U.S. DEPARTMENT OF ENERGY | AFC Advanced Fuels Campaign

Current Topics in U.S. DOE Accident Tolerant Fuel Program

NRC Regulatory Information Conference

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Topics

Current Infrastructure Development

- Testing
- Data and Handbooks
- IMCL EPMA and Thermal Property Line

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ATF Irradiation Testing and Qualification Infrastructure –

ATF-1 Initiated Irradiation Feb. 10, 2015
ATF-2 fueled irradiation ready end of FY2017

Test Series	ATF-1	ATF-2	ATF-H-x	ATF-3	CM-ATF-x	ATF-y
Test Reactor	ATR	ATR	Halden	TREAT	Commercial Power Plant	TREAT
Test Type	Drop-in	Loop	Loop	Static/Loop	LTR/LTA	Loop
Test Strategy	Scoping – Many Compositions	Scoping – Focused Compositions	Focused	Focused Compositions	Focused Composition	Focused Compositions
	Nominal conditions	Nominal conditions	Nominal	Accident conditions	Nominal conditions	Accident conditions
Fuel	UO_2, U_3Si_2, UN					
Cladding	Zr w/coatings, stainless steels, advanced alloys, SiC	Down-selected concepts	Selected	Fuel rodlets from ATF-1 and test rods from ATF-2 irradiations	Concepts selected in 2016	Test rods from LTR/LTA irradiations
Key Features	Fuel-cladding interactions	PWR Conditions	PWR/BWR Conditions	Integral testing	Steady State Irradiation	Integral testing
Timeframe	FY14 – FY18+	FY17 – FY22	FY18-FY22	FY18 – FY25	FY22 – ?	FY – ?

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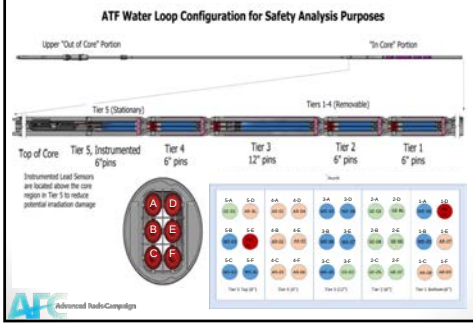
ATF-2 Water Loop Design Schematic
(Currently targeting a December 2017 insertion)



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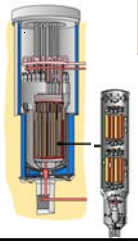
Halden ATF Collaborations

- FeCrAl Alloy and SiC creep test (In-Process)
- ATF cladding and fuel experiment under the EHRP
- 3D MBM V&V Experiment
- BWR/PWR Loop



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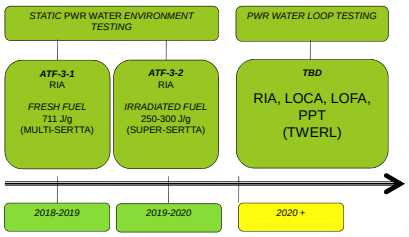
ATF-3 Transient Experimental Series in TREAT



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Irradiated Materials Characterization Laboratory – EPMA and Thermal Properties Line

Irradiated Materials Characterization (IMCL)

Electron Probe Micro-Analyzer (EPMA) installed in shielded enclosure

Thermal Property Measurement Line under Construction

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Integral LOCA Test Facility established and available at ORNL

- Internally pressurized
- Steam environment
- 5°C/s heating
- To 1200°C
- 3°C/s cooling

Based on the same system sponsored previously by NRC at ANL (Billone et al.)

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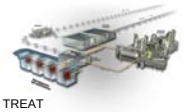
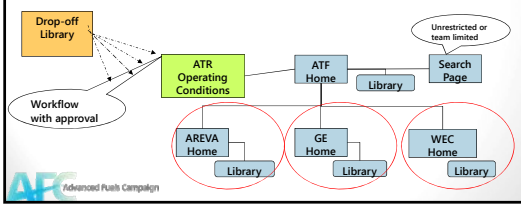
Accident Tolerant Fuels NDMAS Database

- Established the ATF SharePoint site
- Created a home site for the program
- Created a site-wide library for unrestricted documents
- Created sub-sites for Development Teams
- Each site has a home page and a document library
- Qualification plans being developed for ATR, PIE, and TREAT
- Should be available external to INL in FY17.





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Fuel System Handbooks

- FR Fuels
- FR Cladding
- U_3Si_2
- FeCrAl
- SiC

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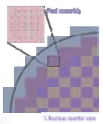
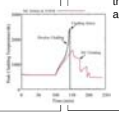
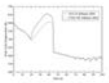
Modeling, Simulation, and Assessment of Accident Tolerant Fuel

Steady State Performance	Off-Normal (DBA and BDBA)	Advanced Modeling and Simulation
Neutronics and thermal hydraulics code sets are adequate to handle ATF. Current focus on: • FeCrAl, SiC cladding • FCM, nitride, silicide fuels	Existing Codes (MELCOR, MAAP, TRACE, RELAP) • Specific to UO_2-Zr • Modified to provide insight into performance trends • Inherent assumptions in the physics may not be applicable to ATF	**Basic fuel performance and properties** for inclusion in existing Industry Proprietary Codes. There are activities funded by the DOE-NEUP program in the university community. **ATF High Impact Problem** – NEAMS funded activity to develop a MBM implementation of U-Si and FeCrAl. **ATF IRP** – MIT project that will utilize MBM and MIT tools to analyze ATF up to the point of fuel failure. Effectively estimating the "coping time" provided by ATF technology. **TREAT Analysis** – NEAMS funded activity to develop a full core model for TREAT that provides analysis of the TREAT core coupled with transient fuel experiments. **LWRS RISMC** Pathway analysis of reactor accident scenarios with ATF







All analysis activities are dependent upon the fuel system material property and performance models.

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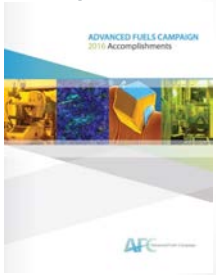
FY2016 AFC Accomplishments Report

- Full 2016 Accomplishments Report at:
  https://nuclearfuel.inl.gov/
- Major Efforts for FY2017
  - Start Phase II of Industry Projects



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Summary

- **Testing program for Phase 2 is underway and coordinated and prioritized for the fuel vendor ATF teams.**
- **Advanced modeling and simulation, NDMAS, and fuel system handbooks will aid with assessment of ATF.**

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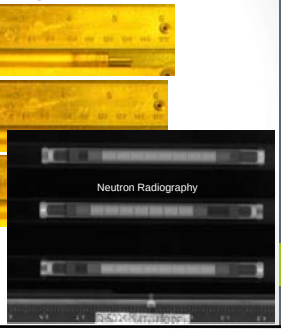
ATF-1 Initial PIE of three rodlets underway – Visuals

ATF-00 (ATF-1A 01, UO_2 base)

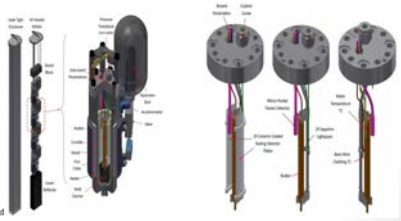
ATF-03 (ATF-1A 04, UO_2 SiC whisker)

ATF-04 (ATF-1A 05, UO_2 Diamond)



Static Capsule Test Vehicle for ATF

- Multi-Static Environment Reactor Transient Test Apparatus (Multi-SERTTA) engineering design review performed in September
  - Mechanical design complete
  - Draft safety analysis package complete
  - Fabrication has been initiated



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