



BRIEFING ON ACCIDENT TOLERANT FUEL

Commission Meeting
April 12, 2018



Committed to enhancing our regulatory infrastructure to facilitate the use of new technologies

- NRC is committed to enabling the safe use of new technologies
- Agency's current efforts will aid efficient licensing of ATF
- Optimistic, yet prepared to address challenges ahead

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Speakers

- Ray Lorson, Deputy Office Director(A), Office of Nuclear Reactor Regulation (NRR)
 - Preparing to license ATF
- Mirela Gavrilas, Director, Division of Safety Systems, NRR
 - Project plan builds on current licensing process
- Andrew Proffitt, Project Manager, Division of Licensing Projects, NRR
 - ATF is compatible with the current regulatory framework
- C.J. Fong, Team Leader, Division of Risk Assessment, NRR
 - ATF impacts on PRA and risk-informed programs
- Michelle Bales, Senior Reactor Systems Engineer, Division of Systems Analysis, Office of Nuclear Regulatory Research
 - NRC developing capability to analyze ATF and next steps

ATF project plan will facilitate the efficient and effective licensing of ATF

- ATF project plan to be a living document
- Project plan covers complete (front-end to back-end) fuel cycle
- Integrates the resources and efforts of four major offices
- Active stakeholder engagement to solicit and consider feedback

Extensive stakeholder engagement



U.S. DEPARTMENT OF
ENERGY

Union of
**Concerned
Scientists**

framatome

EPRI | ELECTRIC POWER
RESEARCH INSTITUTE

 **Westinghouse**

GNF
Global Nuclear Fuel

NEI

NUCLEAR ENERGY INSTITUTE

Nuclear Utilities

Improving LTA guidance

- Lead test assemblies (LTAs) are an integral piece of technical basis
- Feedback regarding concerns related to use of existing guidance for LTAs
- Guidance to clarify existing requirements for LTAs (early Summer)

