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Controlled beta-quench treatment of fuel channels

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The trend towards higher fuel assembly discharge burnups poses new challenges for fuel channels in terms of their dimensional behavior and corrosion resistance. Beta-quenching of fuel channels has been applied by the nuclear industry to improve the dimensional stability of this component. This led AREVA NP to develop a new technique for beta quenching of fuel channels that combines the effect of beta-quenching with the optimization of the microstructure.

AREVA NP's new technique for controlled beta-quenching of fuel channels uses inert gas. The fuel channels remain metallically bright and the intermetallic phases have an optimum size distribution, ensuring good corrosion resistance even at high burnup levels. Thus, this new controlled beta-quenching process improves the dimensional behavior of fuel channels by randomizing the crystallographic texture, while maintaining the excellent corrosion behavior of the fuel channels by providing intermetallic phases of optimum average size.

The first fuel channels with these optimized material properties have been placed in the core of a German boiling water reactor (BWR) nuclear power plant in spring of 2004. Some more channels will follow in 2007 to broaden in-pile experience and to receive irradiation feedback from two other nuclear power plants.

At present, performance data of beta-quenched fuel channels are available after 2 cycles of irradiation corresponding to the burnup of 24 MWd/kgU. The inspection results give evidence of improved dimensional stability and maintained corrosion resistance. Based on the available performance data, significant decrease of irradiation induced channel growth and bow can be expected for beta-quenched fuel channels at high burnup.

Since the dimensional behavior of fuel channels is most important at high burnup, the achieved burnup level so far is not high enough to entirely demonstrate the improvement of the dimensional stability by elimination of the texture. Pool inspections of the beta-quenched fuel channels will be continued.