Apros® Nuclear - Success stories

Loviisa case 5: Modelling and analysis of Loviisa pilot operated main steam safety valves

The main purpose for modelling work was to understand the thermal hydraulic phenomena during opening and closing of the valve in various operating conditions. Apros® simulation model was successtully implemented.

During the renewal project of Loviisa Nuclear power plant (NPP) main steam safety valves (MSSV) in 2015, a detailed thermal hydraulic simulation model of the valves was created. New MSSVs are pilot operated and qualified for two phase conditions.

The main purpose for modelling work was to understand the thermal hydraulic phenomena during the opening and closing of the valve at various operating conditions. The opening of the pilot operated MSSV is strongly dependent of the intensity of depressurization of valve head as the pilot valve set pressure is exceeded. At normal operation condition, the fluid inside the valve head is subcooled, which provides very high intensity of depressurization. However, for example repeated openings can increase the fluid temperature inside the valve head and lead to more slow depressurization and delay in the valve opening.

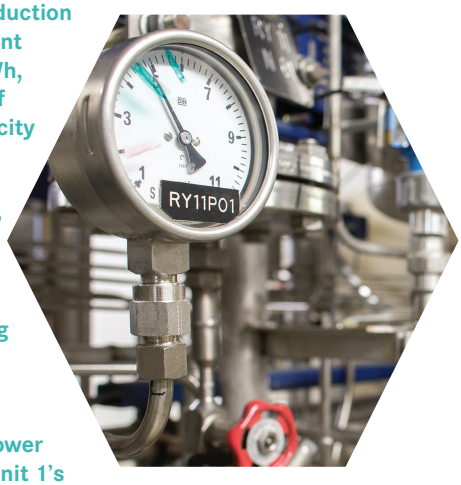
The **Apros®**-model of Loviisa MSSV includes for example the valve body wall structures, fluid volume inside the valve head, drain line, control line and supply line. The modelled fluid volume inside the valve head is connected to the valve body wall structures which conducts heat from the main steam line to the valve head. The depressurization of valve head is conducted through the control and drain lines to atmospheric conditions. As the MSSV opens and main steam line pressure goes below the closing set pressure, the pilot valve shifts position so that flow path through the supply line to valve head is opened and the MSSV starts to close. The opening and closing of MSSV leads to a change in the fluid volume inside the valve head as the valve piston moves up or down. This phenomena was modelled by controlling the node porosity as a function of the MSSV position.

Apros® fulfilled all requirements

The simulation model proved to be able to predict the behavior of MSSV opening at various process conditions including repeated openings and low main steam line pressure conditions. Simulation model was also successfully implemented to the analysis model of Loviisa NPP and several transient cases were conducted. This analysis work provided useful information on MSSV behavior for the use of emergency operation procedures development and plant operation.

Loviisa nuclear power plant, Finland

Loviisa nuclear power plant has two VVER pressurised water reactors, Loviisa 1 and Loviisa 2, with capacities of 498 MW net and 500 MW net. Loviisa 1 was commissioned in 1977 and Loviisa 2 in 1980. The operating licence for Loviisa 1 is valid until 2027 and Loviisa 2 until 2030. In 2015 the production of the power plant totalled 8.47 TWh, i.e. about 13% of Finland's electricity production. On an international scale, the 92.9% load factor of the Loviisa nuclear power plant was among the best in the world for pressurised water reactor power plants. Loviisa unit 1's load factor was 92.7% and Loviisa unit 2's 93.1%. Loviisa 1's production output was the fourth highest in the history of the plant.



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