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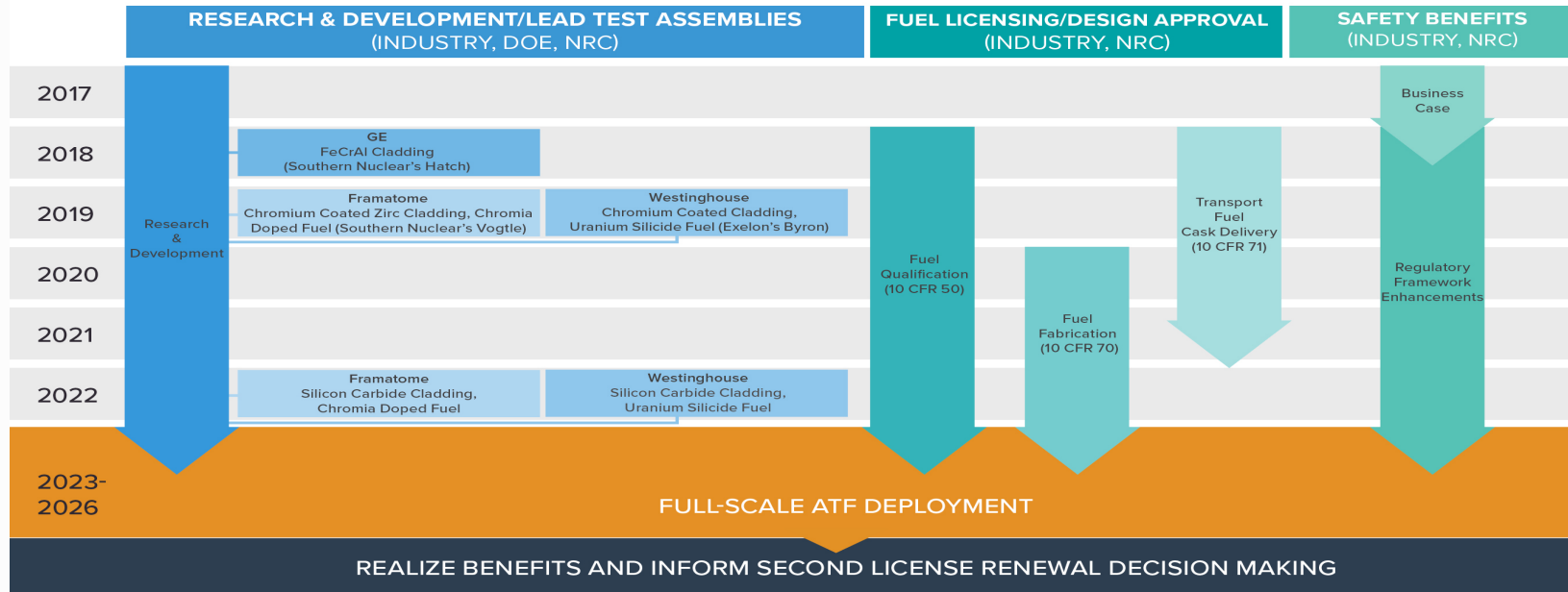
NRC Public Meeting  
February 27<sup>th</sup>, 2018

# Accident Tolerant Fuel (ATF)

*Current Status of ATF Programs*

# Accident Tolerant Fuels: Path Forward

Support initial ATF deployment in the early to mid-2020s and achieve meaningful steps toward NRC regulatory changes that recognize safety benefits



# ATF Concepts Under Development



framatome

- Cr-coated zirconium alloy cladding
- Chromium doped  $\text{UO}_2$  fuel
- SiC composite cladding



**GNF**  
Global Nuclear Fuel

- Fe-Cr-Al cladding
- GNF's Proprietary Coating



Westinghouse

- Cr-coated zirconium alloy cladding
- SiC composite cladding
- $\text{U}_3\text{Si}_2$  high density fuel



