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HTP

Robust Technology for PWR Fuel Assemblies

Challenge

PWR operations are increasingly demanding, requiring ever higher thermal, structural, and neutronic performance requirements to address new criteria and enhance fuel cycle economics. Of particular note are requirements to address Grid-To-Rod-Fretting (GTRF) — the most frequent cause of fuel failure in PWRs worldwide.

Solution

The HTP platform for PWR fuel provides universally proven reliability and robustness for every PWR lattice type in the U.S.

Globally, over 13,500 HTP fuel assemblies have been loaded into 45 reactors, with nearly half of these assemblies in the U.S. With a maximum achieved fuel assembly burnup of 70 GWd/mtU, the operating performance of HTP fuel is exceptional. And, HTP fuel is being universally applied to meet the challenges of the industry's most severe fretting environments, such as the Babcock & Wilcox 15x15 and Combustion Engineering 14x14 reactors.

Reactor Types Supported by HTP		
Babcock & Wilcox	Combustion Engineering	Westinghouse
15x15	14x14 15x15 16x16	14x14 15x15 17x17

Customer benefits

- Over 13,500 fuel assemblies loaded globally
- No GTRF failures when used with HMP bottom end grid
- FUELGUARD reduces the risk of debris failures at internal rod locations.

Reliability and robustness =
confidence you can count on.

Your performance
is **our** everyday **commitment**

Welded Structure

The HTP platform is built around a welded structural cage where intermediate spacer grids and IFMs are directly welded to the fuel assembly guide tubes. The HMP bottom end grid is also tightly captured by rings that are directly welded to the guide tubes. This direct coupling between grids and guide tubes results in the stiffness and robustness required to endure handling and resist fuel assembly bow and twist.

High Burnup Fuel Rods

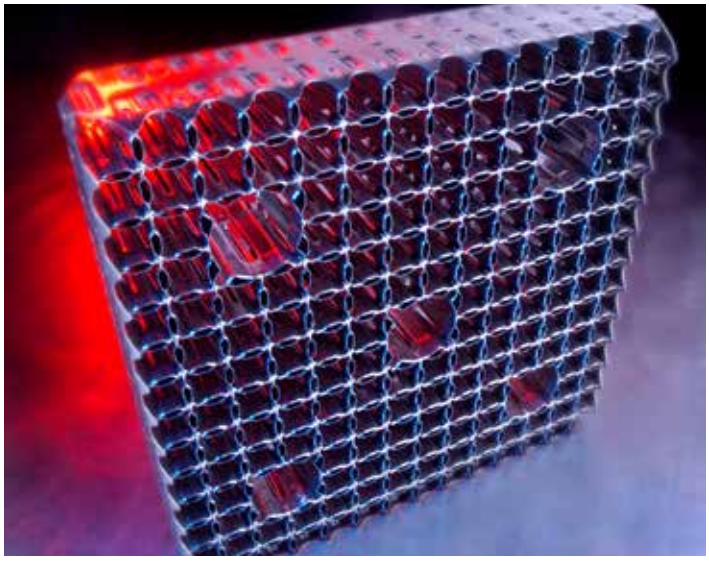
M5, Framatome's standard fuel rod cladding material, is anything but standard. In fact, more than seven million fuel rods having M5 cladding have completed their operation or are operating in 96 commercial reactors worldwide since 1993. Ensuring significant margins with regard to corrosion and hydriding under demanding duty, high burnup, and stringent water chemistry conditions, M5, an advanced zirconium alloy, introduces a unique combination of both chemistry and material processing that yields extraordinary behavior. Relative to other zirconium alloys, M5 is a low-oxidizing alloy with a low hydrogen pickup factor — meaning less embrittlement and greater reliability at higher burnups. This exceptional performance also extends to LOCA conditions, where M5 has been shown to outperform other zirconium alloys, thereby helping to ensure that operational limits are not impacted as a result of burnup-dependent oxidation limits.

MONOBLOC Guide Tubes

MONOBLOC guide tubes have a single outer diameter with a reinforced dashpot. The added thickness of the MONOBLOC guide tube increases the lateral stiffness of the fuel assembly, thereby yielding a more robust assembly that resists twist and bow. MONOBLOC has been in use since 1998 and has been irradiated on over 27,600 fuel assemblies worldwide. In its application, MONOBLOC has had a measurable effect in improving control rod drop times and reducing fuel assembly distortion.

HMP Bottom End Grid

Worried about fretting failures in your fuel assemblies? The worrying stops here with the HMP end grid. In fact, there have been no known fretting failures in fuel assemblies that are designed with the combination of HTP intermediate spacer grids and HMP end grids. Complementing the HTP intermediate spacer design and increasing the resistance to grid-to-rod-fretting failures, the HMP spacer grids are built from the same design concept as HTP, but fabricated from Alloy 718. The HMP spacer grid has enhanced strength and relaxation characteristics and straight (non-mixing) flow channels, making this spacer grid ideal for supporting the fuel rods with increased margin against flow-induced vibration and resulting fretting damage.



Intermediate Flow Mixers

Intermediate Flow Mixers (IFMs) incorporate the same design concept as the HTP intermediate spacer grids. IFMs are available in select designs to improve thermal-hydraulic (T/H) performance and help ensure optimal fuel efficiency and minimal fuel cycle costs.

HTP Spacer Grids

Unique. Innovative. The HTP spacer grid design combines fuel rod support and coolant flow mixing in a single component. The line-contact fuel rod support ensures a large contact area to provide the optimum resistance to GTRF. This line-contact support provides the protection needed to confidently guard against fuel failures. Plus, the curved flow channels create a vortex flow pattern to increase coolant mixing and improve T/H behavior.

Robust FUELGUARD

FUELGUARD has been in use since 1988 to trap debris and has been loaded onto over 8,000 PWR assemblies. Providing a "no-line-of-sight" flow path for the coolant that is very effective at trapping debris, FUELGUARD is proven to be resistant to damage by impact of large debris. Larger particles are trapped by the close spacing of the blades while long linear particles (wires, pins, etc.) are trapped by the curved path through the filter blades. Since its introduction, no debris-related failures have been known to occur at internal rod locations on an assembly using FUELGUARD.

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http://www.framatome.com/EN/us_platform-812/framatome-u-s-fuel-reliability.html

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