

Analysis Method for Leak Probabilities in Complex Structures

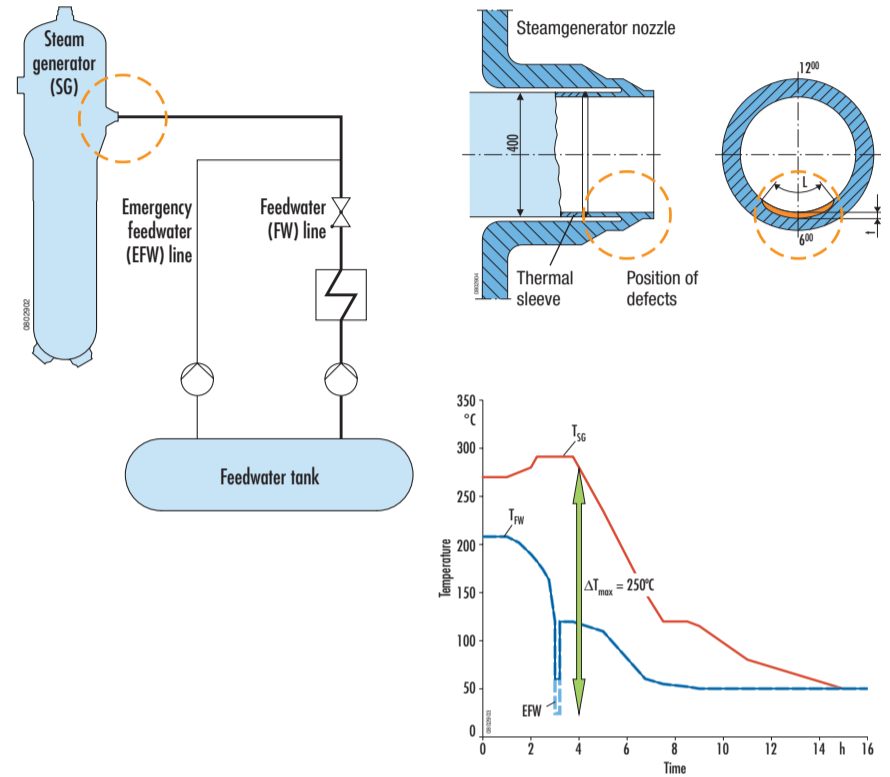
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In Germany, deterministic approaches are the chosen methods for the assessment of the safety of pressure vessels, piping, and other passive structures in nuclear installations. On the other hand, in the US, Sweden and also in other countries experts have for several years been following the approach of underpinning safety demonstrations required by the regulatory authorities for the reliability of relevant components by a quantitative assessment of the reliability of structures in the form of leak and break probabilities.