ATF Project Plan compatible with all concepts under development

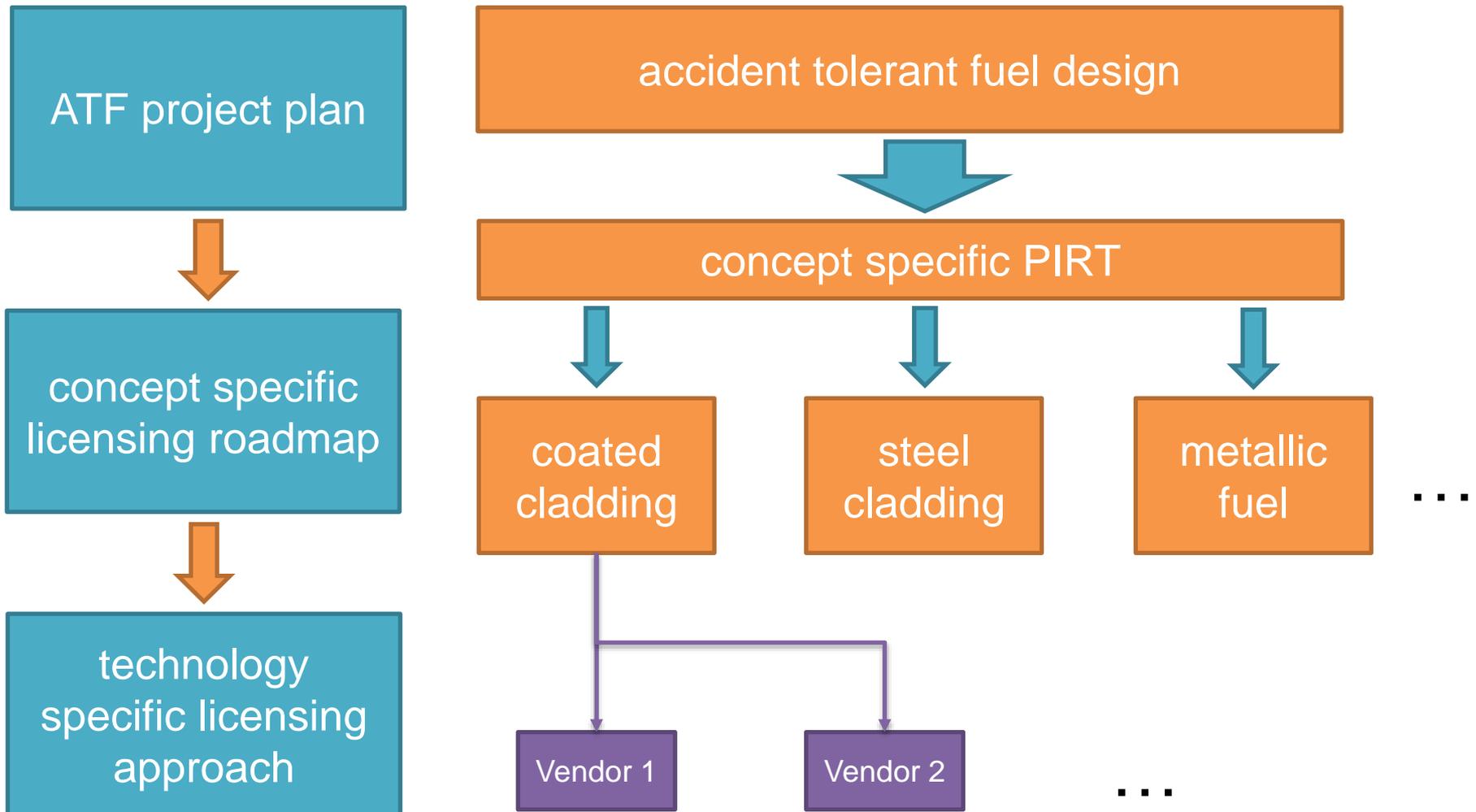
Near-term concepts

- Coated claddings
 - Multiple vendors
 - Standard zirconium alloy material with thin coating applied to outside
 - Reduce corrosion and metal-water reaction
- Doped fuel pellets
 - Reduce pellet clad interaction
- Steel cladding
 - FeCrAl

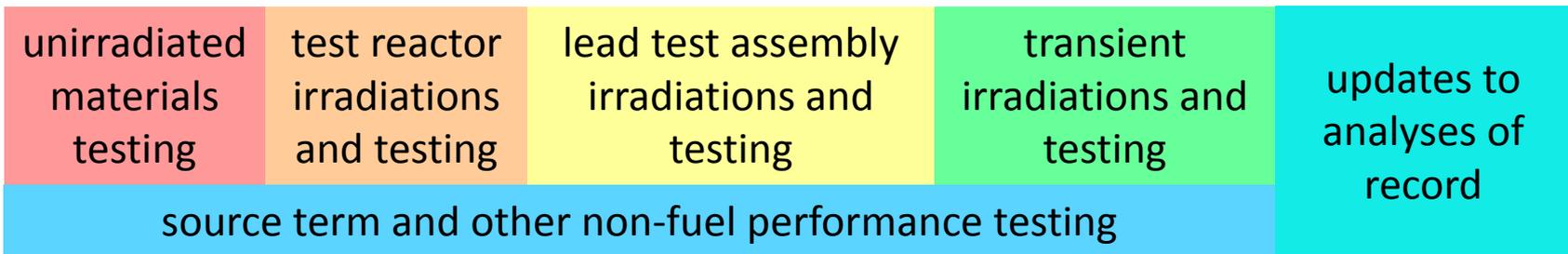
Longer-term concepts

- Silicon carbide cladding
 - Multiple vendors
- Uranium silicide fuel pellets
 - Higher fuel density
 - Limited information on fuel performance
- Metallic fuel
 - Lightbridge

ATF project plan will be augmented by concept-specific licensing roadmaps



New fuel technical basis development is an extensive process



Plan builds innovative ideas into an improved fuel licensing approach

development of technical bases



old paradigm

development of regulatory infrastructure

licensing activities

ATF project plan

phenomena identification and ranking exercise

PIRT maintenance

refinement of regulatory infrastructure

licensing activities

← schedule efficiency enabled by plan →

Exploring additional innovations and solutions

- Use of vendor inspection to verify experiments and data
- Development of a standard topical report change process
- Use of DOE and advanced computational capabilities
- Expedited issuance of NRC guidance

