

CNS | consolidated nuclear security, llc
PANTEX PLANT | Y-12 NATIONAL SECURITY COMPLEX

Y-12 CAPABILITIES AND EXPERTISE RELATED TO MO-99

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DISCLAIMER

The Y-12 National Security Complex

The Y-12 National Security Complex

Located in Oak Ridge, Tennessee

Operating production facility specializing in uranium material safeguards, technologies, and manufacturing:

- Operational U-Metal Production and Technology Development Facilities
- Uranium Metallurgical and Manufacturing Expertise
- On-Site Source Material Availability

Since FY06, Y-12 has been integrated in fuel development activities supporting the RERTR Program goals.

This presentation will focus on the capabilities that might be of interest to the Mo^{99} community

- Capability
- Equipment
- Processes

Areas of responsibility related to minimization of the use of HEU

Support directly the Materials Management and Minimization (M3) Goals

- Remove, eliminate, and minimize the use of proliferation-sensitive materials
  - Nuclear Material Removal
  - Conversion
  - Material Disposition

- Core uranium capabilities for Y-12:
  - Processing
  - Handling
  - Storing
  - Packaging
  - Shipping

- Collaborate with the World to meet these objectives

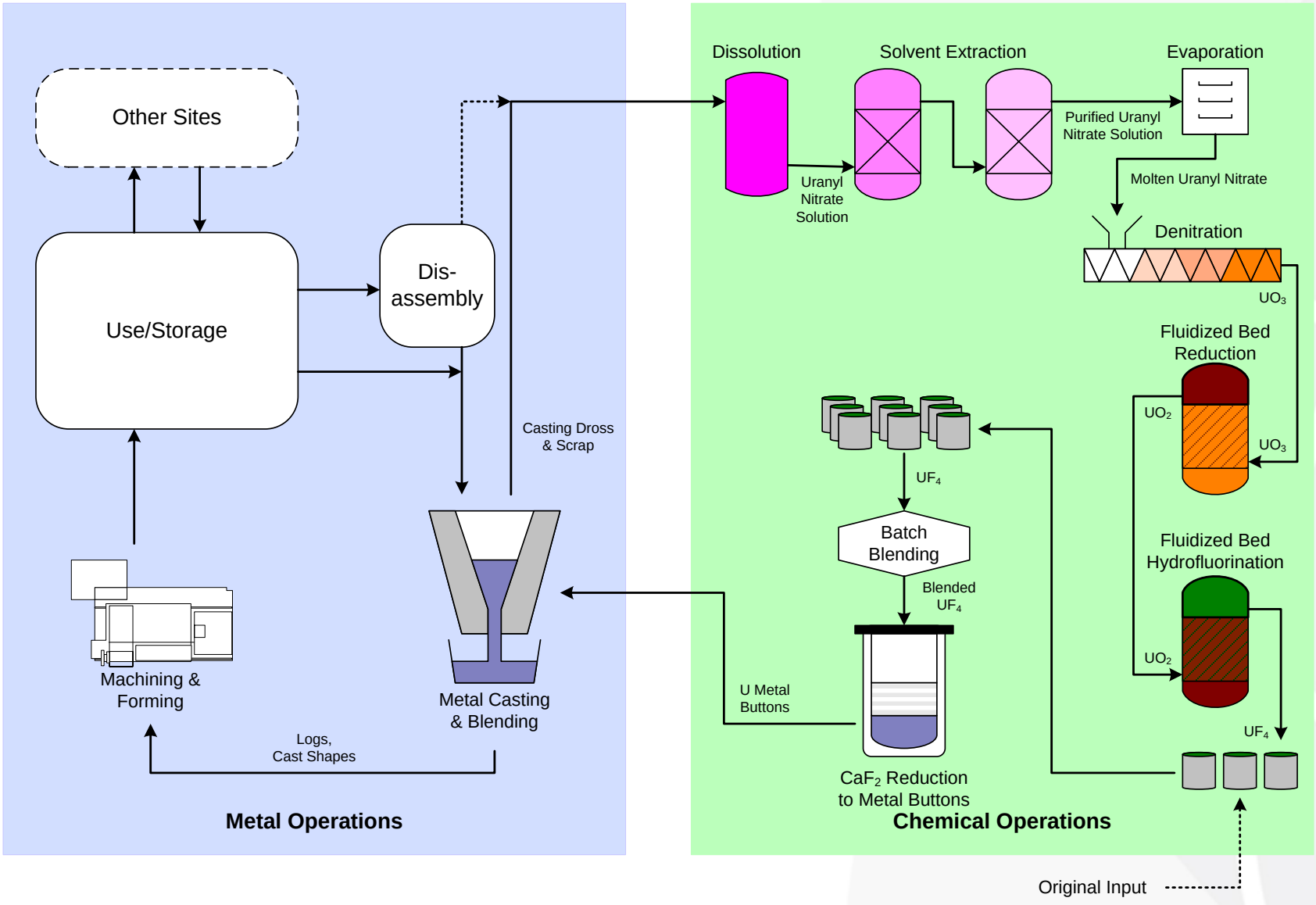
Supply Material for Research Reactors

