



U.S. DEPARTMENT OF
ENERGY

Nuclear Energy

The Advanced Fuel Cycle Initiative

Fuels Topics in the NEUP Call

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NEUP Workshop

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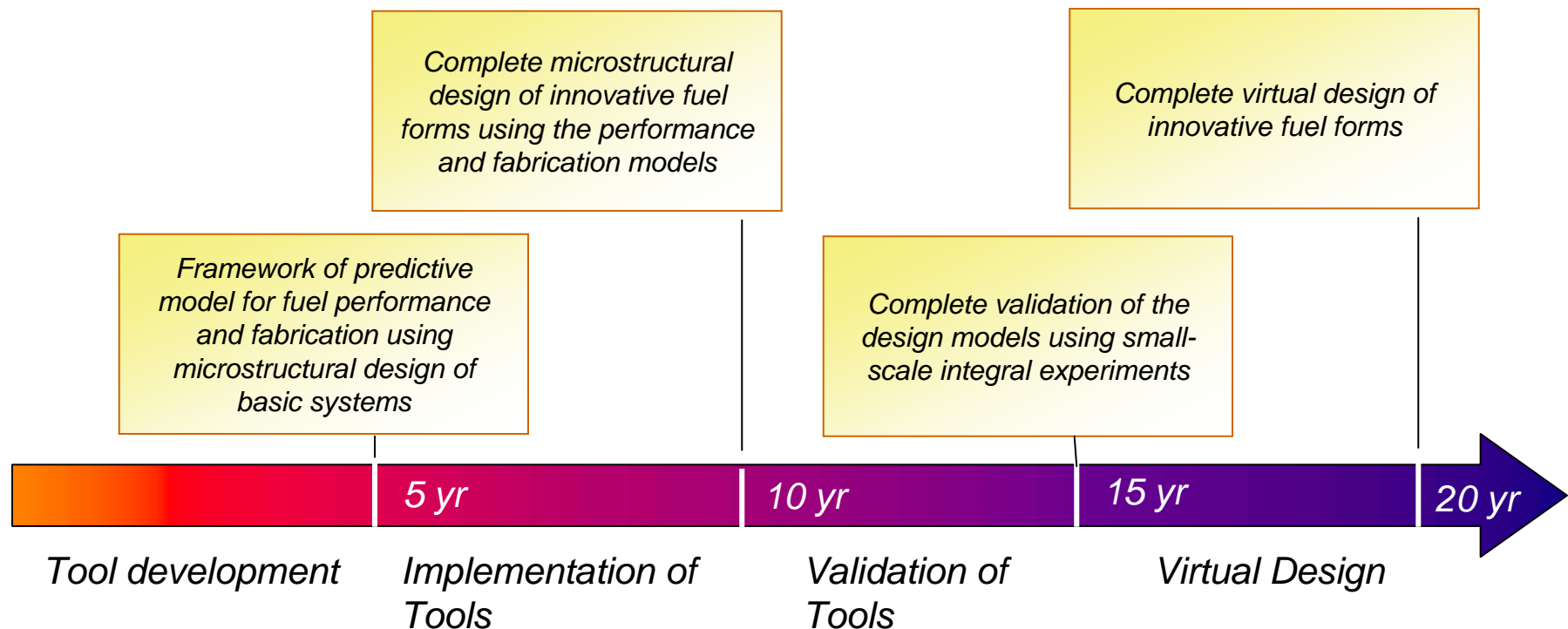
Salt Lake City, Utah



Mission and Objective

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- The **Mission** of the Transmutation Fuel Campaign (TFC) is to perform research and development (R&D) activities on fuel system's behavior under irradiation and fabrication processes to achieve multi-fold improvements for in-pile performance and process efficiency.





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- *Develop ultra-high burnup fuels (≥ 400 MWd/kgHM) for fast reactors.*
 - this challenge will almost certainly require development of advanced cladding alloys or composites and will possibly require innovative assembly design.
 - Fuel failure fraction target: near zero (10^{-6} ??).

