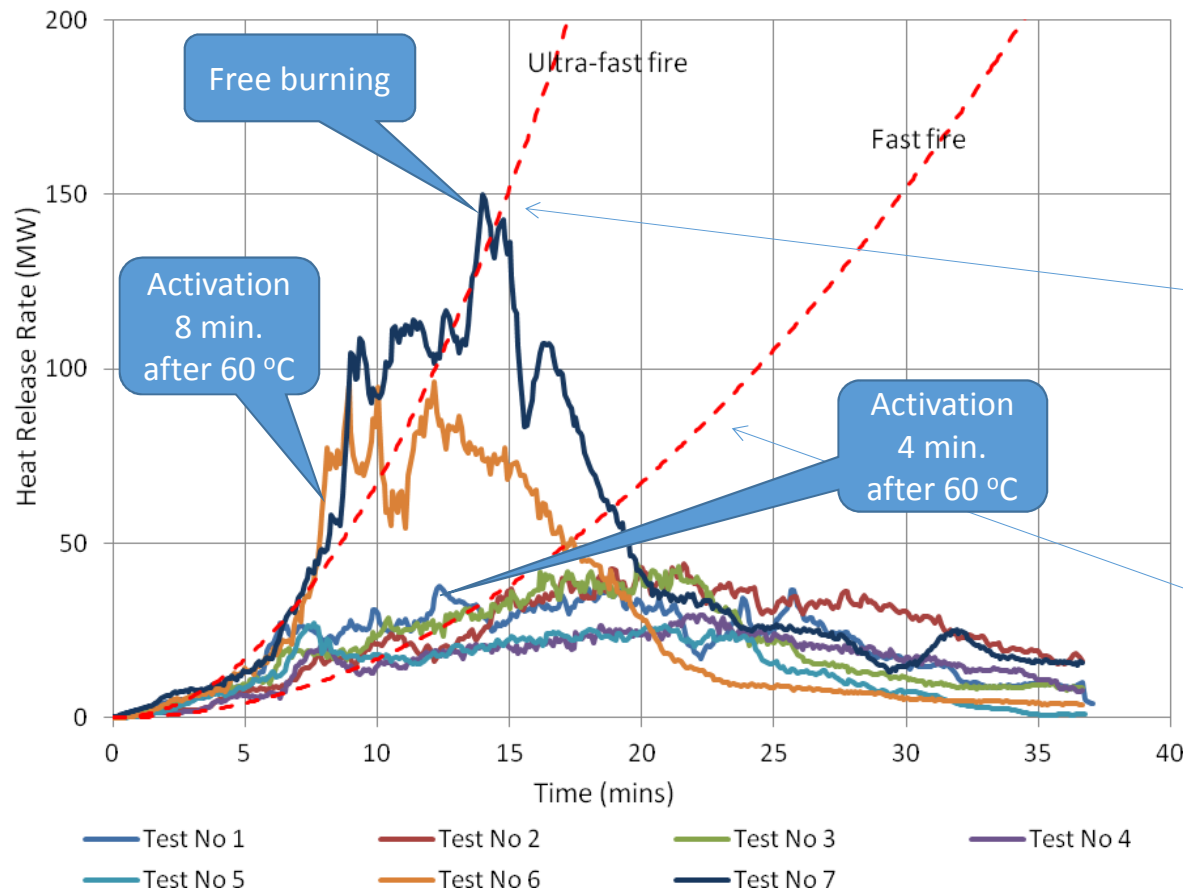
Test no 1. 180° Directional, 12mm/min, fire at centre zone



Test no 7. Free burning



Test results – Rate of heat release



Discussion

- NOTE: Validity of results limited to relatively small and covered HGV!
- Peak HRR:
 - without deluge (free burning): 120 MW – 140 MW
 - deluge on time: 27 MW - 44 MW: always < 50 MW
 - deluge on time vs free burning: 60% - 80 % reduction
 - delayed activation: only 35 % reduction
- Fire growth rate:
 - Fast – ultra-fast
 - Even faster without deluge on time after 7 minutes
- Activation of deluge system at early phase of fire (within 4 minutes after 60 °C) is critical due to high energy content of HGV

Thank you!

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