Comprehensive Analysis of Severe Accidents – CASA

Anna Korpinen, Mikko Ilvonen, Jukka Rossi, Tuomo Sevón, Magnus Strandberg, Veikko Taivassalo, Eveliina Takasuo
VTT Technical Research Centre of Finland Ltd

Analysing Fukushima Accidents

The Fukushima accident provides a unique opportunity for gaining more information on the progress of severe accidents and their prevention and mitigation. VTT has MELCOR models for all three units that have been updated when new plant data has been obtained

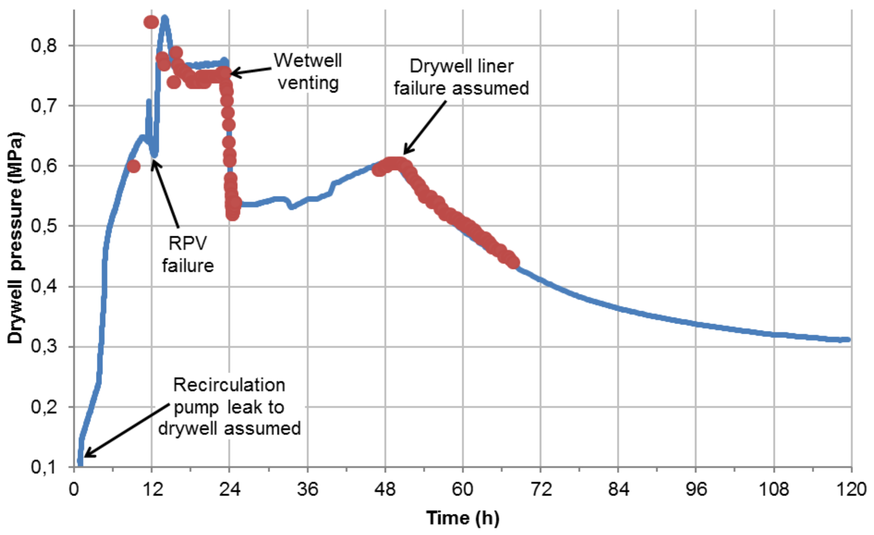

Figure 1. *Fukushima unit 1 pressure in the containment drywell during the accident. Red dots are measured values and blue curve is the result from the MELCOR simulation.*

Debris Bed Coolability

Coolability of corium should be ensured in all of its locations and forms. Instead of the dryout heat flux, that might be overly conservative, it has been proposed that the coolability limit of a debris bed should be based on the increase of the particle temperature. It was found out that the friction model effects notably the level the temperature stabilizes.

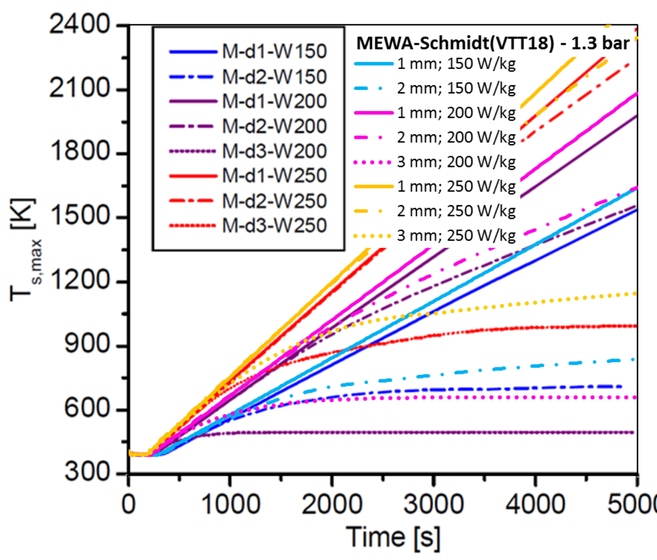

Figure 2. *Comparison of the time evolution of the maximum solid particle temperature for the truncated-cone debris beds in the MEWA simulations of this study and in the DECOSIM simulations by Yakush & Kudinov, 2014. In the MEWA simulations, the top surface pressure is 1.3 bar.*

Pool Scrubbing

Pool scrubbing experiments performed in the SAFIR2018 CATFIS project provide excellent validation data for the integral codes. MELCOR simulations were in a good agreement with the pool scrubbing experiments for non-soluble aerosols whereas ASTEC results were in a good comparison with the experiments for soluble aerosols.

