ULTRA FOG®

FIRE EXTINGUISHING SYSTEM

High pressure water
mist sprinkler system
for fighting fires

Rolling Stock | Marine | **Land** | Offshore

Water Mist in Tunnels: Experience of Fire Testing in Spain

ULTRAFOG – WHO WE ARE

Marine Applications

Cruise ships, Ro-Ro, Ro-Pax, tankers, naval vessels, historic ships, special purpose vessels, luxury yachts.

Land Applications

Hotels, commercial offices, shopping malls, schools, historic buildings, museums, archives, restaurants, construction, care homes, hospitals, power plants.

Offshore Applications

Machinery space, engine rooms, thruster rooms, control rooms, accommodation, spaces, turbine enclosures, galleys, deep fat fryers and ducts, paint lockers.

TUNNEL FIRE TESTS:

- Purpose of the test program.
- Testing facility in San Pedro de Anes.
- Fire scenarios (30,50,100MW)
- Test procedures.
- Performance criteria and test results.
- Conclusions.

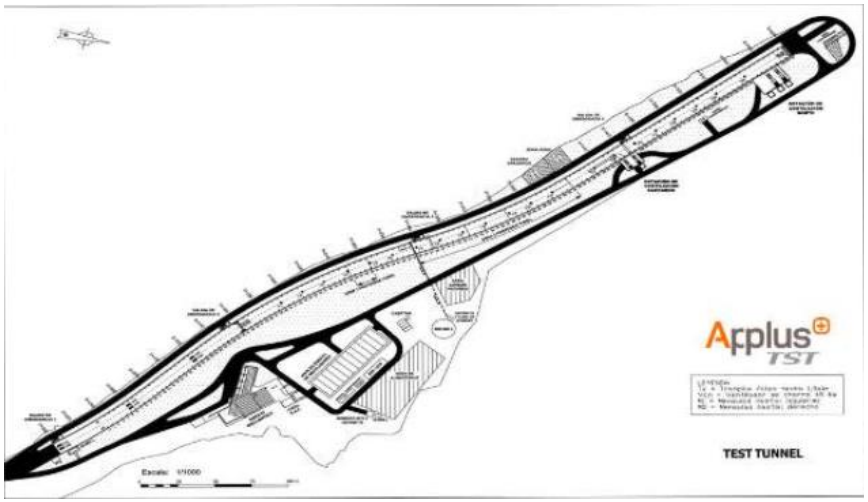
Purpose of the testing session.

- In 2020, during the summer, Ultrafog planned a full scale fire test session in San Pedro the Anes, Spain to determine the effectiveness of Ultrafog watermist system against a CLASS A fire (wood pallets fire) in the ambient of a road tunnel.

- The effectiveness of the Watermist system with respect to life safety, was tested simulating a road vehicle fire. In order to determine the performance several measurements were recorded and analyzed.