YGG-14-0200R2

Supplier of 19.75% Enriched Material

- Down-blended from HEU stocks
- Currently not available commercially in the US
- Necessary for current and future conversion

Uranium Processing at Y-12 - Simplified



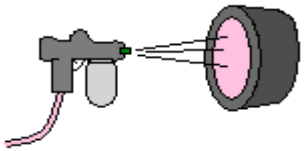
Vacuum Induction Melt Furnace

Low Enriched Uranium Work Flow

Y-12 Casts Metal from Dismantlement into a consolidated casting in the form of a hollow log.

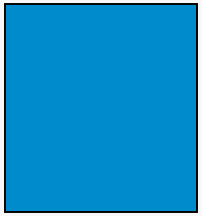
The hollow logs are broken, sheared, and pickled in accordance to the NR requirements

The broken metal pieces are then canned and drummed into an ES-3100



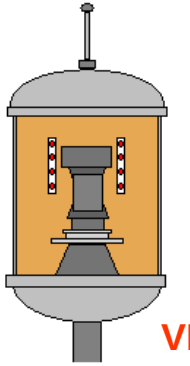
Graphite Coated with Erbia

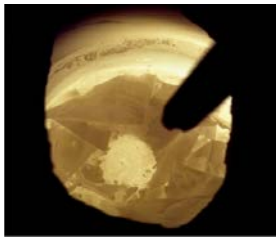
Mold Preparation
- Procure mold components
- Procure erbium oxide paint
- Roller-mix paint
- Check viscosity
- Coat mold components
- Clean spray gun
- Assemble hollow cylinder stack



HEU + DU

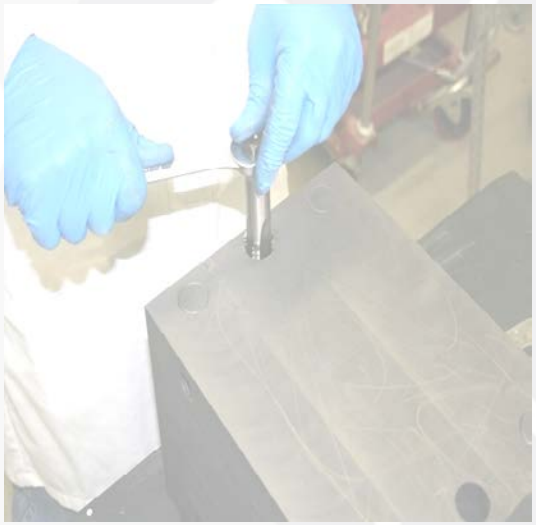
Batch Make-up
- Acquire HEU and DU for isotopic blend
- Break charge uranium as necessary
- Place material in hospital pan
- Create (weigh) batch





VIM Isotopic-Blending Pre-melt

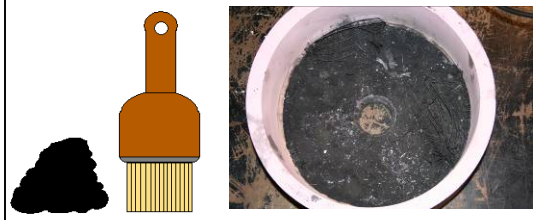
Casting
- Verification weigh/re-weigh
- Load induction furnace
- Heat, hold, cast, and cool.
- Unload furnace
- Line-cool



