Experimental and numerical investigation of a vehicle fire with fixed-firefighting system

Dipl.-Ing. Stephan Klüh, September 11, 2020

Project SUVEREN

“Safety of Urban Underground Structures due to the Use of New Energy Carriers”

Partner

FOGTEC FIRE PROTECTION

STUVA

BAM

Associated Partner

INERIS

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DB

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GEFÖRDERT VOM

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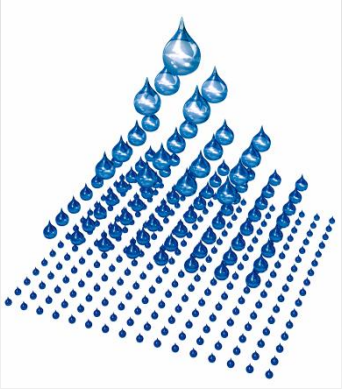
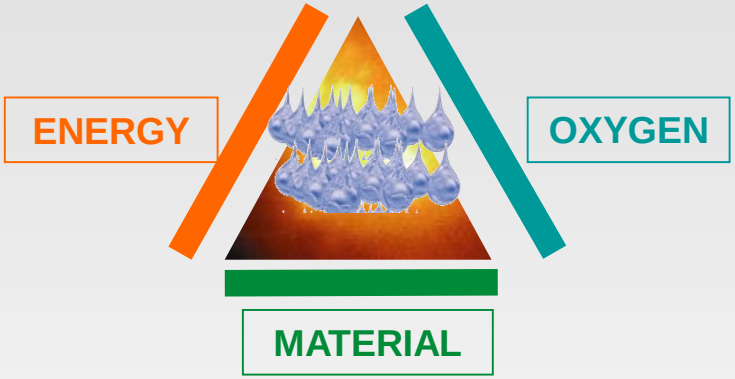
Principals of High-Pressure Water Mist

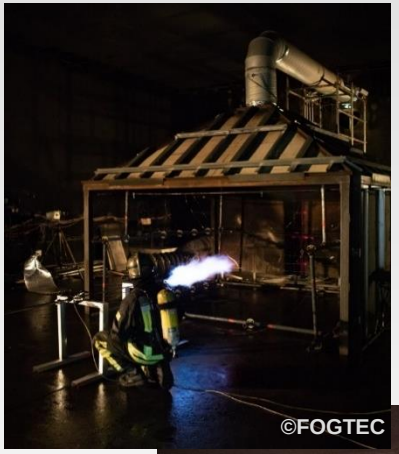


$D_{V,90}$ < 200 µm



Fire Tests – The Heart of SUVEREN

Li-Ion batteries

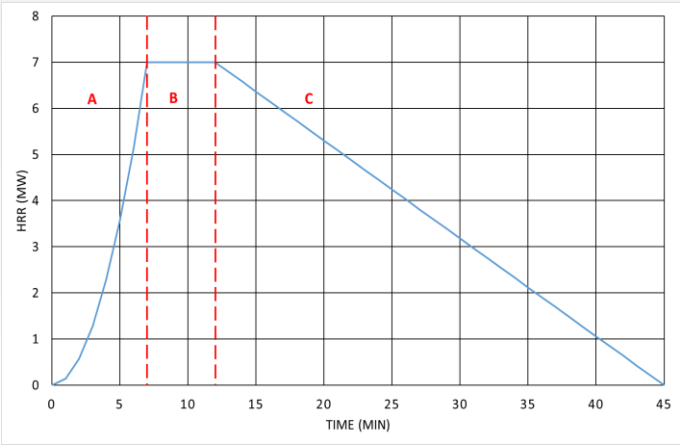


CNG – jet fire

Firefighting

SUVEREN Results Vehicle fires & car parks

- Vehicle design has changed significantly
- Fire protection in car parks by prescriptive guidelines
  - Use of performance-based design
- SUVEREN proposal for a vehicle design fire
  - All type of vehicles (battery, gasoline, LPG, …)



Safety Objectives & Fire Safety in Car Parks

- **Structural safety**
  - **High temperature challenges the stability of ceiling and columns**

- **Safety of rescue services**
  - **(rapid) fire spread from vehicle to vehicle**

- **Water mist reduces temperature**

Does water mist simulation work in FDS?

