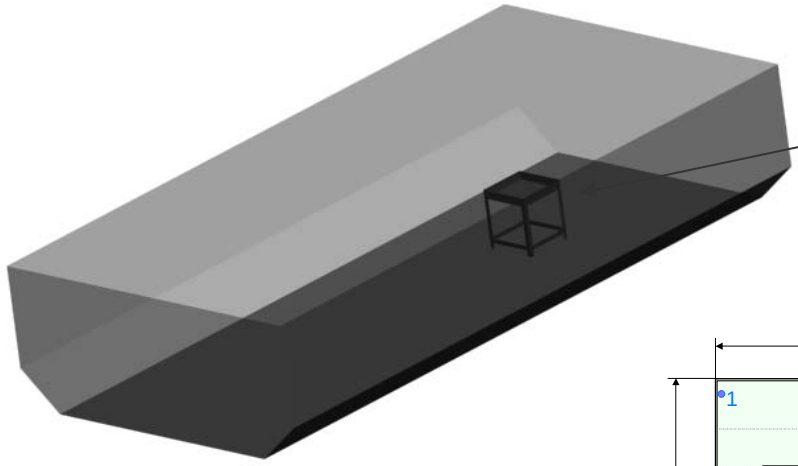
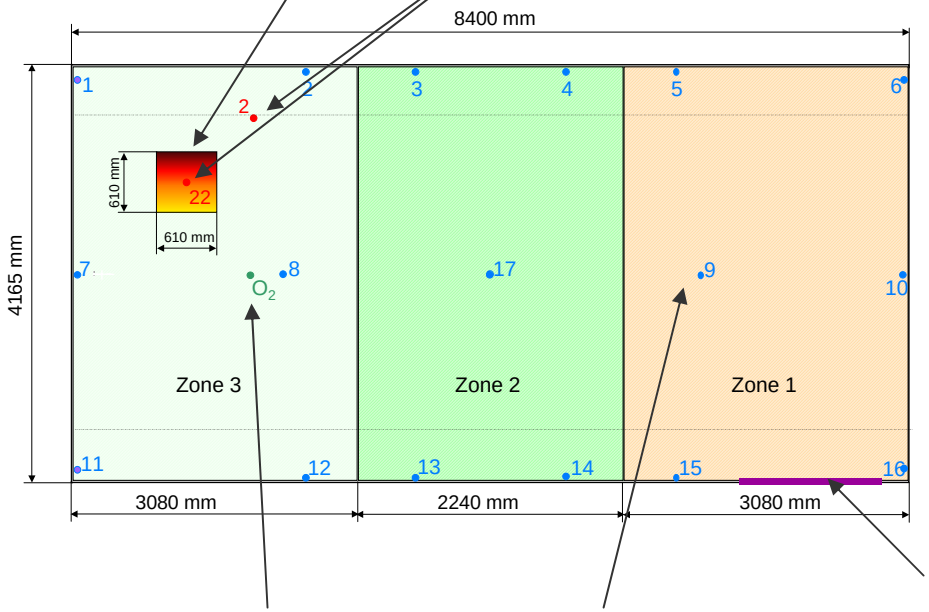
Konstantin Kallergis

Considerations on the Physics behind the Cargo MPS „Open Surface Fire Test“

International Aircraft Systems Fire Protection Working Group
Cologne, 19/20 May 2009