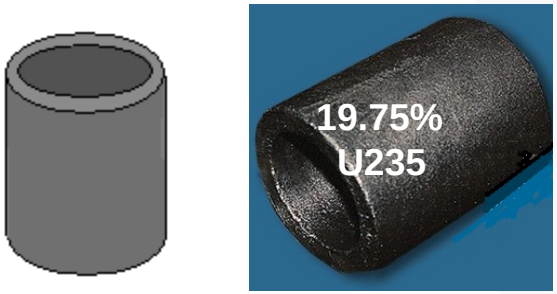
To Knockout

From Casting

Ship oxide off-site



Crucible with Skull Oxide



Hollow Cylinder/Log/161

Samples to Plant Lab

Chips for Chemical Analysis

Graphite Handling
- Sweep/can oxide
- Remove coating from unbroken mold stack components using a rotary wire-brush
- Evaluate condition of unbroken components
- Break unusable graphite
- Place broken graphite in "carbon can"
- Move reusable components to coating (mold-prep) area
- Burn skull, sweep, and can

Knockout
- Remove crucible
- Remove skull oxide from crucible
- Place skull metal and pallet scrap in hospital pan
- Disassemble rest of mold stack
- Remove cast log from housing
- Break/gouge/cut out mold core
- Rotary-brush log
- Apply oil to log
- Weigh log
- Verify Enrichment using multi-channel analyzer
- Drill chemistry samples

Break/Shear
- Break using hydraulic press
- Shear to smaller piece size using alligator shear
- Place metal in hospital pan
- Weigh broken/sheared batch