Mock-up Fire Tests I: Calorimeter

Smoke exhaust duct, mechanical ventilation attached

Roof collect exhaust gases

Scale

Temperatures

Mock-up Fire Tests II

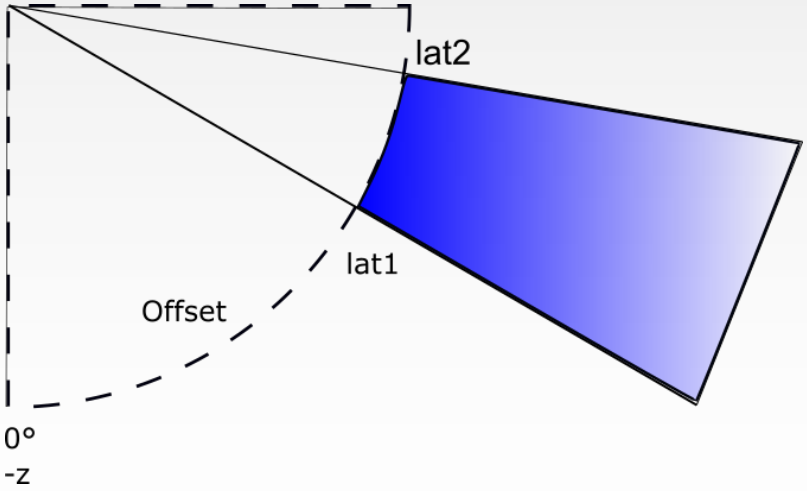
Fire load:

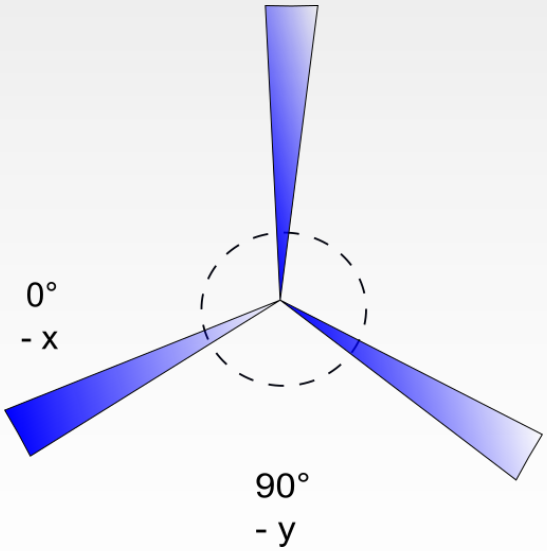
- 4 stacks of 6 wood pallets each
- Total area: 2.88 m²
- Ignition: Heptane (2 l)

Water mist system

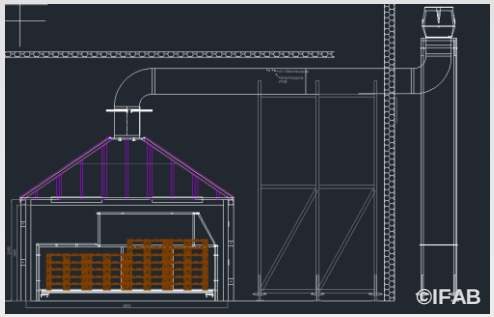
- 4 nozzles
- Room protection
- Activation times
  - SU08: 3 min
  - SU09: 5 min