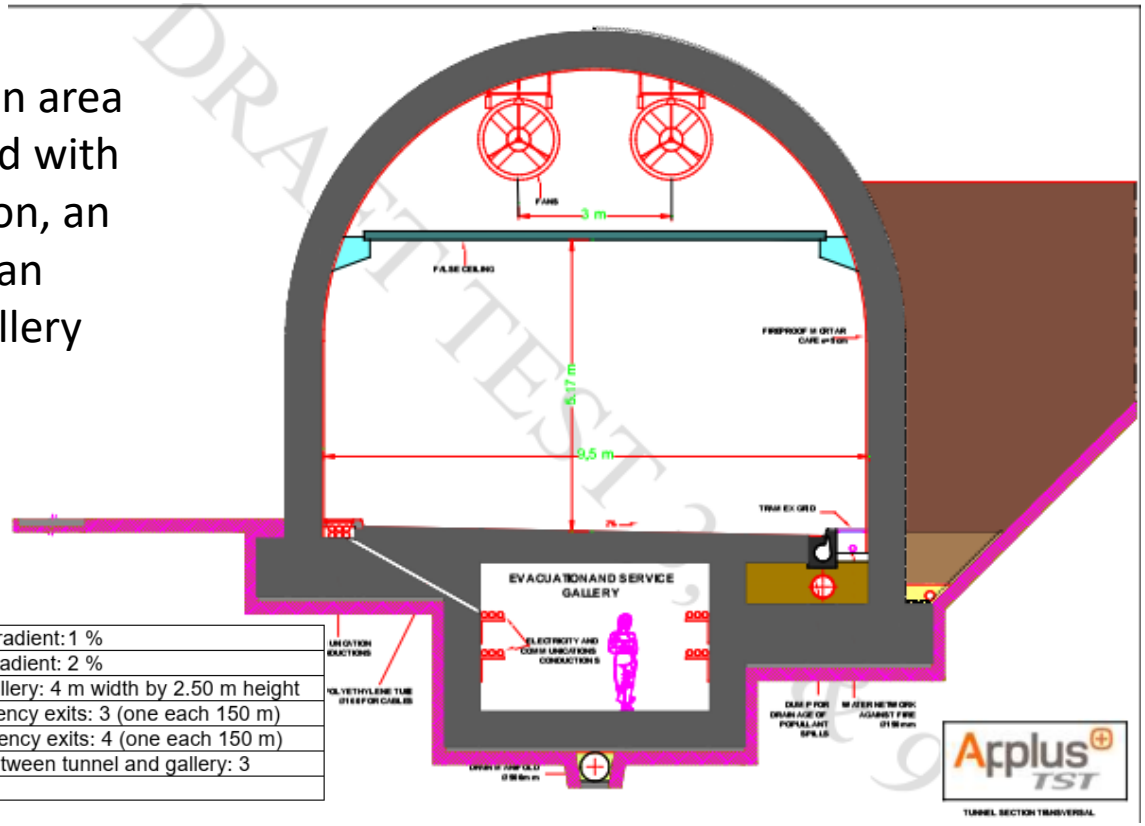
Testing facility in San Pedro de Anes

The best way to verify the real performance of a watermist system is to carry out tests in a tunnel where is possible to develop a full scale scenario inside. Applus+TST facilities are the optimal option because of the availibility of a tunnel, built in concrete, with equivalent dimensions of a two lane road tunnel, designed for tests with different types of ventilation and data management.



Testing facility in San Pedro de Anes

The tunnel is built in a open area (false tunnel) and equipped with different types of ventilation, an insulated false ceiling and an emergency/evacuation gallery underneath the floor.

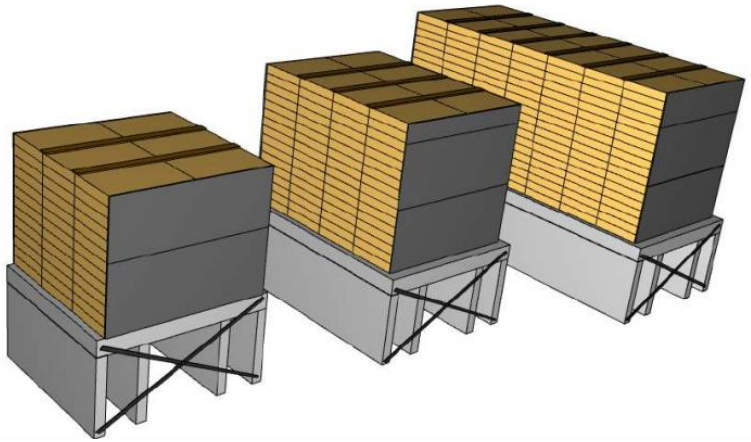


Length: 600 m	Longitudinal gradient: 1 %
Width: 9.50 m	Transversal gradient: 2 %
Height: 8.12 m	Emergency gallery: 4 m width by 2.50 m height
Height (with false ceiling): 5.17 m	Tunnel emergency exits: 3 (one each 150 m)
Cross-section: 66 m^2	Gallery emergency exits: 4 (one each 150 m)
Cross-section (with false ceiling):48 m2	Connection between tunnel and gallery: 3
Width of the concrete walls: 0.60 m	

Fire scenarios:

- The idea behind the configuration of the fuel loads is to simulate different sized vehicles with a corresponding HRR (Heat Realease Ratio) coming from a specific fire load for each scenario.

- Each fuel load consisted of an array of stacks of wood palets positioned on a platform located inside the tunnel (370 mtr from entrance South, 230 from North).
- Standard EUR/EPAL wood pallet have been selected, with a weight between 20Kg and 25Kg each.