Ship broken carbon off-site

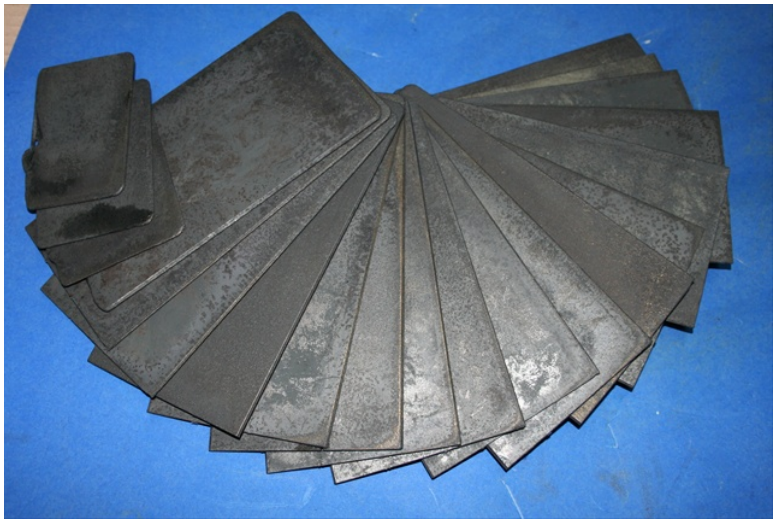
Reusable graphite to Mold Preparation

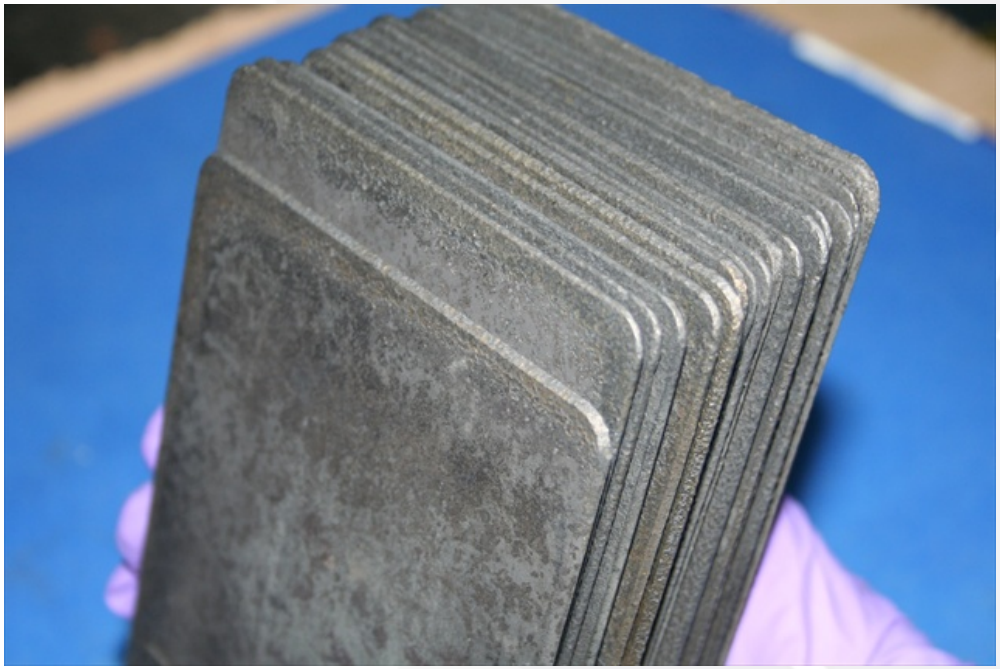
Product from Knock Out

The original baseline process combined DU/NU, and HEU to make a LEU Cast

- At this point, sampling occurs to examine U-235 enrichment, and impurities
- If material meets criteria, material is broken
- Recast into a plate form or shipped for other use

Thin Cast Plates (MWV)



