

German Research Project SUVEREN **Safety of Urban Underground Transportation Areas considering New Energy Carriers: Objectives - Status - Results**

ITA-COSUF Workshop on New Energy Carriers in Road Tunnels, 21.02.2019, Utrecht

Frank Leismann, STUVA e. V.













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Motivation

Dynamic increase of New Energy carrier (NEC):







Gap of

Knowledge Risk and impact of NEC

Regulation

Existing, standards regarding design are based on conventional energy carriers only

BMBF Call 2016

German-French cooperation in the field "safety of future urban areas"





Project SUVEREN

Partner



Associated Partner

- INERIS
- DB Station & Service
- Feuerwehr München

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Project duration

August 2017 to July 2020

Sub-Contractor





Overview SUVEREN approach













Risk assessment

- Release of toxic / suffocating gases
 - different propagation mechanisms (cold) which endanger the areas for evacuation
- NEC are high-energy fire sources, which likely lead to vehicle fires.
 Different fire development (in terms progression) result from
 - Thermal Runaway (Battery)
 - Jetflames (Gas)



Source: STUVA



Threats of Lithium-Ionen-Batteries

- Thermal runaway due to
 - Mechanical impact (accident)
 - Thermal impact (external initial fire)
 - Incorrect operation (defect BMS, charging, short circuit)
 - spontaneous (aging, production fault)
- changed fire load and / or changed fire development
 - Depending on design, battery capacity and state of charge (SOC)



- Release of critical amounts of toxic substances (e.g. hydrogen fluoride, heavy metals)
- gas emission of toxic gases before fire
- Threat to fire service
 - High voltage
 - Delayed re-ignition



Threats of pressurized gases

- Bursting pressure vessels
- Jet flame
- Flammable mixture (deflagration, explosion)
- Oxygen displacement
- Extreme cold temperature



 wide ignition range with low ignition energy high pressure vessels up to 700 bar ĥ high diffusion rate almost invisible flames, flame temperature 2.000° C CNG Gas accumulation in the ceiling area Gas accumulation in the ceiling area Puddle (extreme cold) LNG Poolfire BLEVE LPG Gas accumulations in deeper areas BLEVE Gas accumulations in deeper areas DME Puddle (extreme cold) Poolfire BLEVE









Szenarious





Examples design-scenarios - Gas



CNG Szenario I

- Buses parked close to each other (Depot)
- 3 CNG buses
- Fire spread from motor compartement of middle bus



CNG Szenario II

- Busdepot
- Single CNG-Bus
- Gas leakage due to defect PRV
- Ignition by external source



Examples design-scenarios - Battery



LIB Scenario I

- Underground carpark
- 6 vehicles, thereof 2 electrical
- Thermal runaway induces fire



LIB Scenario II

- Busdepot
- 3 electro-Buses
- Thermal runaway induces fire on the middle bus









NEC in underground urban transportation areas

- Flowing traffic
 - Traffic tunnel (road)
 - Access tunnel (traffic area)
- Stationary traffic
 - Parking garages
 - Deliveryzones
 - Vehicle depots
- Stations and hubs











Case study parking garage



Quelle: https://www.berlin.de/tourismus/fotos/sehenswuerdigkeiten-fotos/1355918-1355138.gallery.html?page=1

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CFD-Modelling of Jetflame



Source: Bundesanstalt für Materialforschung und -prüfung (BAM)





CFD-Simulation



Source: Bundesanstalt für Materialforschung und -prüfung (BAM)



Source: FOGTEC



Evacuation simulation

- Determine the impact of NEC (based on results of CFD-calculation)
- Quantify the difference between conventional and NEC
- Develop recomendations for calculation and rescue concepts











Development of measures to mitigate the impact

- Identification of appropropriate detection sensors and threshold values
- Development and proof of active measures for the reduction of the effects of NEC induced events





CFD modeling of watermist





Large scale fire tests for calibration and validation of CFD

Test Location

DLR - Fire Test Hall (Traun, Germany)





Real scale fire tests are scheduled 25.03.2019 – 12.04.2019

Fire load

- Full size Lithium-Ion Batteries
 30 kWh / 40 kWh
- CNG Jet flame
- Substitute fire load

Mock up

- Separate fire load
- Car

Active Measures

- Water mist / Aerosol
- Testing of Sensors











Project results

Safety concepts for underground urban areas:

- Engineering methods to calculate and to asses the risk and impact of NEC (performance based design)
- Recommendations for appropriate design and equipment of new and existing underground infrastructures (best practice)

Technologies for mitigation:

 Evaluation and validation of sensors and active measures







Project publications

- SUVEREN-Guideline (Leitfaden) providing concrete support
- Training programes for designer and operators
- Results will be used as input for standards and regulations







Thank you very much for your attention

www.stuva.de

f.leismann@stuva.de













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