Test Arrangement „Open Surface Fire Test“





cargo compartment size: 57 m³

suppression agent: water mist

suppression zones: 3

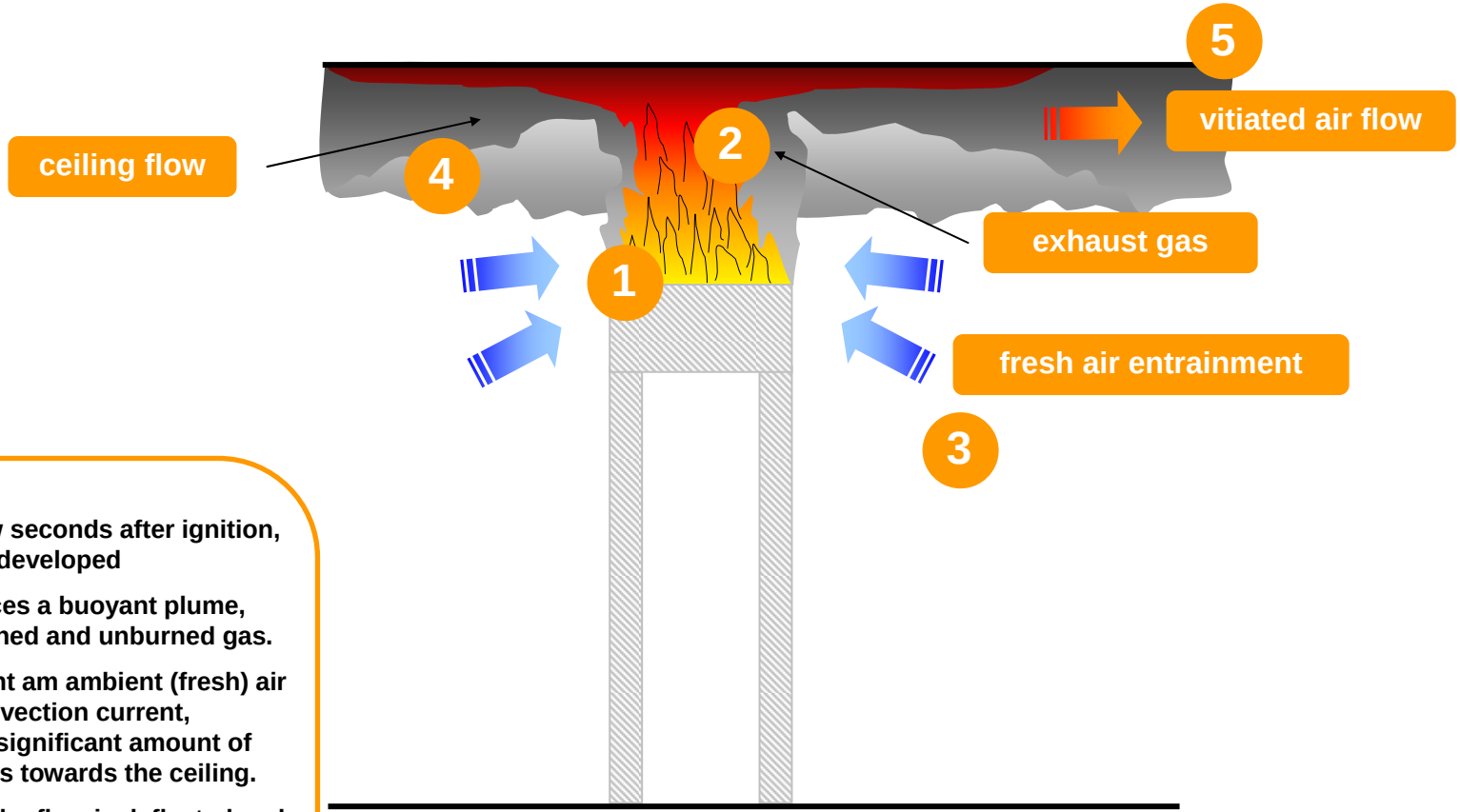
fire load: 1.9 l kerosene, 0.385 l gasoline