Project plan outlines the activities to prepare NRC for licensing ATF

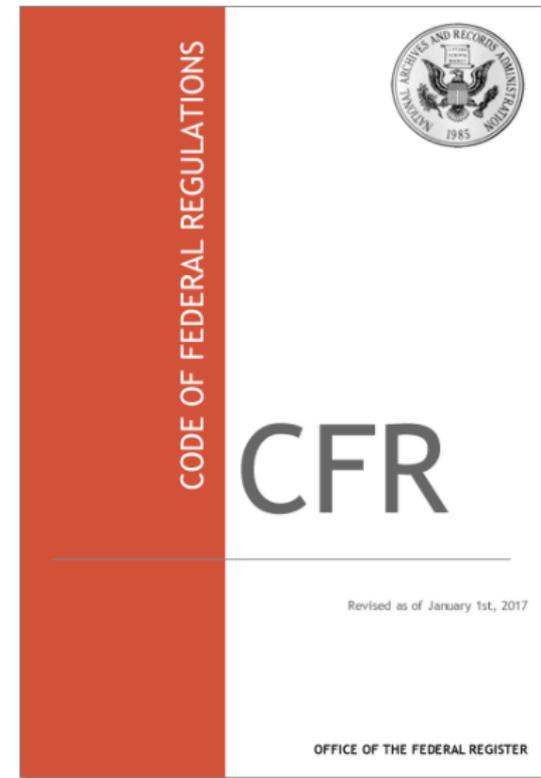
- High level, concept independent, strategy for licensing
- Describes required preparatory tasks
- Includes preliminary estimates of lead times
- Draft issued for public comment

Improving plan based on stakeholder feedback

- Concerns with regulatory requirements associated with lead test assemblies
 - Guidance to be issued early Summer
- Emphasize importance of communication/coordination
 - Staff committed to maintain enhanced engagement
- “Evolutionary” vs. “revolutionary” binning
 - Language removed, each concept treated individually
- Opportunity to transform fuel licensing process
 - Continually looking for efficiencies, open to specific suggestions
- Schedule concerns
 - Committed to minimizing time between development of technical basis and licensing
- Leverage use of DOE/advanced computational capabilities
 - Staff will utilize most optimal means for confirmatory analysis

ATF is largely compatible with the current regulatory framework

- Mapping of hazards based on PIRTs
- Examples of potential refinement:
 - 50.46: Zr/UO₂ based
 - 50.68: 5% enrichment limit



Plan addresses entire fuel cycle



**10 CFR Part 70
Fabrication**



**10 CFR Part 71
Transportation**



**10 CFR Part 72
Storage**

Incorporation of ATF into PRA models will be consistent w/ Commission Policy

- “The use of PRA technology should be increased in all regulatory matters to the **extent supported by the state of the art** in PRA methods and data...”
- “PRA evaluations in support of regulatory decisions should be **as realistic as practicable**...”

Excerpts from 1995 Commission Policy Statement on PRA, emphasis added

Realistic PRA models focus attention on safety-significant SSCs

- Risk-informed decision-making relies on accurate modeling of plant performance
- Examples:
 - Licensee risk-informed programs (e.g., maintenance rule)
 - Risk-informed licensing actions (e.g., risk-informed tech spec changes)
 - PRA tools in reactor oversight (e.g., SDP, ASP)
 - Generic Issues