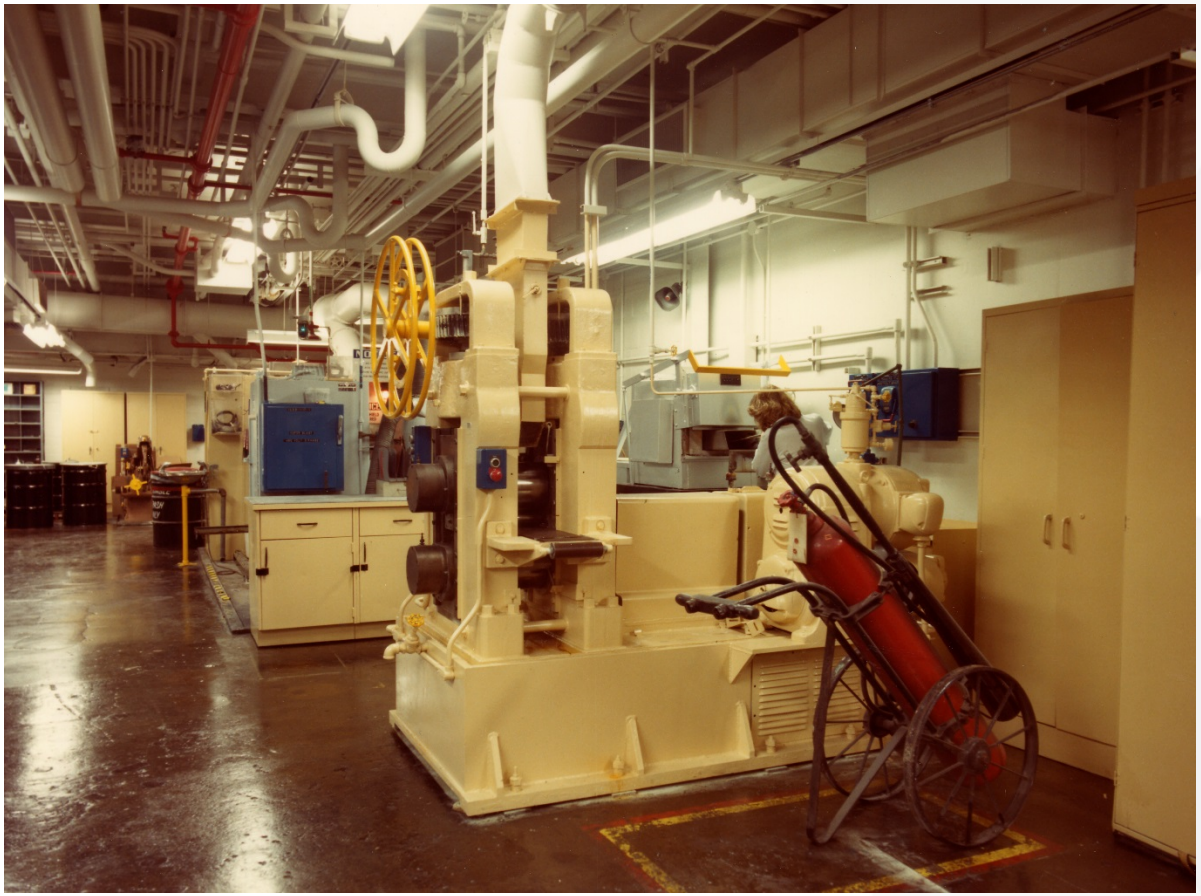


Oxide Production

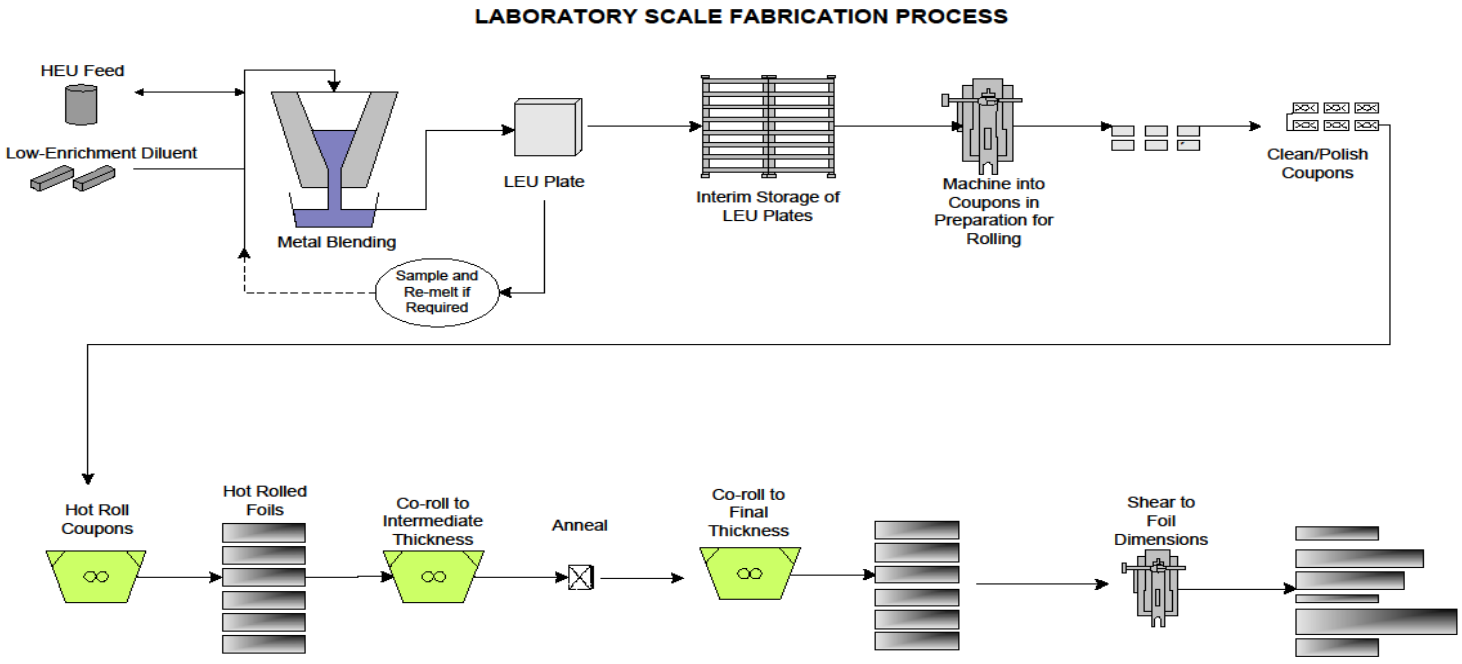
- Currently produce high fired ceramic grade U_3O_8 for High Flux Isotope Reactor (HFIR) for ORNL and NBSR
- Produced UO_2 for Slowpoke Reactor Conversion (Jamaica)