- The HRR figures are based on experimental data from large scale testing in fire test laboratories

Fire scenarios:

- 3 different scenarios have been tested:

- 30 MW configuration: 78 pallets
- 50 MW configuration: 128 pallets
- 100MW configuration: 252 pallets

Parameter	Potential maximum HRR		
	30 MW	50 MW	100 MW
Number of pallets per stack	13	16	18
Number of stacks in width	2	2	2
Number of stacks in length	3	4	7
Total number of pallets	78	128	252
Nominal stack height (m)	1.87	2.30	2.59
Nominal overall width of array	2.40	2.40	2.40
Nominal overall length of array	2.40	3.20	5.60
Width of platform (m)	2.60	2.60	2.60
Length of platform (m)	2.60	3.40	5.80
Nominal overall height of fuel load above floor (m)	3.27	3.70	3.99

Test procedure:

- Ultrafog nozzles, with a K factor of 4.2, have been installed on both sides of the tunnel but were activated only on one side for 30 and 50 MW configuration. Both sides were spraying only for 100MW configuration.

- All nozzles have an inclination angle of 40°.

- 20 nozzles each side were installed, with a spacing of 4 meters, covering a total lenght of 80 meters. Fire load was located in the middle of this 80 meter tunnel portion.

- A nozzle spray test without fire has been performed to verify coverage, design pressure, good functioning of the pump unit.

Test procedure:

- Let's start with some fire!

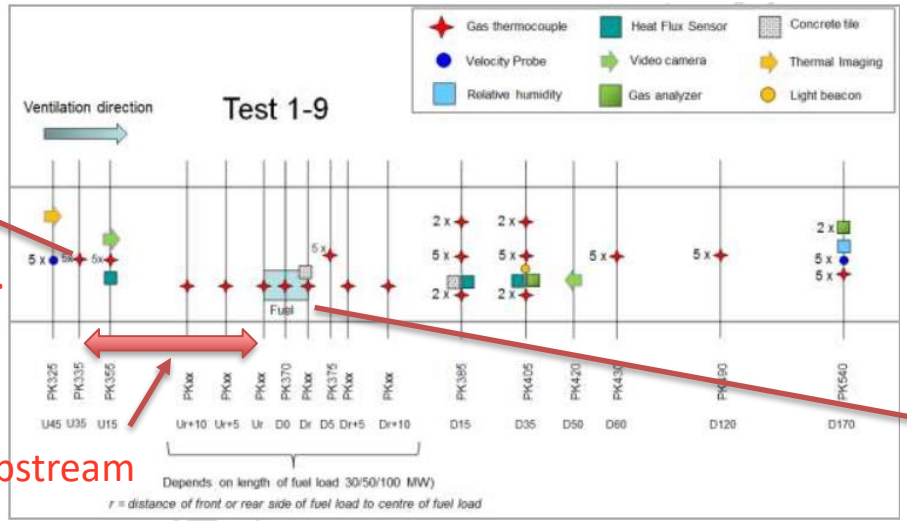
Test procedure:

- Fire was initiated using 2 rectangular trays with 2,5 liters of E5 gasoline, inserted into the pallet column, at the bottom. At the start signal , both trays were ignited simultaneosly.
- Watermist system was activated 3 minutes after the detection of fire.
- Detection of fire was defined as the time necessary for at least one of 19 thermocouples installed around the fuel load was exceeding the temperature of 60°C.
- Duration of the test was set at 30 minutes after the activation of the watermist system. Tests ended after this 30 minutes , when the fire brigade took control of the fire for total extinguishment.
- Ventilation was running during all 3 test scenarios.

Performance data and test results:

- First performance criteria is related to tunnel temperature at 1.8mtr height , 35 meters upstream of the fire load, that shall not exceed 60°C -for a duration of 10 minutes- no later than 120 seconds after activation of the watermist system.

Temperature shall not exceed 60°C at this termocouple.