Hydrogen Combustion

The common tools for hydrogen combustion modelling are strongly simplified models for complicated processes occurring in complex geometries. VTT's modelling framework for hydrogen combustion works reasonably as the maximum pressure was close to the experimental result and the pattern of the flame front propagation was similar enough.

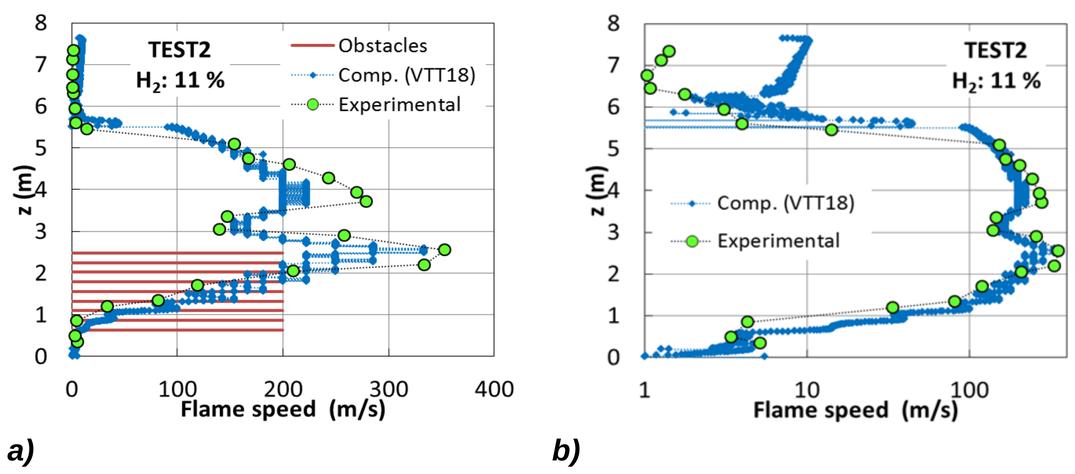

Figure 3. *Computed and experimental flame speed in Test 2 of the Etson-Mithygene benchmark a) with and b) without obstacles that accelerate the flame propagation as in real containment rooms.*

Environmental Consequences

Assessing the environmental consequences from atmospheric releases is important for emergency preparedness. The competence to perform level 3 PSA was improved. VALMA was further developed by implementing there the ingestion dose pathways and the calculation of acute and late health effects of radiation doses.

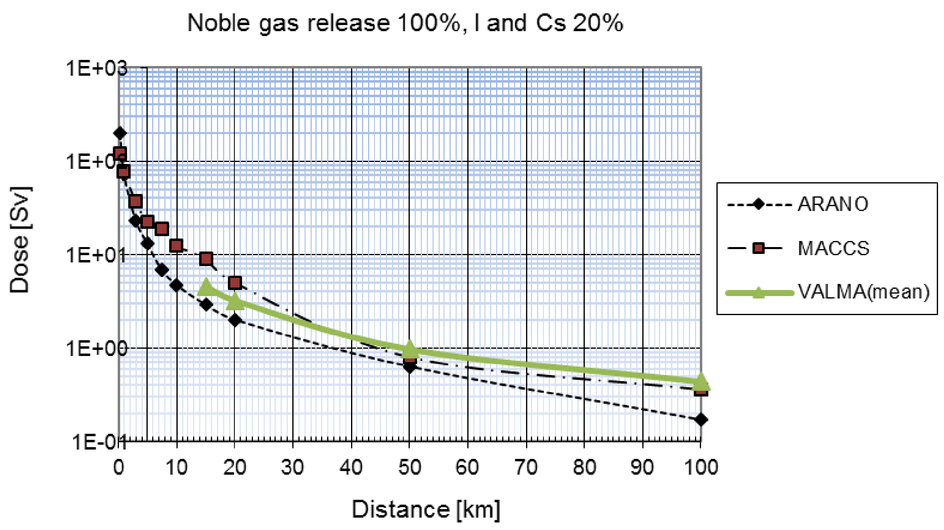

Figure 4. *The dose of 95% fractile as a function of distance from the power plant. Integration time is one year for external radiation from the ground.*

Conclusions

- **Overall understanding of the progress and mitigation of severe accidents as well as understanding of specific phenomena has been strengthened.**

VTT – beyond the obvious

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Contact
Anna Korpinen
Tel. +358 40 159 1156
anna.korpinen@vtt.fi