GAIA: The New Generation Fuel for 17x17 PWR Fuel Assemblies

Improved Fuel Cycle Costs while Ensuring the Safety & Robustness of Nuclear Fuel Operation

The Challenge
The requirements of PWR operators are increasingly demanding and include power uprates of up to 20% or beyond in some cases, maximum batch average burn-up increased from 40 MWd/kgU to 60 MWd/kgU, lower neutron leakage with cycle lengths of up to 24 months and challenging water chemistry conditions.

Furthermore, with taxes on nuclear fuel already levied in some countries and planned in others, there is a general push for more efficient fuel utilization.

All of these factors affect the available margins of the fuel assembly which must remain robust against Grid-To-Rod-Fretting (GTRF) – the most frequent cause of fuel failure in PWRs worldwide – while enhancing thermal-hydraulic performance.

The Solution
Developed to meet the increasingly demanding requirements of utilities, the GAIA fuel assembly (Fig. 2) ensures the safety and robustness of fuel operations, while offering optimal performance and a high burn-up capacity.

Current AREVA PWR fuel designs, HTP™ with its unsurpassed robustness against GTRF failures and AFA 3G™ with its superior thermal-hydraulic performance, provided the basis for the development of the GAIA Spacer Grid.

The GAIA fuel assembly boasts M5™ advanced cladding which offers superior margins and meets anticipated changes in U.S. regulatory requirements.

The innovative GAIA fuel design offers utilities cost savings through its high mechanical fretting resistance, improved thermal performance and better debris filtering efficiency.

Key Features

High Thermal Performance & Fretting Resistance
- The GAIA spacer combines the mixing principle of AREVA’s vane-spacers (AFA 3G™) with the fretting resistance of the HTP™ spacer

High Debris Filter Efficiency
- The GRIP™ bottom nozzle combines the low pressure drop of AREVA’s TRAPPER® nozzle design with the high flow equalization of the FUELGUARD™ nozzle and improves the filtering efficiency compared to these two designs

High Grid Stability
- The GAIA spacer has a predictable deformation mode under lateral loads (Fig. 1)

High Fuel Assembly Dimensional Stability
- Guide tubes (GT) made of Q12™ material with increased creep resistance
- Increase of guide tube outer diameter and reinforced GT-to-grid connections for increased cage lateral stiffness, providing improved resistance to fuel assembly distortion, reduced stresses in the guide tubes

Flexible Fuel Management and Low End-of-Life Pin Pressure
- GAIA fuel rod made of M5™ cladding, chromia-doped fuel and a reduced pellet-to-cladding gap for increased loading

Fig. 1: Superior grid behavior ensuring higher safety margins under the most severe category 4 accidents

a – Typical spacer  b – GAIA spacer
Expertise & References

Through its engineering and manufacturing operations in the U.S. and Europe, AREVA supplies nuclear fuel assemblies and associated core components to PWRs across the world, with some 125,000 fuel assemblies supplied as of late 2014.

Furthermore, AREVA has acquired unrivaled experience in the development, manufacturing and operation of long bundles through its AFA 3G™ and HTP™ fuel assembly technologies. This, combined with its close cooperation with PWR and BWR utilities in over 70 plants across the world and the expertise of AREVA engineers, means that GAIA – the new fuel assembly design offered to AREVA customers – benefits from unmatched experience and expertise.

GAIA technology has been deployed in a reactor in Sweden since 2009. As part of the GAIA deployment program in the U.S., a Technical Advisory Board was established in July 2014 by six U.S. utilities, one of which will load a set of 8 lead test assemblies into one of its reactors in mid-2015.

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Your advantages at a glance

- Enhanced reliability and robustness through
  - Superior rod supports ensuring that Grid-To-Rod-Fretting (GTRF) margins are kept for long cycles and severe environments
  - Increased margins against incomplete rod insertion and fuel assembly distortion
  - Superior debris filtering efficiency

- Increased flexibility
  - M5™ excellent corrosion resistance allows higher burn-ups, extended fuel cycle operation that enhance operating flexibility
  - Chamfered pellets made of chromia-doped fuel reduce the risk of chipping and increase margins regarding Pellet-Cladding Interaction (PCI) which allows a more flexible plant operation
  - The chromia-doped fuel provides more design margins at end-of-life conditions which is supported by a low volume of fuel rod springs
  - M5™ higher resistance to corrosion and extremely low hydrogen uptake are both key to flexible used fuel management

- Improved fuel cycle economy

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For more information on how AREVA can help your organization deliver more value please contact:

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