



PWR Fuel Performance Update

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Framatome/NRC Fuel Performance Meeting

September 14, 2021

AGENDA

- Objectives
- Framatome PWR Fuel Operating Experience
 - Status of Product Implementation
 - Fuel Reliability Statistics
- Status of Framatome PWR Fuel Failures and Investigations
 - Cause of Failure Examinations
- Poolside Surveillance Results and Plans
 - Recent PWR Poolside Surveillance Campaigns
 - Upcoming PWR Poolside Surveillance Campaigns
- EATF PROtect Summary
- Summary / Conclusions

Objectives

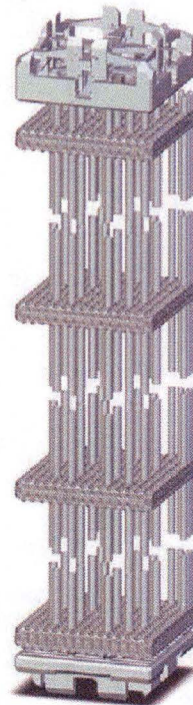
- Summarize key aspects of current PWR fuel product features
- Provide a status update of the overall performance of Framatome's PWR designs
- Provide an updated status of GAIA and AGORA lead fuel programs
- Provide an overview of PWR fuel examinations and results of recent surveillance campaigns
- Provide an overview of anticipated fuel examinations
- Provide an overview of the current EATF projects

AGENDA

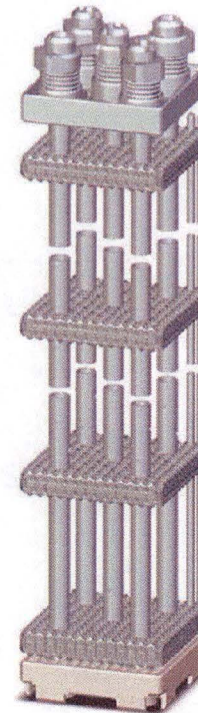
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HTP Fuel - Proven Features

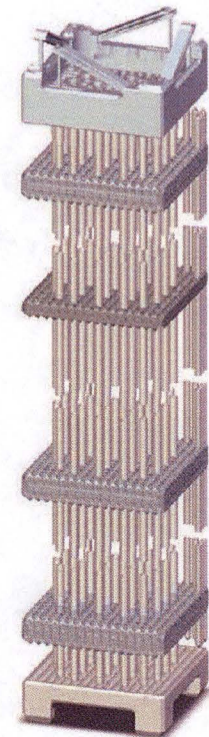
- Reconstitutable Upper Nozzle/ End Fitting / Tie Plate
- M5_{Framatome} Fuel Rod Cladding
 - Low oxidation compared to Zry-4
 - Low hydrogen pick up
- HTP Spacer Grid
 - Exceptional GTRF performance
- HMP Lower Grid
- FUELGUARD Bottom Nozzle/ End Fitting / Tie Plate



Mark-B HTP

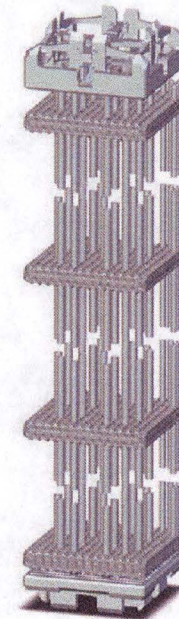


CE HTP



W HTP

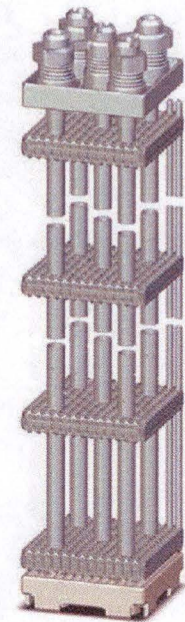
Framatome PWR Reloads B&W Plants



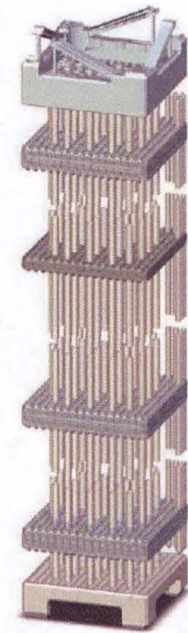
Mark-B HTP has effectively eliminated past performance issues associated with GTRF, growth and fuel assembly distortion