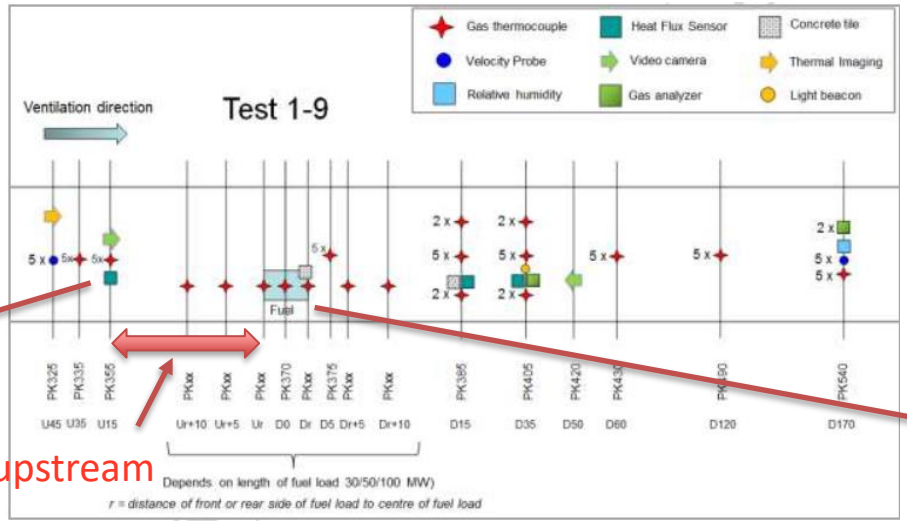
35 meters upstream

Fuel load

Performance data and test results:

- Another factor to be evaluated is the radiant heat flux at 15 meters upstream, at 1.8mtr height, that shall not exceed 5.0kW/m2 for a duration of 10 minutes , no later than 120 seconds after activation of the watermist system.

Heat flux shall not exceed 5kW/m2 at this sensor.



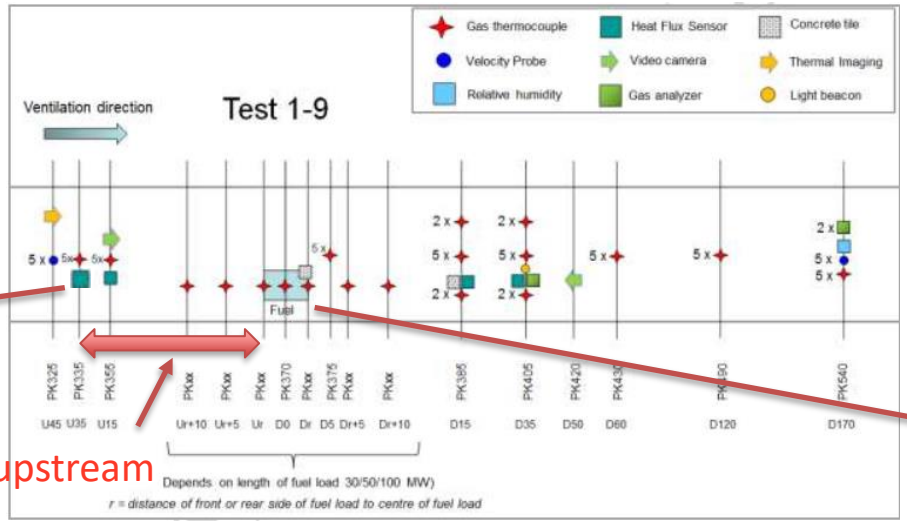
15 meters upstream

Fuel load

Performance data and test results:

- The radiant heat flux is to be measured also from the smoke layer at 35 meters upstream, at 1.8mtr height, and it shall not exceed 2,5kW/m2 for a duration of 10 minutes , no later than 120 seconds after activation of the watermist system.

Heat flux shall not exceed 2.5kW/m2 at this sensor.



