Fire Risk Evaluation and Defence-in-Depth (FIRED)

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FIRED
The main objective of the FIRED project is to develop tools for fire risk evaluation and create a new methodology for assessing the defense-in-depth in the context of fire safety. The research concentrates on four main topics:
1. Cable fire risks during plant life cycle,
2. Performance of the fire-barriers,
3. Tool development, maintenance and validation, and
4. Participation and utilization of OECD/NEA PRISME2 and PRISME3 projects.

Fire cable risks during plant life cycle
Reactive Molecular Dynamics simulations can provide information on the thermal degradation chemistry of fire retardant chemicals and polymeric base materials. Using a model system consisting of ATH embedded in an amorphous PE matrix, we have shown that ATH is chemically promoting the carbonization of PE.

![Figure 1. Left: atomistic model of an ATH grain in an amorphous PE matrix. Right: Water formation and virgin polymer degradation during thermal decomposition, indicating a chemical effect due to ATH.](image1.png)

The effects of thermal and radiative ageing of the modern, flame retarded cable materials have been studied experimentally. The results indicated that the elevated temperature alone does not alter the fire performance of the studied cable materials significantly. Radiation exposure in elevated temperature may slightly weaken the protection provided by the flame retardant.

![Figure 2. Heat release rate of the new and aged cable materials in cone calorimeter.](image2.png)

Fire simulation development, maintenance and validation
The liquid dispersal after an aircraft impact on a nuclear power plant can be predicted using the Fire Dynamics Simulator (FDS) spray model (Figure 6). The model was developed and validated using data from the IMPACT experiments conducted at VTT.

The steady state burning rates of liquid pool fires in mechanically ventilated compartments can be predicted within 20% of the experimental value with FDS (Figure 7). The effect of lowered oxygen vitiation on the burning rate of pool fires was correctly captured.

![Figure 3. Peak heat release rates in the cone calorimeter experiments at two heat fluxes.](image3.png)

Parameters representing the model error in barrier performance analysis can be evaluated by comparing the model simulations with experimental data. With a priori knowledge of modelling error parameters, the true output quantity can be estimated from the simulated one.

![Figure 5. Relative uncertainty in the estimated cold side barrier temperature (vertical axis) against the modelling error of the last link of the modelling chain.](image5.png)

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