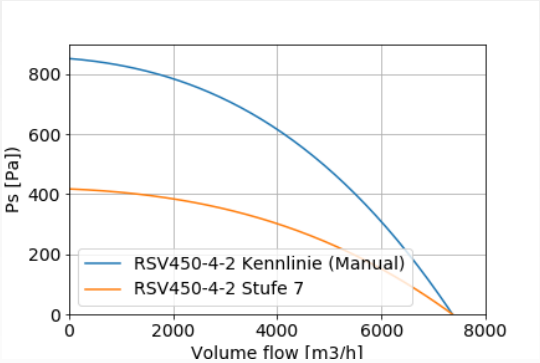
Water Mist Nozzle in FDS

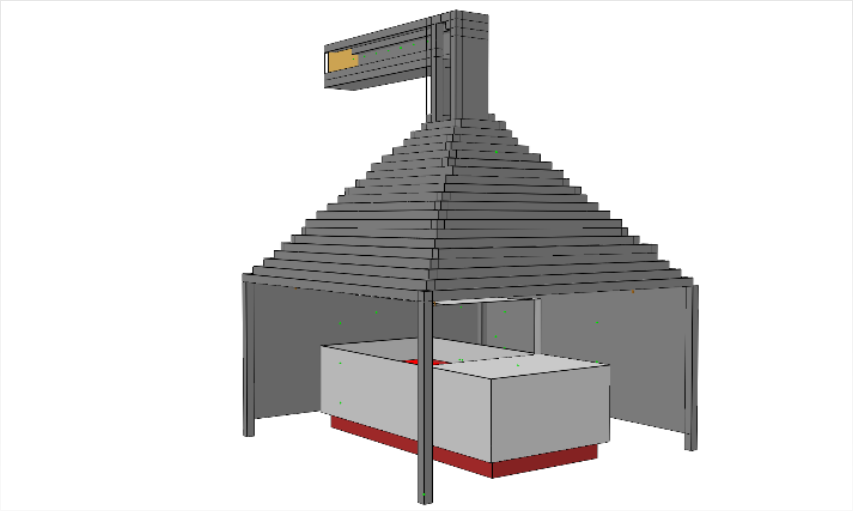




FDS Simulation Mock-up I: Set-up







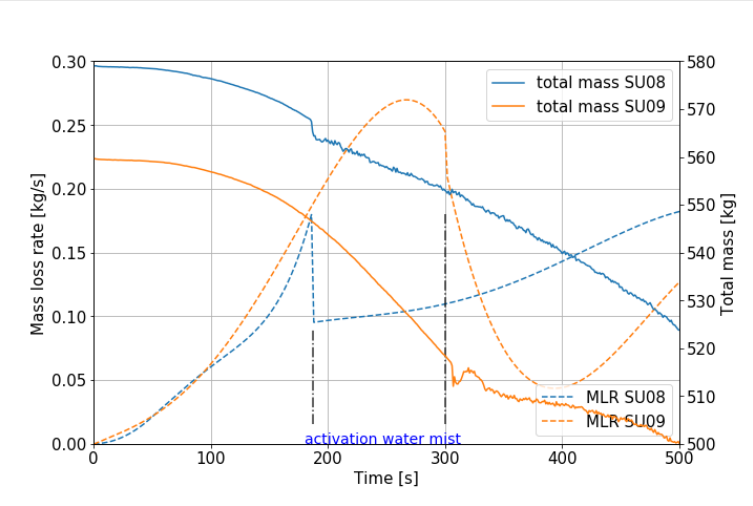
from technical documentation

to the numerical model

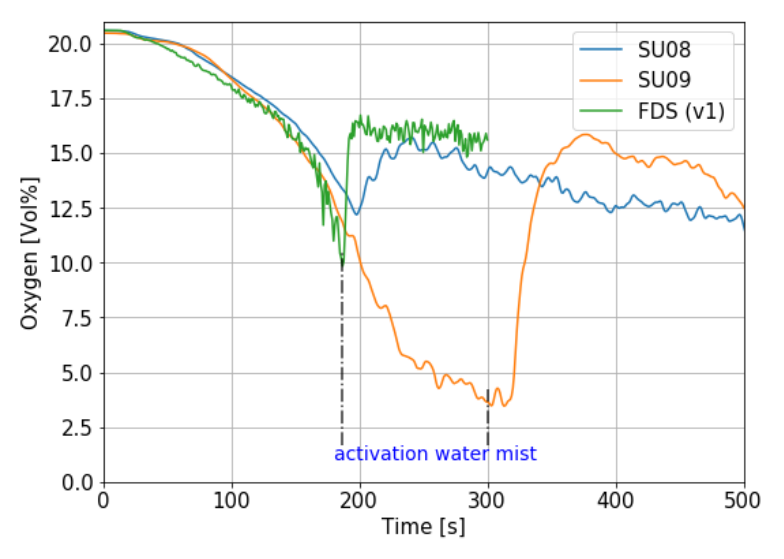
FDS Mock-up Boundary Conditions

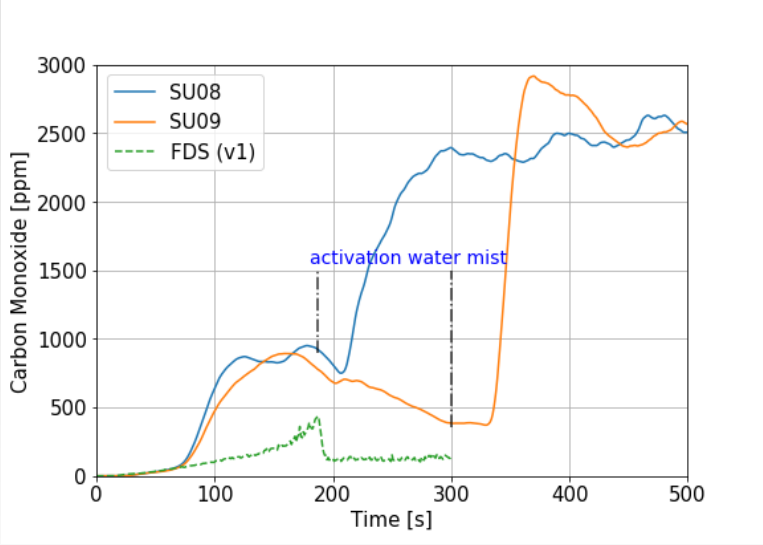
Heat release

- VENT inside the mock up
- determined based on experimental data
- Measurement: total mass
  - Mass loss rate +
  - Effective heat of combustion