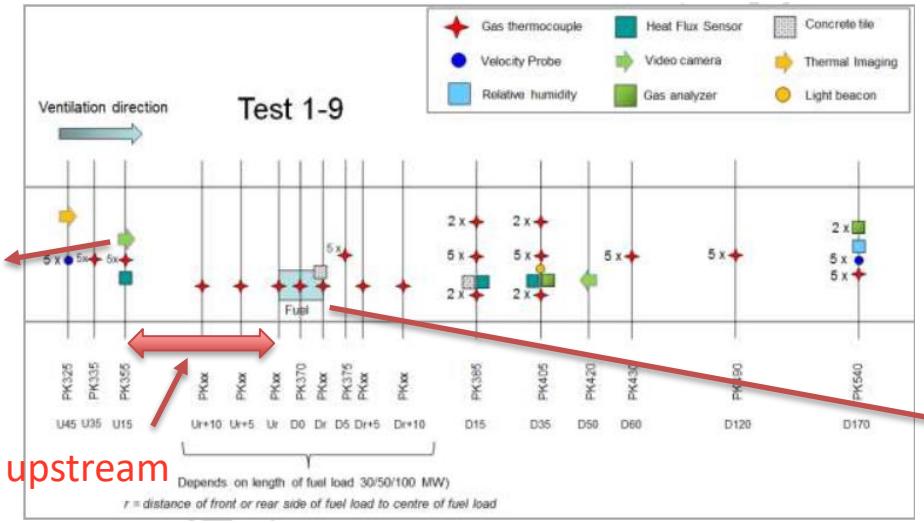
35 meters upstream

Fuel load

Performance data and test results:

- Visibility must have a minimum lenght of 15 meters for the duration of the test, no later than 120 seconds after activation of the watermist system.

Visibility minimum 15 meters from this camera.



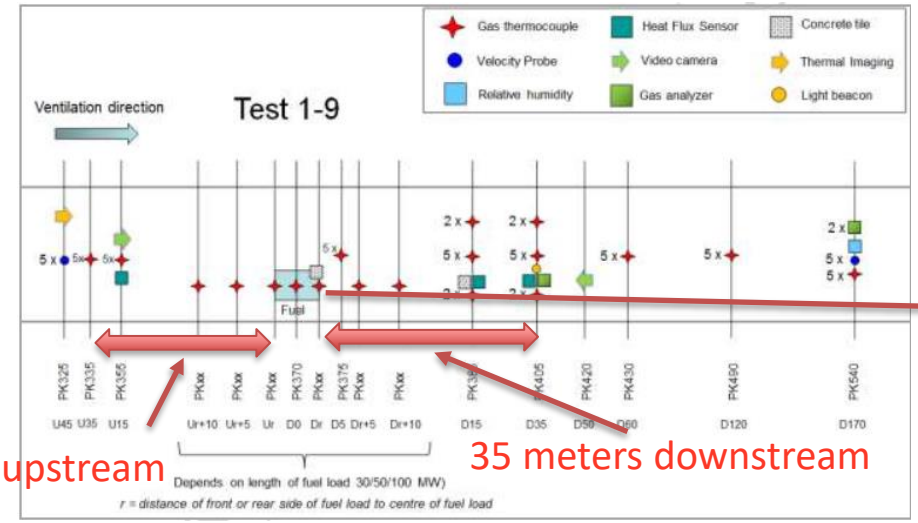
15 meters upstream

Fuel load

Performance data and test results:

- Last data to be monitored is the FED (Fractional Effective Dose) for toxicity at 1.8 meters height to be =0 in upstream side and to be <=0.3 in downstream side at 35 meters each side of the fuel load.

FED is calculated by multiple sensors (Temperature,CO sensors, Heat flux etc).



Performance data and test results:

- TEST RESULTS FOR **30 MW** SCENARIO

DATA	Measured	Limit
Ambient temp. U35 mtr	22°C	60°C
Heat Flux U15 mtr	0,2kW/m2	5 kW/m2
Heat Flux U35 mtr	<0,2kW/m2	2,5kW/m2
Visibility	Over 15 mtr	15 mtr
FED	U35=0 D35=0,07	<=0,3

Performance data and test results:

- TEST RESULTS FOR **50 MW** SCENARIO

DATA	Measured	Limit
Ambient temp. U35 mtr	18°C	60°C
Heat Flux U15 mtr	0,64kW/m2	5 kW/m2
Heat Flux U35 mtr	<0,6kW/m2	2,5kW/m2
Visibility	Over 15 mtr	15 mtr
FED	U35=0 D35=0,09	<=0,3

Performance data and test results:

