U.S. DEPARTMENT OF ENERGY

The U.S. Department of Energy's Enhanced Accident Tolerant Fuel Program

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U.S. Nuclear Regulatory Commission
Regulatory Information Conference
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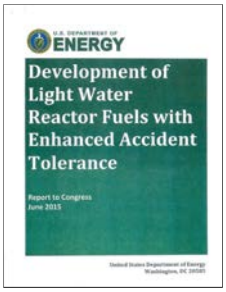
Agenda

- Program Overview: Development Plan, Contributors
- Phase Two: Concepts, Awards, Irradiation Test Series
- Closing Remarks

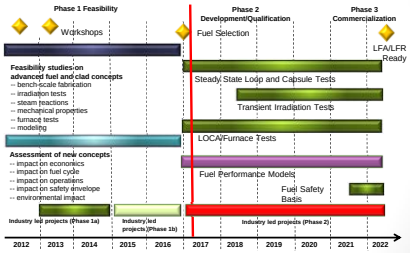
Report to Congress – June 2015



- Defines the general attributes of fuel with enhanced accident tolerance.
- Lays out an aggressive 10-year schedule starting in 2012.
- Establishes 2022 insertion of a lead fuel rods or lead fuel assemblies in an operating commercial LWR as the goal.

https://nuclearfuel.inl.gov

RD&D Strategy For Enhanced Accident Tolerant Fuels – 10 Year Goal



Supported by a large part of the U.S. nuclear complex

National Laboratories

Universities

Nuclear Industry

International Collaborations Include Significant Development Partners

France
- *Advanced core materials*
- *Joint support of Halden collaborative irradiations*

European Union
- *Three general INERIs currently underway with JRC-ITU*

Japan
- *Definition of attributes and metrics*
- *Coordination of technology research and development*
- *Coordination of facilities used for R&D*

China
- *Attributes and metrics*
- *Information exchange on R&D facilities*
- *Assessment of ATF performance*
- *Collaborative testing opportunities*

UK
- *Active partners in ATF FOAs and IRPs*
- *Joint participation in ATF OECD/NEA*
- *Basic material properties of high density fuels*

Multilateral
- *OECD/NEA Expert Groups*
- *IAEA Expert Group*
- *Halden Reactor Project*

Vendor Teams are Pursuing a Wide Range of Promising Concepts

AREVA

- Chromium coated zircaloy cladding
- Chromia doped UO_2 fuel

GE – imagination at work

- Ferritic/martensitic steel alloy cladding (e.g., Fe-Cr-Al)
- Conventional UO_2 fuel

Westinghouse

- Silicon carbide ceramic matrix composite cladding
- U_3Si_2 high density fuel

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Initial Phase Two Awards

- Two years, $5 million of government funding per team per year. *(Subject to appropriations and available funds.)*
- AREVA and GE: 20% cost share. Westinghouse: 36% cost share.
- FY 2017 - Develop a licensing approach for the concept that includes the involvement of a nuclear power plant owner-operator that has been shared with the NRC.
- FY 2018 - Have a prototypic test article of the proposed concept under irradiation in a water loop of a materials test reactor.

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Irradiation and Qualification Test Series

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	BWR Conditions	Integral testing	Steady State Irradiation	Integral testing
Timeframe	FY14 – FY18+	FY16 – FY22	FY15-FY22	FY18 – FY25	FY22 – ?	FY – ?

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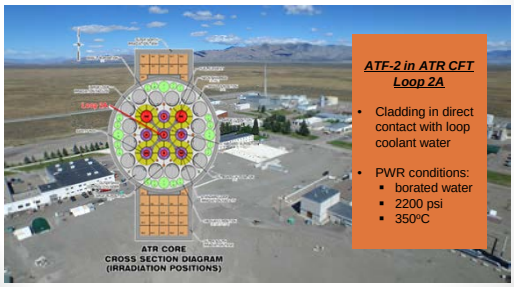
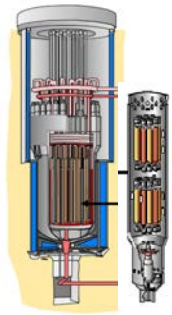
ATR-2 Water Loop

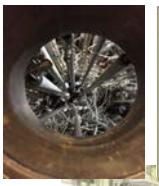


ATF-2 in ATR CFT Loop 2A

- Cladding in direct contact with loop coolant water
- PWR conditions:
  - borated water
  - 2200 psi
  - 350ºC

Halden Collaborations





The Halden Boiling Water Reactor (HBWR) is a versatile tool for nuclear fuels and materials investigations.

- More than 300 positions individually accessible
- About 110 positions in central core
- About 30 positions for experimental purposes (any of 110/300)
- Height of active core 80 cm
- Usable length within moderator about 160 cm
- Experimental channel Ø:
  - 70 mm in HBWR moderator
  - 35-45 mm in pressure flask
- Loop systems for simulation of BWR/PWR conditions

Transient Reactor Test (TREAT) Facility

- Large Graphite based 'driver core' to produce intense neutron fields that simulate off-normal nuclear environment.
- Core design provides an instantaneous, large negative temperature coefficient (self protecting driver core).
- Experiments are contained in pressure vessel located in central cavity of reactor.
- Experiments are assembled/disassembled and loaded with pre-irradiated fuel samples in a shielded hot cell.
- Unique instruments allow for visualization of fuel failure in real-time.

Closing Remarks

- The program continues on the track that was set by Congress and our development plan.
- Phase 1 resulted in a wide range of promising concepts.
- Initial Phase 2 priorities are developing a licensing approach and preparing prototypic test articles for irradiation testing.
- The program is benefitting from enthusiastic domestic and international support.

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