Lightbridge

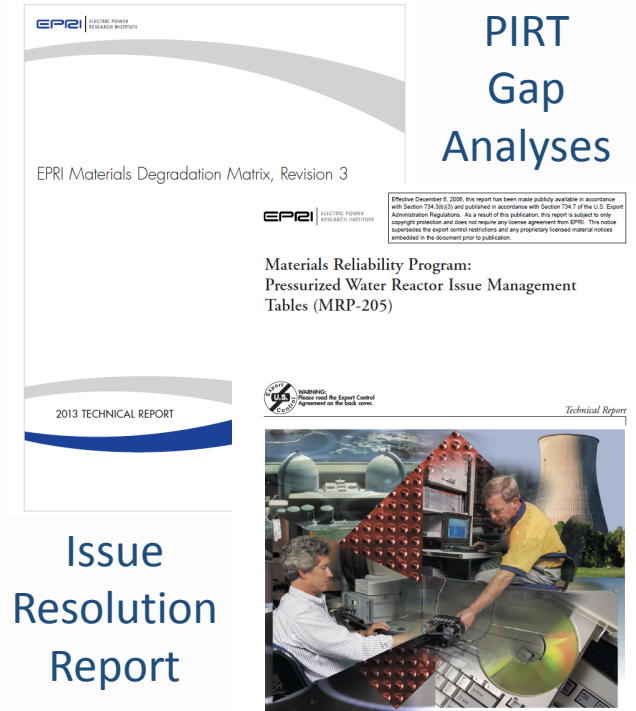
- Zirconium alloy cladding
- Metallic uranium alloy

# Lead Test Assemblies in US

- Southern Nuclear Plant Hatch Unit 1 - Feb 2018 with GNF
  - Iron-chromium-aluminum fuel cladding material (Non-Fueled Rods)
  - Chromium-coated zirconium cladding
- Exelon Plant Byron Unit 2 – 2019 with Westinghouse
  - Chromium-coated zirconium alloy cladding
  - Uranium silicide pellets
- Southern Nuclear Plant Vogtle Unit 2 – Spring 2019 with Framatome
  - Chrome-coated fuel rod cladding
  - Chromium doped fuel pellets
- Exelon Plant Clinton – Fall 2019 with GNF
  - Iron-chromium-aluminum fuel cladding material
  - Chromium-coated zirconium cladding
- Additional LTAs under commercial development

# Expert Elicitation: PIRT Process

- Potential Collaboration on SiC and Advanced Fuels PIRTs:
  - Existing regulatory guidance focus on metallic clad with  $\text{UO}_2$
  - Advanced fuels to include  $\text{U}_3\text{Si}_2$  and metallic fuels
  - Provide guidance on potential design criteria for specific ATF concepts to inform R&D priorities with early NRC engagement
- Discussions with NRC, DOE, EPRI, and OECD/NEA on domestic and international cooperative efforts to minimize duplication of PIRT elicitation
- NRC/EPRI Memorandum of Understanding Addenda on ATF identified cooperative efforts on expert elicitation
- Issue resolution reports to be done separately:
  - Prioritized plan to address identified gaps



# EPRI ATF PIRT Research Collaboration Vision

Foster ATF stakeholder engagement that addresses technical and regulatory issues

Mission	Goals	Phased Approach
<ul style="list-style-type: none"><li>• <b>Foster cooperation</b> between <b>ATF stakeholders</b> to <b>accelerate</b> development of R&amp;D data, models, and technical bases for full core implementation of new ATF designs that can tolerate the loss of active cooling in the core for a considerably longer time period, while maintaining and improving the fuel, system, and plant performance during normal operations.</li></ul>	<ul style="list-style-type: none"><li>• Facilitate <b>information exchange &amp; collaboration</b></li><li>• <b>Identify</b> technical/regulatory gaps, <b>areas of synergy</b>, and common opportunities for research collaboration</li><li>• <b>Foster integrated, approaches to resolve technical and regulatory issues</b> for full core ATF implementation</li></ul>	<ul style="list-style-type: none"><li>• Phase I:<ul style="list-style-type: none"><li>– Establish PIRT Steering Committee</li><li>– Identify common goals, needs, and technical focus areas through PIRTs</li></ul></li><li>• Phase II:<ul style="list-style-type: none"><li>– Review current technical bases and establish PIRT technical committees to address key focus areas</li></ul></li><li>• Phase III:<ul style="list-style-type: none"><li>– Develop issue resolution reports separately for stakeholder needs</li><li>– Coordinate tests, modeling, and risk/deterministic analyses to address PIRT identified priorities</li></ul></li></ul>