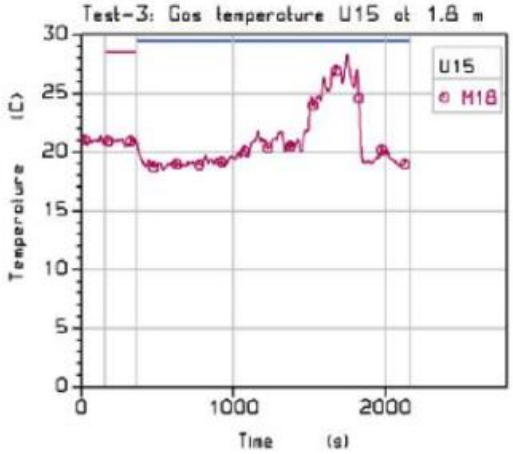
- TEST RESULTS FOR **100 MW** SCENARIO

DATA	Measured	Limit
Ambient temp. U35 mtr	12°C	60°C
Heat Flux U15 mtr	0,27kW/m2	5 kW/m2
Heat Flux U35 mtr	<0, 2kW/m2	2,5kW/m2
Visibility	Over 15 mtr	15 mtr
FED	U35=0 D35=0,12	<=0,3

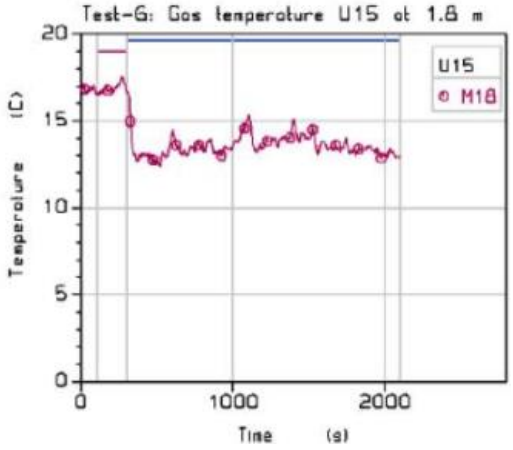
Conclusions:

- The ambient temperatures around the fire load are significantly lowered by WMS. You can see that only 15 meters away from the fire, the temperature is like ambient temperature.

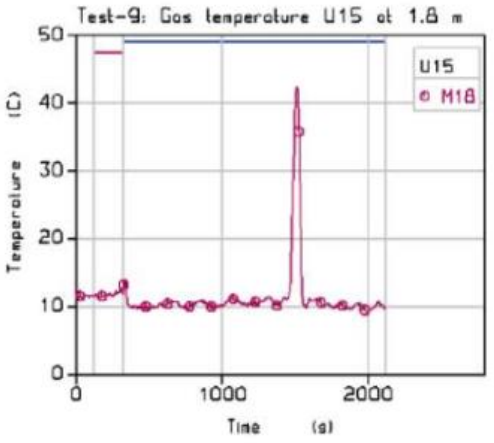
30MW



50MW



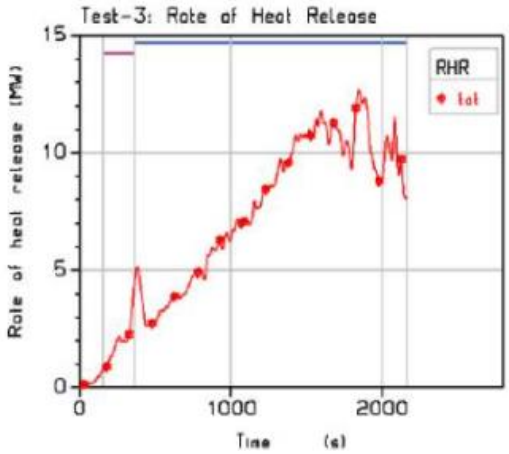
100MW



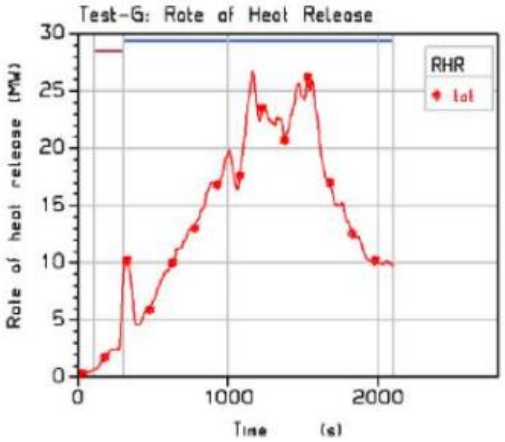
Conclusions:

- HRR (Heat release ratio) is taken under control by WMS. In comparison to free burn of the fire load , the WMS is lowering significantly the HRR.
  - 30MW reduced to a peak of 13MW (44% of nominal fire load)
  - 50MW reduced to a peak of 27MW (53% of nominal fire load)
  - 100MW reduced to a peak of 30MW (30% of nominal fire load)