HFIR Fuel Element

Rolling and Forming of the U-Mo Foil Process

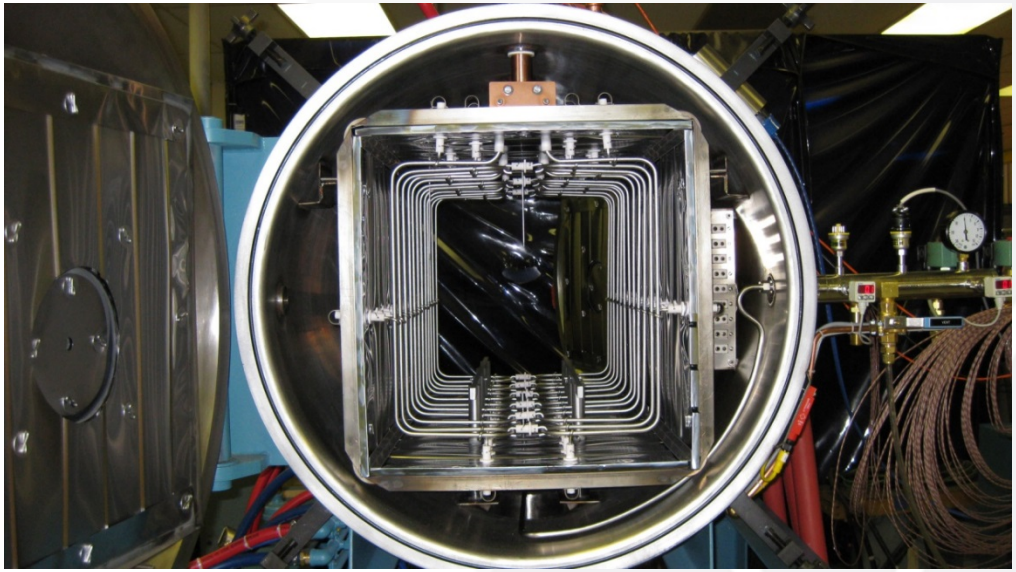


Foil Production Flowsheet



LEU-Foil Target Development & Manufacturing

Rolling Mill



Heat Treatment Furnace Development

Rolled foils (Bare)

112 µm thick foil

Target as Manufactured

Rolling Target Foil Lessons Learned

Target foil thickness is difficult to manufacture

- < 150 μm

U foil more difficult to roll than U/Mo

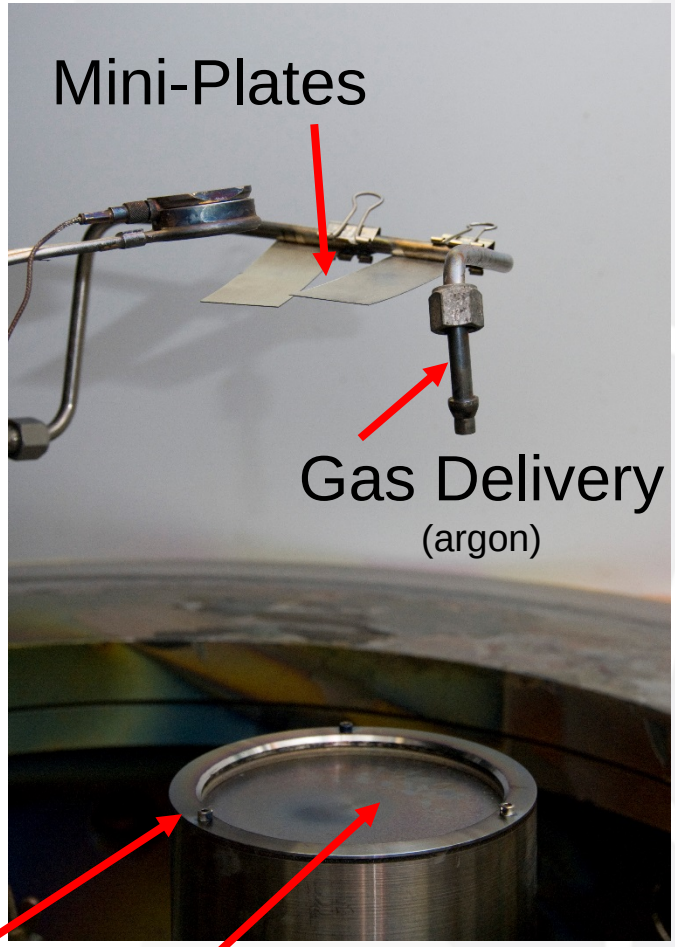
Heat Treat Anneals Necessary for desired thickness

