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INL HALEU Capabilities

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Outline

• EBR-II metal uranium product

- Recast- metal product
- Small-scale polishing- oxide product

Aluminum or Zirconium clad HEU fuels

- Headend treatment (ZIRCEX)
- Processing (pilot-scale and engineering-scale)



EBR-II Driver fuel processing





Electrorefined uranium dendrite product



Cast uranium product ingot



Pyroprocessing – EBR II Driver Fuel





HALEU EBR-II Metal Feedstock Progress

- HALEU as metal from EBR-II is the nearest term feedstock available to support fast-spectrum advanced reactor concepts
- Processing of EBR-II driver fuel will continue until all driver fuel is processed
- Production of EBR-II HALEU reguli will continue until all EBR-II driver fuel has been treated
 - Operations ramp up to 7 day/wk, 12 hr/day
 - 0.365 MT produced in 2019
 - 2nd furnace available 2020 1 MT/year
 - 5 MT forecast to be available by 2024





Recovered U metal

Large metallic ingot



New graphite crucible



Novel Multi-function furnace

Low dose rate. small size HALEU metal regulus



HALEU EBR-II Oxide Feedstock Demonstration

- Polished EBR-II uranium product suitable for thermal spectrum reactors
- Demonstrated U Polishing in small-scale equipment (using equipment on-hand)
 - Dissolution of EBR II uranium metal regulus
 - Uranium purification from residual fission products by solvent extraction
 - Precipitation of uranium using peroxide process
 - Uranium oxide produced by calcination



Low dose rate, small size HALEU metal regulus





U metal dissolution

U purification







U metal regulus

Uranyl Peroxide - UO₂(O₂)·4H₂O

UO₂ pellets



EBR-II oxide product characteristics

- All metal species except uranium were below analytical detection limits
- Uranium isotopic analysis (same as metal)
 - **U-235: 19.77%**
 - **U-238: 79.5 %**
 - **U-234: 0.18%**
 - U-236: 0.55 %
- Dose rates (theoretical dose for unirradiated 20% U-235 HALEU)

	HALEU Regulus	Uranyl Peroxide (UO₄·4H₂O)	Uranium Trioxide (UO₃)	Uranium Oxide	Theoretical Dose At Contact*
Dose rate per Kg	583 mR Hr ⁻¹ β ⁻ 6.3 mR Hr ⁻¹ γ	6.8 mR Hr ⁻¹ β ⁻ , γ	2.2 mR Hr ⁻¹ β ⁻ , γ	0.9 mR Hr ⁻¹ β ⁻ , γ	0.053 mR Hr ⁻¹ β ⁻ 0.908 mR Hr ⁻¹ γ



Dry headend for zirconium or aluminum clad fuels







ZIRCEX Headend Progress

- Pilot plant operational on October 3, 2019
- Zirconium decladding testing initiated (10 completed runs to date)
- 2020 test schedule to include Zr and AI
- Receipt of unirradiated HEU fuel elements was completed in November 2019





Zirconium sample after dry ZIRCEX decladding process

Simulated Zircaloy-2 clad fuel



Process scale-up

- Design of pilot-scale processing glove box line for clean or lightly irradiated materials - in progress
 - Dissolution/solvent extraction/ conversion/waste vitrification
 - EBR-II product (19.7% HALEU)
 - ZIRCEX pilot plant product (unirradiated HEU)
 - Other fuel/orphan materials
- Engineering-scale demonstration conceptual design in progress
- Projected 1-2 MT/yr of HALEU based on EBR-II and ATR recycled fuels







Projected INL HALEU Production Rates

HALEU Production

EBR II Production HZD Production



2021 – Planned Activities

- EBR-II
 - Continue processing EBR-II driver fuel
 - Continue to recast previously processed EBR-II uranium product into reguli
 - A total of 1 MT of HALEU reguli will be produced per year

ZIRCEX

- Complete testing of Zr and Al simulated fuels
- Initiate testing of unirradiated HEU fuel
- Complete design of pilot-scale glovebox line for polishing EBR-II product and ZIRCEX HEU product
- Complete conceptual design of Hybrid-ZIRCEX Engineering-Scale Demonstration
- Initiate NEPA (Environmental Assessment) for Hybrid-ZIRCEX Engineering-Scale Demonstration
- Complete construction of in-can vitrification pilot plant