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Framatome PWR Reloads CE Plants



Framatome PWR Reloads Westinghouse Plants



First domestic GAIA Reload was loaded in the spring 2021

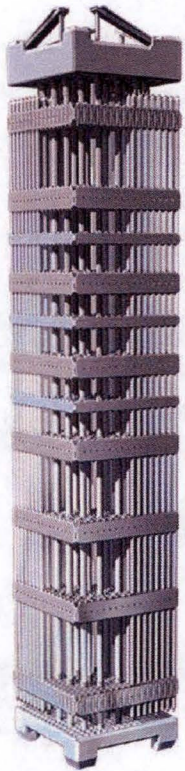
HTP Irradiation Experience

Nearly 25,000 HTP assemblies irradiated in 51 reactors worldwide

- Arrays from 14x14 to 18x18
- Operating in a variety of reactor platforms
 - B&W, CE, Framatome, Siemens, and Westinghouse

GAIA Fuel Assemblies

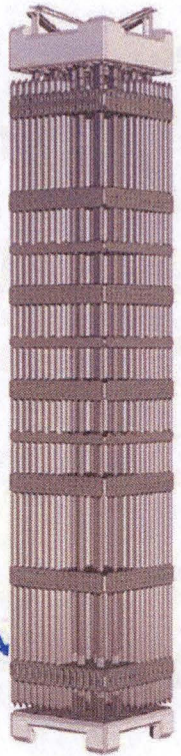
Key Design Features & Irradiation Experience



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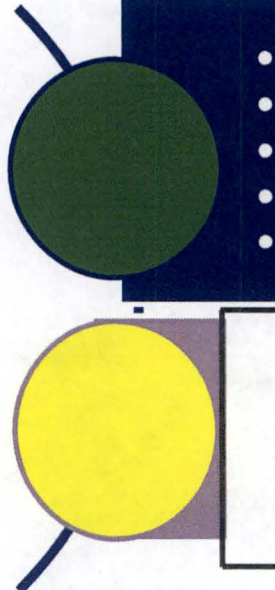
AGORA 5AI Lead Fuel Assemblies

Key Design Features & Irradiation Experience



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Framatome PWR Fuel Performance Summary United States

- 
- All PWRs with Framatome fuel in-core operating defect free in US
 - HTP continues to demonstrate improved performance over predecessor designs
 - 4 EATF GAIA Assemblies are completing their 2nd cycle of irradiation in March 2022
 - First GAIA reload in the United States began irradiation in May 2021
 - 4 AGORA 5AI assemblies completed a 3rd cycle of operation with no performance concerns

Framatome PWR Fuel Performance Summary United States

PWR Fuel Failure Mechanisms (United States 2017-Current)

PWR Fuel Failure Mechanisms

Focus on Debris Failure Trends, Since 2012 - PWR

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Recent US PWR Failed Fuel Exams

2020 Cause-of-Failure Exams

Reactor	Cycle	Assembly	Fuel Product	# Rods	Exam	Cause
No PWR Failures						

2021 Cause-of-Failure Exams

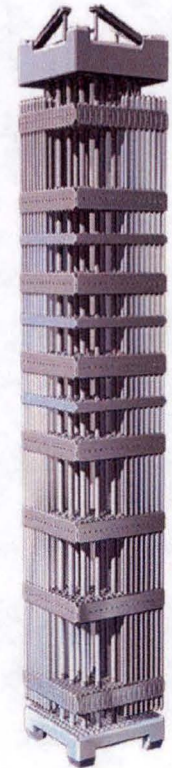
Reactor	Cycle	Assembly	Fuel Product	# Rods	Exam	Cause
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Domestic PWR Poolside Surveillances