- *Develop highly reliable, repeatable, efficient and affordable fabrication processes with $< 0.1\%$ irretrievable TRU losses and $< 1\%$ reject/scrap rate.*

- *Support the NE LWR Sustainability activity by seeking ways to significantly enhance the performance of LWR fuels in a utility acceptable fashion.*



Activities to support the revised functions and requirements

- In-pile measurements aimed at isolated phenomenology with instrumentation.
 - Development advanced in-pile instrumentation.
 - Out-of-pile testing
 - Characterization methods at micro-scale
- Characterization equipment development (emphasis on hot samples)

Design of targeted in-pile and out-of-pile experiments guided by the theory and the needs of the closure models.

Design of scalable bench-scale fabrication tests with instrumentation

Micro-structural description of the fuel and cladding:

- Closure of combined transport and phase-field equations
- Separate effect testing and properties measurement needs at sub-grain scale.
- Interpretation of results at multi-grain, multi-phase scale
- Effect of nano-scale implantations

Detailed characterization of feedstock properties ★

Small-scale fabrication tests with enhanced instrumentation

Fabrication simulator using mechanistic models to scale up to engineering-scale applications

EXPERIMENTS

THEORY

MODELING & SIMULATION

Understanding of feedstock effects on the product quality ★

Fabrication techniques for controlling microstructure

Integral fuel-performance code to predict behavior at assembly-scale during steady-state and transient conditions.

★ *Interface with separations campaign*



Areas of Focus for 2009/2010 NEUP Call for Fuels

- **Develop advanced fuel designs (for LWRs and advanced fast reactors), including fuels and target forms that can accommodate high actinide loadings, higher performance and achieve multi-fold increases in burn-up than yet achieved, including the associated fabrication processes.**
- **Develop in-situ instrumentation for use in irradiation experiments.**
- **Develop innovative micro-scale characterization equipment for use on fuels and materials.**



AFCI Fuels

AFF-1 Advanced Fuel Design. - This element is primarily focused on design of innovative fuels for advanced reactors. The objective is to come up with fuel designs that can achieve higher performance requirements (higher burnup, higher linear power, etc...) compared to conventional fuels used in today's reactors. The scope includes both Light Water Reactors and Fast Reactor fuels for the next generation reactors. The processes needed for fabricating the proposed fuel types also is within the scope of this program element.

The university will be expected to provide monthly updates on the progress of their work, produce an end-of-year report on the accomplishments for the yearly effort, and participate in Fuels Campaign meetings as requested by the campaign director.

Greater than \$200K 2 - 3 years



AFCI Fuels

AFF-2 In-Situ Instrumentation – This element is focused on innovative in-situ instrumentation design that can provide data during in-pile testing of fuels. Different phenomena in the fuel occur at different time-scales and the scope include instrumentation that can provide data on property changes in the earlier phase of irradiation as well as at later stages of burnup.

The university will be expected to provide monthly updates on the progress of their work, produce an end-of-year report on the accomplishments for the yearly effort, and participate in Fuels Campaign meetings as requested by the campaign director.

Greater than \$200K² - 3 years



Characterization Equipment and Methods

AFCI Fuels

AFF-3 Characterization Equipment. – This element is focused on developing advanced characterization equipment that can be used with fuel samples (fresh and irradiated) where various thermal-mechanical properties of interest can be measured at micron scale (or lower-scale). The proposal may include modification to already existing equipment to enhance radiation tolerance or lower the length-scale of the measurement domain, as well as design of innovative concepts tailored for nuclear fuel applications.

The university will be expected to provide monthly updates on the progress of their work, produce an end-of-year report on the accomplishments for the yearly effort, and participate in Fuels Campaign meetings as requested by the campaign director.

Greater than \$200K 2 - 3 years