

N207. Steam Generator Strategy for Ringhals 3 and 4

The Swedish utility Vattenfall has decided to replace the steam generators at Ringhals 3 in 1995, but to operate Ringhals 4 until 2010 with the existing units. An examination of twelve steam generator tubes (six from Ringhals 3 and six from Ringhals 4) removed during the 1988 refueling outage revealed that several tubes had cracks in the roll transition zone, all tubes had shallow intergranular attack at tube support plate (TSP) intersections, and some tubes from Ringhals 3 had cracks in the TSP position due to intergranular stress corrosion.

The steam generator problem task force of the utility concluded that the extent of the attacks was such that it could drastically limit the possibility of successfully operating Ringhals 3 (which entered commercial operation in 1981) to 2010, which is the year when all nuclear power in Sweden will be phased out in accordance with the parliamentary decision of 1980.

Repair or Replace? A project was undertaken to find the optimal way of operating Ringhals 3 and 4 over the period 1990-2010. Two possible ways to deal with the steam generator problem were investigated:

1. Replace the steam generators and uprate the plant -- the replacement alternative.
2. Operate with the existing steam generators and reduce the rate of degradation by lowering the primary water temperature, with most failed tubes assumed to be repaired by sleeving -- the repair alternative.

In the case of the replacement alternative, investigation showed that, in general, the technique already successfully used for the Ringhals 2 steam generator replacement could also be used for Ringhals 3 and 4. The replacement of the steam generators at units 3 and 4 would create an uprating potential of about 12% due to the larger heat transfer area in the new steam generators. A scoping study demonstrated, from a safety point of view, that it would be acceptable to uprate the units to 112% of nominal power, i.e., increase the thermal power from 2,785 to 3,120 MWt. From the repair alternative, the study showed, for Ringhals 3, that it would be necessary to reduce the primary water temperature by about 13°C to get to 2010 without exceeding the plugging limit of the plant. By adjusting the turbines to the lower secondary pressure resulting from the temperature reduction, it was judged possible to limit the power loss to 35-40 MWe. This power level was used as the economic reference point when estimating the cost effectiveness of steam generator replacement at Ringhals 3. The analysis showed that replacement of the Ringhals 3 steam generators would be a good investment.

Manufacturing the Replacements. The new steam generators for Ringhals 3 are of Siemens design and will be manufactured at Framatome's workshop in Chalon, France. Inconel 690 will be used in the tubing, to be supplied by the Swedish company Sandvik. Manufacture of the steam generators has started and will last 36 months with delivery to Ringhals site by May 1, 1995. The replacement outage will start in June 1995 and Ringhals 3 is planned to be reconnected to the grid 84 days after the shutdown.

While the steam generators are being manufactured, Framatome is doing a safety analysis in parallel. This should support the increase of thermal power by 12%.

Taken from, "Handling Steam Generator Problems: The Strategy for Ringhals 3 and 4," Gosta Larsen, Nuclear Engineering International, September 1992, p. 38.