fire pan size: 0.61 m x 0.61 m

test duration: 300 s

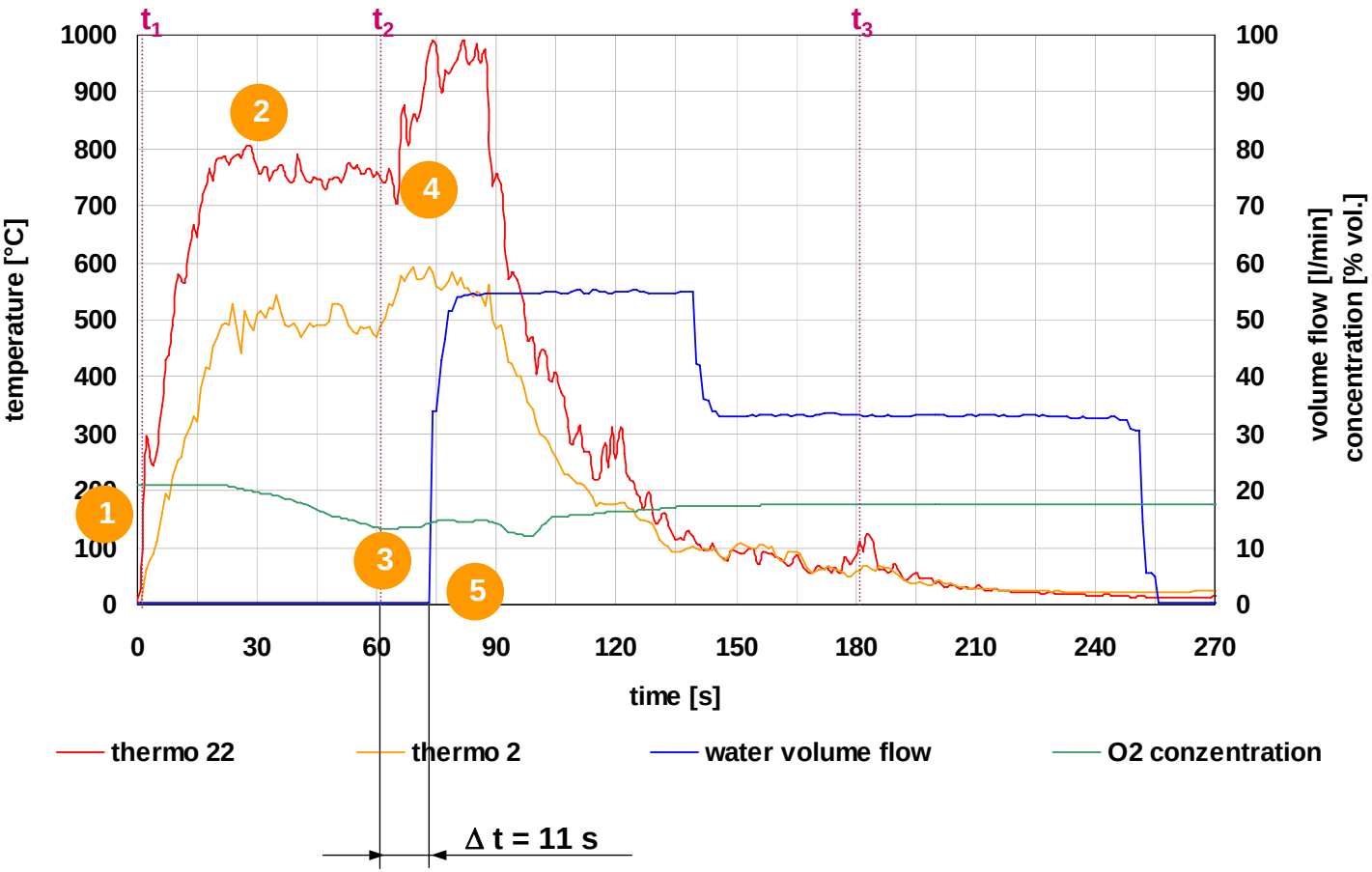
The Fire

The Flow Field



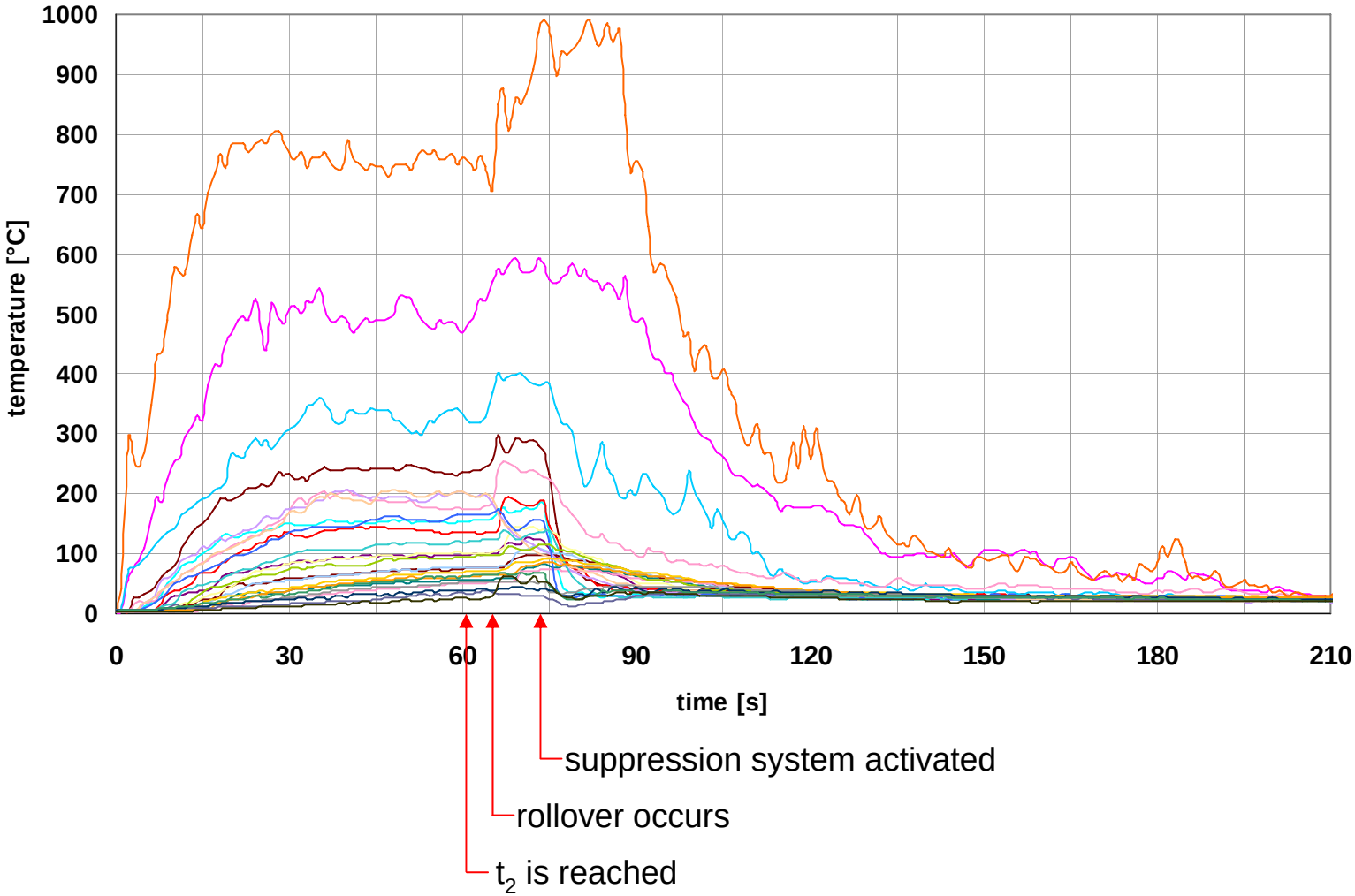
1. Within very few seconds after ignition, the fire is fully developed
2. The fire produces a buoyant plume, containing burned and unburned gas.
3. The entrainment am ambient (fresh) air keeps up a convection current, transporting a significant amount of unburned gases towards the ceiling.
4. At the ceiling, the flow is deflected and a layer of hot gas below the ceiling.
5. The vitiated air is transported away, but in an enclosed space, it accumulates at the ceiling, and the ceiling layer will become thicker with the time. Temperature is growing.

Test Chart



1. As expected, this type of fire produces a steep temperature increase in the vicinity of the fire source.
2. The temperature directly above the fire pan reaches 800°C (1472°F). Then, a decrease of ca. 50K is observed which is due to the complete consumption of the gasoline, which has a higher flame temperature than the kerosene.
3. At t = 62 s, t_2 is reached and the suppression process should have started. As the system was a prototype, it took another 11 s until the water mist system was activated by the electronic management.
4. Few seconds after t_2 a steep temperature increase is observed for all thermocouples inside the cargo compartment: rollover has occurred!
5. During rollover stage, the suppression system is activated. In the following, the fire is extinguished but the required volume of water is enormous!

Test Chart Back-Up



Conclusion

Whenever the suppression process started, even after the incidence of rollover, it was possible to extinguish the open surface fire in time and completely.

However, the required volume of water (mist) exceeded the targets by far (target: 100 l max., tested average: 150 l)

The rollover occurred at t ~ 70 s (5 trials, 5 rollovers due to late suppression activation)

An early (as possible) water mist activation is crucial for the required weight minimization.

Every second counts.