Simulation Results – Fuel Modelling



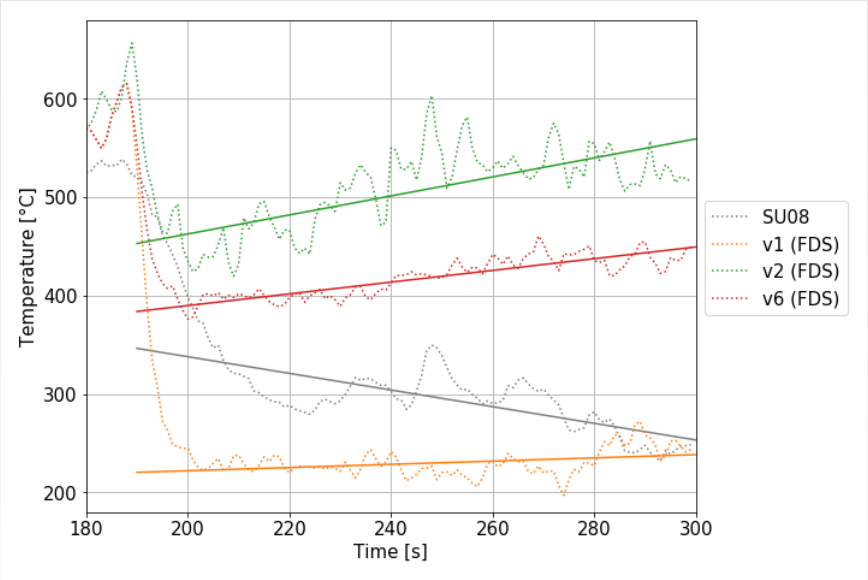


Oxygen prediction with FDS works satisfactory

CO predictions are very low, especially after the activation of water mist

Simulation Results – Water Mist Effects

- HRR not impacted by water mist
- Reduced HRR, no water mist
- Reduced HRR with water mist



Conclusion

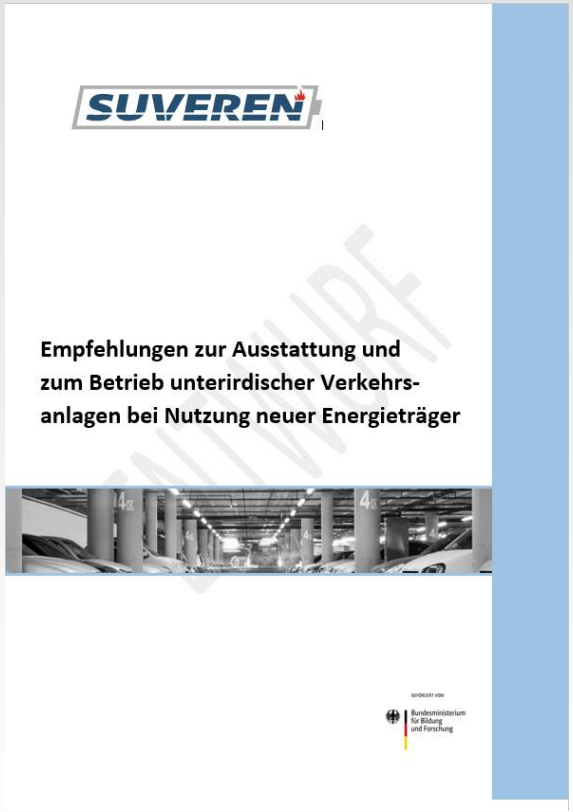
- FDS set-up with the experimental data worked fine
- When simulating water mist CO-yields have to be adjusted
- Two mechanisms are responsible for the decreasing of gas temperature in FDS
  - Cooling of the gas phase by vaporization of water (mist)
  - reduction of HRR determined during the suppression of the fire
- The reduction of HRR has to be determined by fire tests

Outlook

- Some „numerical parameters“ concerning water mist have to be investigated in FDS more in detail
- Determination / calculation of the suppressed HRR:
  - E_COEFFICIENT?
  - Fire testing
- The analysis of the experimental data collected in SUVEREN will be continued
  - A more accurate approach for HRR determination
  - Data for oxygen consumption calorimetry has been measured and a suitable adjustment for the water vapor is under development

Outlook: SUVEREN Guideline

- Provide information and suggestions about fire risks of new energy carriers
  - Design & planning of structures
  - Federal authorities
  - Rescue Forces
  - CFD & firefighting parts: summary about use of water mist in FDS



http://www.suveren-nec.info/

Thank you very much!

Any questions?