GAIA Fuel Assemblies with EATF PROtect Fuel Rods



» Good overall performance of lead assemblies confirmed

GAIA Fuel Assemblies with EATF PROtect Fuel Rods Visual Inspection

GAIA Fuel Assemblies with EATF PROtect Fuel Rods Visual Inspections

GAIA Fuel Assemblies with EATF PROtect Fuel Rods Visual Inspections

AGORA 5AI Lead Assemblies

AGORA 5AI Lead Assemblies Visual Inspection

AGORA 5AI Lead Assemblies Fuel Assembly Growth

AGORA 5AI Lead Assemblies Rod-to-Rod Spacing

AGORA 5AI Lead Assemblies Guide Tube Oxide and ID Wear

Anticipated PWR Fuel Surveillance Campaigns through 2025

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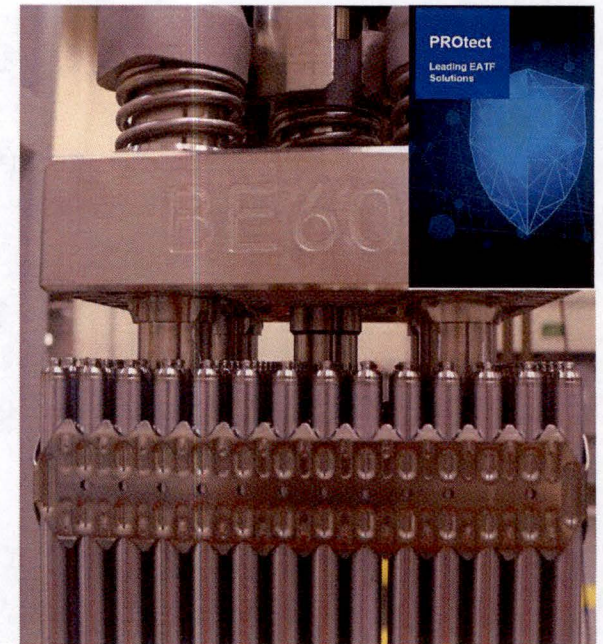
EATF PROtect Summary

GAIA Fuel Assemblies with EATF PROtect Fuel Rods Vogtle-2

ANO-1 EATF PROtect Fuel Rods

ANO-1 EATF PROtect Fuel Rods

Calvert Cliffs EATF PROtect Fuel Assembly



Summary/Conclusions

- HTP and GAIA continue to demonstrate improved performance over predecessor designs
- All US PWR customers have transitioned to advanced cladding (M5_{Framatome}) with low oxidation, growth, and hydrogen pickup
- Framatome is successfully implementing next generation PWR products (via LFA programs) incorporating proven and effective design features
- Framatome is committed to resolving conditions adverse to fuel reliability
- Framatome's active PIE program continues to validate the successful performance of Framatome PWR fuel products

» Framatome is committed to proactively addressing conditions adverse to fuel reliability and supporting our customers with leaker free performance

Acronyms/Nomenclature

- ANO Arkansas Nuclear One
- B&W Babcock and Wilcox
- CE Combustion Engineering
- DNB Departure from Nucleate Boiling
- EATF Enhanced Accident Tolerant Fuel
- EOC End of Cycle
- FA Fuel Assembly
- FR Fuel Rod
- GTRF Grid-to-Rod Fretting
- ID Inside Diameter
- IFM Intermediate Flow Mixer
- IGM Intermediate GAIA Mixer
- LFA Lead Fuel Assembly
- LOCA Loss of Coolant Accident
- NRC Nuclear Regulatory Commission
- PIE Post Irradiation Examination
- PWR Pressurized Water Reactor
- RCCA Rod Control Cluster Assembly
- TMI Three Mile Island
- US United States
- W Westinghouse
- Zry-4 Zircaloy-4 alloy

Trademarks

The alloy M5_{Framatome} is named “M5” in this document.

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