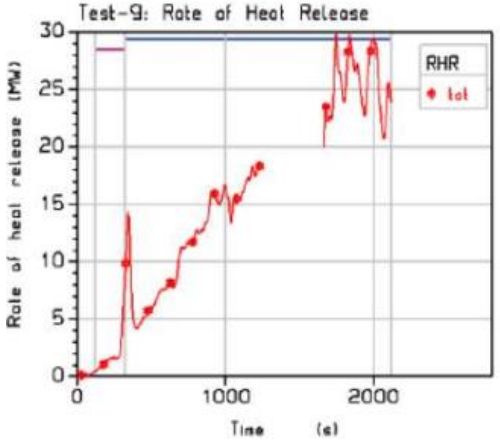
30MW



50MW



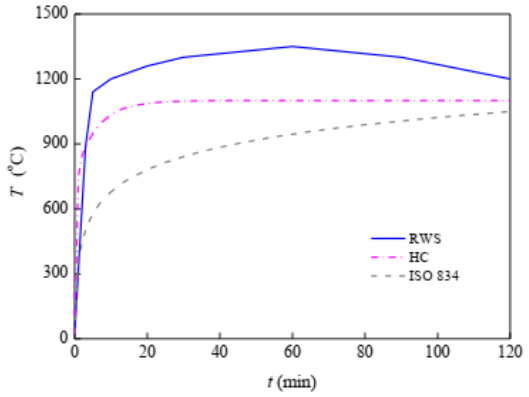
100MW

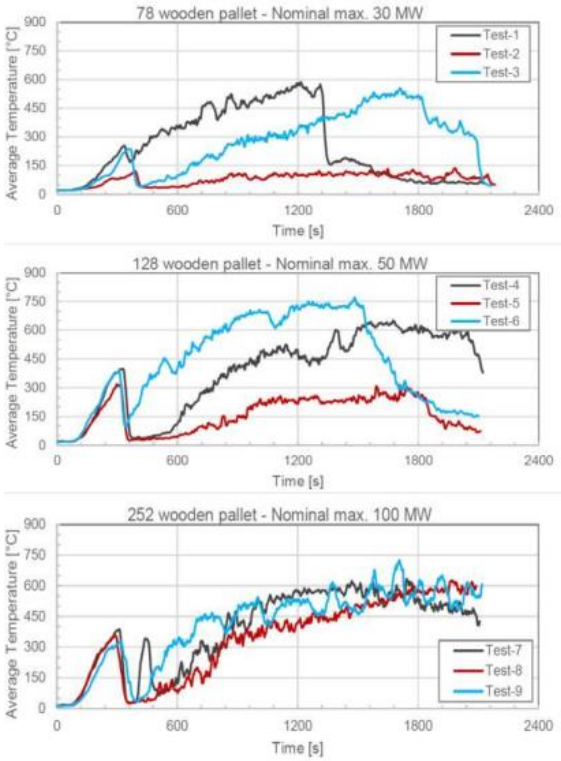


Conclusions:

- Temperature at the ceiling height are also significantly lowered , protecting the structure from permanent damages.

During all test the temperature at the ceiling level never peaked over 650/750°C (depending on fire load configuration), far below a free burn scenario.





Conclusions:

- The outcome of the test session gave us some important data about the effectiveness of the watermist system used in a full scale fire test in tunnels:
  - The combination of lowering temperatures, controlling the fumes , reducing the heat flux radiation, keeping the visibility to good levels, will make the ambient compatible with tenability criteria to allow a safe escape of the people from the tunnel and a safe, quick and effective intervention of fire brigades.
  - The watermist system was capable to reach the shown data with less than 700 liter/minute for a 80 meter zone for 30 and 50MW fire load and about 1260 ltr/minute in the 100MW configuration. This means that the need of big infrastructures to contain large amount of water normally necessary for traditional water deluge systems are not needed.
  - All tests were performed with pure water, without any other additive or foam, making the system configuration easier (no foam proportiner or additive injector are required).

Thank You!

Delivering fire protection solutions for industry, buildings, occupants and property

Ultra Fog Fire Extinguishing System | Reliable and efficient | Environmentally friendly and safe

ULTRA FOG®
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