Leverage global resources to identify, prioritize, and target R&D to accelerate innovation



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# Accident Tolerant Fuel (ATF)

*Industry Comments on NRC Project Plan*

# NRC Project Plan Implementation Timeframe

- Past licensing of new fuel and cladding designs with current licensing practices has taken up to twenty years.
- The safety and sustainability benefits of ATF need a more efficient licensing approach to fully realize those benefits by the early to mid-2020s.
- We do not believe the current draft project plan provides sufficient change to the current NRC licensing practices to support ATF deployment and realize the safety and sustainability benefits within industry's timeframe.
- The draft project plan needs additional information on tasks and schedules to support loading of ATF in 2023
  - Future alignment is needed between NRC and industry regarding schedule milestones

# NRC Project Plan Detail and Path Forward

- The level of effort should be commensurate with the safety significance of the design changes.
- Regulatory stability needs to be established through the project plan for all designs
- Each ATF concept is unique and should be evaluated on its own merits rather than being binned into the broad categories of evolutionary and revolutionary designs.

# ATF Research and Development

- We support the NRC's position that independent testing of ATF performance characteristics is not required.
- Close collaboration between NRC, DOE, the national laboratories and the fuel vendors will eliminate the need for NRC independent development of codes and methods as it did for NRC independent research and development of fuel performance data.
- There is significant uncertainty in the time needed for NRC independent computational models development. Close alignment with DOE and national labs will enhance regulatory efficiency and stability.
- The NRC project plan should include tasks to develop confidence that advanced M&S tools can be used reliably in the regulatory process.

# Advanced Modeling and Simulation (M&S) for ATF

- Benefits of Leveraging DOE Advanced M&S Programs for ATF:
  - Benefits vary between near-term vs. longer-term concepts:
    - Near-term concepts can leverage existing approved codes
    - Longer-term concepts need code development for vendors and NRC
  - Reduce iterations of irradiation testing and post-irradiation examinations with confirmation to blind data sources and potentially advanced NDE
  - Design evaluations (transition cores, fuel performance phenomenon etc.)
- Advanced M&S (NEAMS/CASL) could be leveraged for longer-term ATF concepts as tools for both regulators and industry

# NEI ATF Licensing Task Force (LTF)

- NEI ATF LTF has been working to address many of the aspects of the NRC draft Project Plan since early 2017
- Four subcommittees have been established, aligned with the main tasks in the NRC draft project plan, and we look forward to frequent interactions as we finalize the development and implementation of the project plan:
  - In-Reactor Regulatory Framework
  - Fuel Cycle, Transportation and Storage Regulatory Framework
  - Probabilistic Risk Analysis (future)
  - DOE, Fuel Vendor and NRC Collaboration on Research and Development



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# Accident Tolerant Fuel (ATF)

*Closing Comments*

# Summary

- ATF presents an opportunity to implement more efficient practices at the NRC
- Industry is committed to the pursuit and development of accident tolerant fuels on a timeline that supports initial deployment in a commercial reactor in the early to mid-2020s.
- Close collaboration and alignment between industry, DOE, the national labs and NRC will be required.
- A shift in the NRC's licensing approach is needed in order to license ATF and realize the safety and economic benefits from these advanced technologies.
- The implementation of the proposed changes to the project plan will enable parallel progress for several ATF concepts using an approach tailored to each ATF concept while leveraging the modeling and simulation work now available to the NRC.
- Industry stands ready to meet with NRC staff to work on the details of the plan.

# Questions?