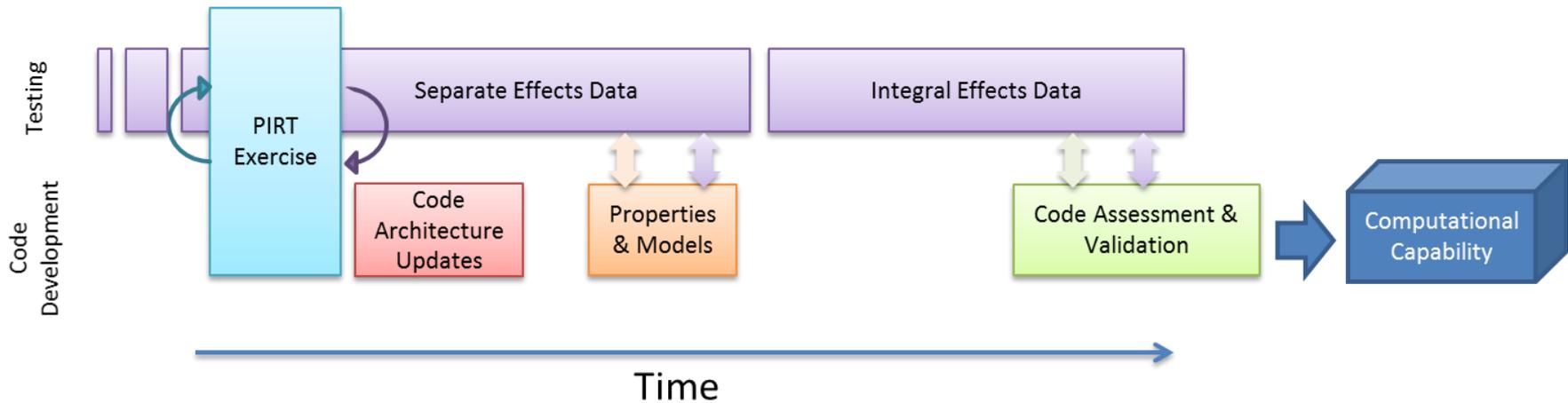
Full impact of ATF on plant risk profiles is currently unknown

- PRAs will leverage results of deterministic testing and analysis to assess ATF's impact on:
 - Parameters and criteria for determining core damage
 - System success criteria
 - Sequence timing
 - Other potential impacts
- NRC PRA staff will remain engaged so that our models and guidance are ready in time to support decision-making

ATF Project Plan addresses code development for key disciplines

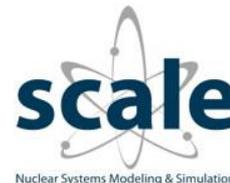
- Disciplines impacted by changes in fuel design:
 - Fuel performance
 - Thermal hydraulics
 - Neutronics
 - Severe accident/source term
- Computational tools are employed to demonstrate acceptance criteria are met

Code development requires testing and data



Staff's confirmatory analysis follows a graded approach

- Graded approach is developed based on:
 - complexity of the application
 - safety significance
 - uncertainty of key phenomenon
- Staff employ, as appropriate:
 - Confirmatory analysis
 - Confirmatory calculations
 - Confirmatory testing
- With appropriate controls, staff can use non-NRC codes while maintaining independence



Safety case verified through the most effective and efficient approach

- NRC will work with applicants to ensure code development needs are met
 - Plan assumes NRC independent confirmatory testing will not be necessary
- The need for confirmatory calculations and approach to perform confirmatory calculations will vary by concept

Next step is to start concept specific PIRT activities

- The outcome of a PIRT is identification of:
 - phenomenon important to safety
 - assessment of the level of knowledge of each phenomenon
- This outcome can be used by different entities for distinct purposes:
 - Applicants use the PIRTs to develop their safety case
 - NRC uses the PIRTs to inform regulatory requirements
 - DOE uses the PIRTs to prioritize research

NRC is well positioned in our preparations to license ATF

- Publish NRR Office Director memo on LTAs
- Finalize ATF project plan
- Continue strong stakeholder engagement
- Begin PIRT process for near-term designs

Acronyms

- ASP – Accident sequence precursor
- ATF – Accident tolerant fuel
- Cr – Chromium
- DOE – U.S. Department of Energy
- EDO – Executive Director for Operations
- EPRI – Electric Power Research Institute
- IPE – Individual plant examination
- IPEEE – Individual plant examination external events
- LTA – Lead test assembly
- NRC – U.S. Nuclear Regulatory Commission
- NRR – Office of Nuclear Reactor Regulation
- OD – Office Director
- PIRT – Phenomenon identification and ranking table
- PRA – Probabilistic risk assessment
- SDP – Significance determination process
- SSC – Systems, structures, and components
- UO₂ – Uranium dioxide
- Zr – Zirconium