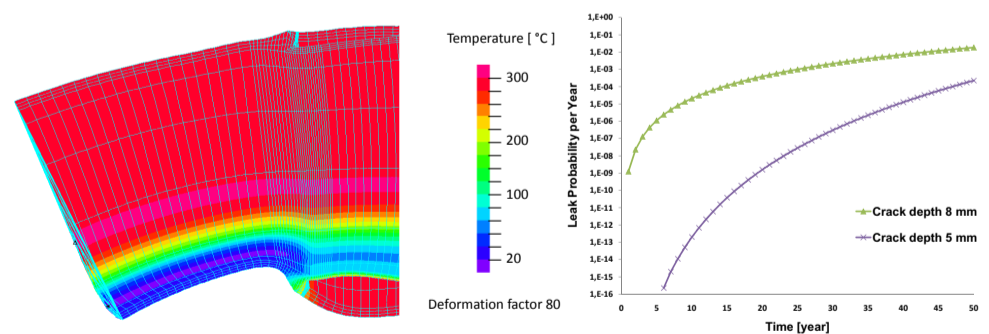
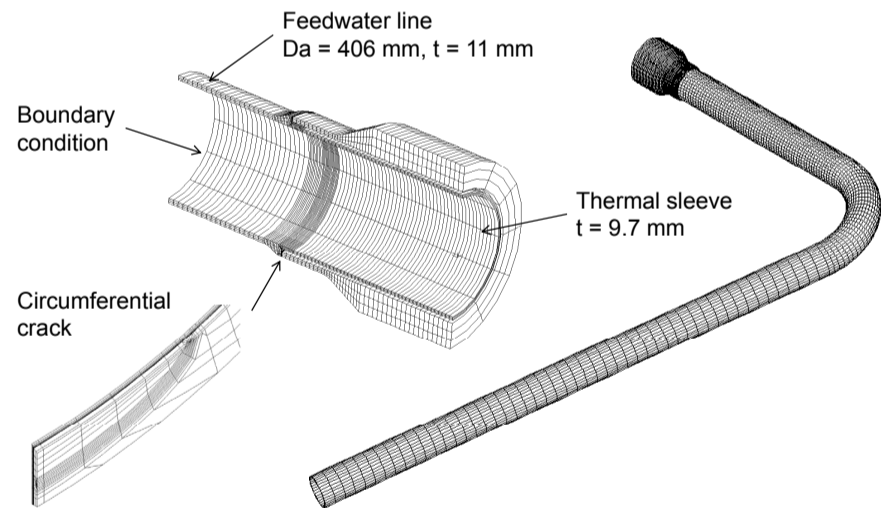
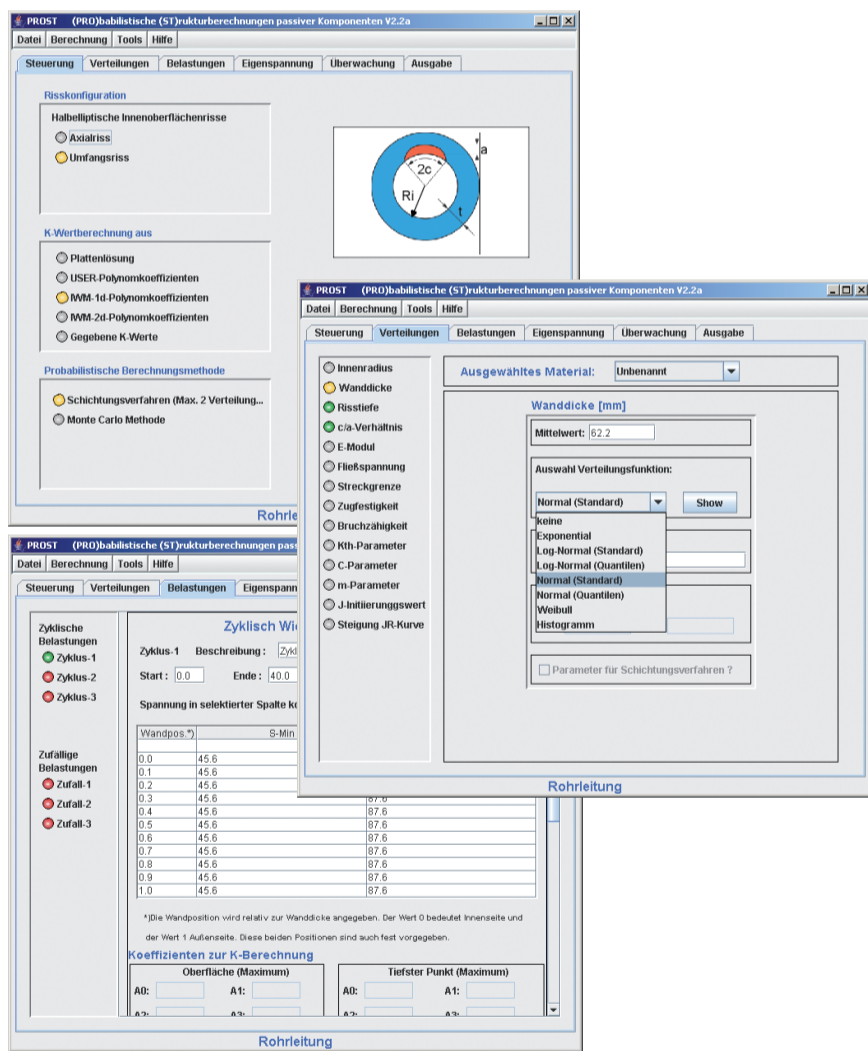
Probabilistic Analysis Method

For the determination of leak and break frequencies for complex structural geometries and load conditions within the framework of the assessment of a defect or as part of a probabilistic safety analysis (PSA), GRS is developing the probabilistic analysis tool PROST (PRObabilistic STructural calculation). Here, the focus is on the consideration of the damage mechanisms "fatigue" and "corrosion" in piping and in pressure vessels.

differences may occur between the lower and upper part of the feedwater line.



PROST and ADINA were used to study the leak probability in a feedwater nozzle loaded by inner pressure and cyclic thermal stratification.



For complex boundary conditions regarding geometry and load, a deterministic fracture-mechanical analysis method based on the finite-element (FE) code ADINA (Automatic Dynamic Incremental Nonlinear Analysis) is available, which has been coupled with PROST.

Application Case

In-service inspections revealed crack indications on the inner surfaces of the feedwater nozzles of a pressurised water reactor. The crack indications were located in the base material at the fillets where the thermo-sleeves are fitted. Under cooldown conditions, cyclical loads in the form of temperature

The results of the probabilistic analysis based on the stratification method show that quantitative statements can be made on the leak probability of a detected or postulated crack as a function of operating time within the range $< 10^{-7}/a$.

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