Fuel Fabrication Capability Overview

National Academy of Sciences Meeting

Current Status of and Progress toward Eliminating Highly Enriched Uranium Use in Fuel for Civilian Research and Test Reactors

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FFC Mission & Goals

» **FFC Mission** - Develop the commercial-scale fabrication process for manufacturing the LEU fuel under development
  
  **Process development**
  - Cannot adversely affect fuel performance or qualification
  
  **Process optimization**
  - Reduce the steady-state fuel manufacturing costs

» **Specific FFC Goals**
  
  - Transfer fabrication knowledge and processes to the Y-12 National Security Complex and Babcock & Wilcox Nuclear Operations Group – Lynchburg
  
  - Fabricate demonstration and experiment fuel products
Recent FFC Accomplishments

- Demonstration of key R&D tasks
  - Removal of log casting process
  - Optimized HIP can
- Foil Demonstration Line - installation completed and foil process commenced
  - Tech transfer & process modeling helped to make initial demonstrations successful
- Optimized Baseline Process identified
- Alternative Zr application processes showing progress
Baseline Process

**Downblend and Alloying**
- HEU Feed
- Low-Enrichment Diluent
- Alloy Material
  - Metal Blending
  - Intermediate Product
  - Scrap Recovery

**Casting and Coupon Preparation**
- Final Casting
- LEU-Mo Ingot
- Machine into Coupons in Preparation for Rolling
  - Scrap Recovery

**Foil Rolling**
- Can Zip & Coupon Using Arc or F-Beam Welder
- Heat Coupons
- Cold Roll to Final Thickness
- Shear to Foil Dimensions
  - Various Foil Sizes Produced from a Standard Coupon
  - Scrap Recovery

**Forming and Assembly**
- Series of Curved Plates Form Complete Elements
- Flat Plates Bent over Form to Curve
  - Scrap Recovery

**Hot Isostatic Pressing**
- Fuel Plates
- Hot Isostatic Pressing
- Foils & Al/Steel
  - Scrap Recovery
Baseline Process

1. Cast DU-Mo master alloy
2. Cast DU-Mo and HEU to LEU log
3. Break & sample log
4. Cast LEU into triple plate mold
5. Remove plate hot top

6. Machine surface and edges of coupon
7. Inspect coupon & ship
8. Receive 4” x 6” coupon at B&W
9. Nitric etch coupon
10. Assemble coupon in hot rolling can

11. Hot roll coupon/Zr into foil
12. Decan foil
13. Cold roll foil
14. Anneal foil
15. Slit & shear foil

16. Inspect foil
17. Assemble foil & Al into HIP can
18. HIP assembly to bond Al
19. Size fuel plate
20. Inspect fuel plate
Optimized Baseline Process

1. Cast DU-Mo master alloy
2. Cast DU-Mo and HEU into LEU triple plate mold
3. Remove plate hot top
4. Cut plate into 2 ingots
5. Inspect ingot & ship

Sub-processes:

1. Receive 3.5” x 9.5” ingot
2. Homogenize ingot
3. Nitric etch ingot
4. Assemble ingot in hot rolling can for grain size optimization
5. Hot roll ingot

1. Cold roll ingot
2. Decan & shear ingot
3. Assemble ingot & Zr in hot rolling can
4. Hot roll coupon/Zr into foil
5. Decan foil

1. Cold roll foil
2. Anneal foil
3. Slit & shear foil
4. Inspect foil
5. Assemble foil & Al into HIP can

1. HIP assembly to bond Al
2. Size fuel plate
3. Inspect fuel plate
Coupon to Ingot

- Significant reduction in castings
- Significant increase in material utilization
- Increased flexibility for downstream processing
Additional Operations

 Goals
- Ensure a robust and repeatable process
- Reduce scrap and overall lifecycle cost

 Ingot Homogenization & Rolling
- Minimize/eliminate micro segregation
- Control of microstructure
- Reduce cracking edge scrap
- Increase thickness uniformity of Zr in co-rolled foils
- Increase material utilization for various foil thickness requirements

 Foil Annealing
- Increase ability to shear/slit foils at precise requirements
- Increase ability to meet fuel centering requirements
- Reduce scrap from sizing operations
Current Fabrication Status

Pack Welding Operation

Hot Roll Pack

Hot Rolling Operation

Decan Operation

Cold Roll Operation

Slitting Operation
Hot Rolled Foils
Hot Rolled Foils

RTR U-Mo Foils
Cold Rolled Foils
Cold Rolled Foils
Batch Rolled Foils
FFC Priorities

- Continue focused R&D for process demonstration & optimization
  - Demonstrate key alternative technologies
- Continue feasibility studies of proposed HFIR designs
- Continue to apply research to refine the Optimized Baseline Process
- Demonstrate Optimized Baseline Process
- Fabricate MP-1 with Optimized Baseline Process