- New Heat Treat Furnace Installed and Operational

100 μm foils are now possible.

Physical Vapor Deposition (PVD)

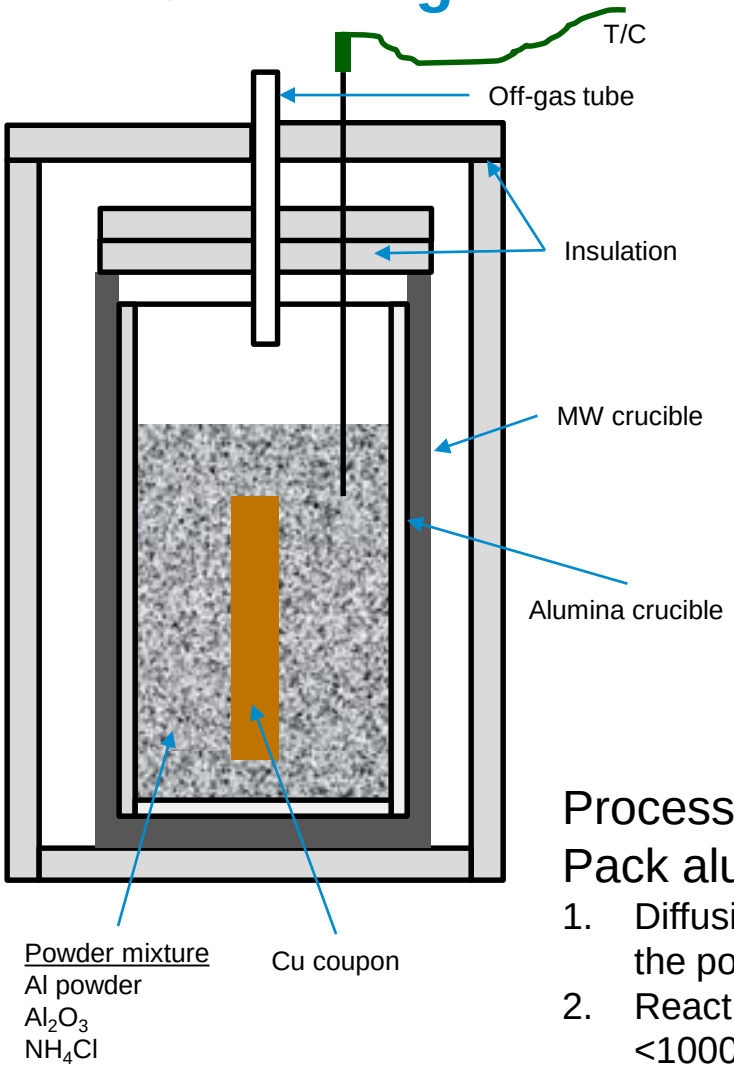
Bell Jar



Magnetron Sputter

Zr Metal Source

MW Aluminizing



FY18:

- Perform proof-of-concept test with Cu in MW
  - 2 different compositions:
    1. 5%Al, 93%Al_2O_3, 2%NH_4Cl
    2. 10%Al, 88%Al_2O_3, 2% NH_4Cl
    3. 800~900°C for 1 to 6 hrs
  - Perform optical metallography
    - Thickness & microstructure
  - Micro hardness testing

FY19:

- Perform in MW with DU coupons
- Repeat same tests and evaluations as with Cu

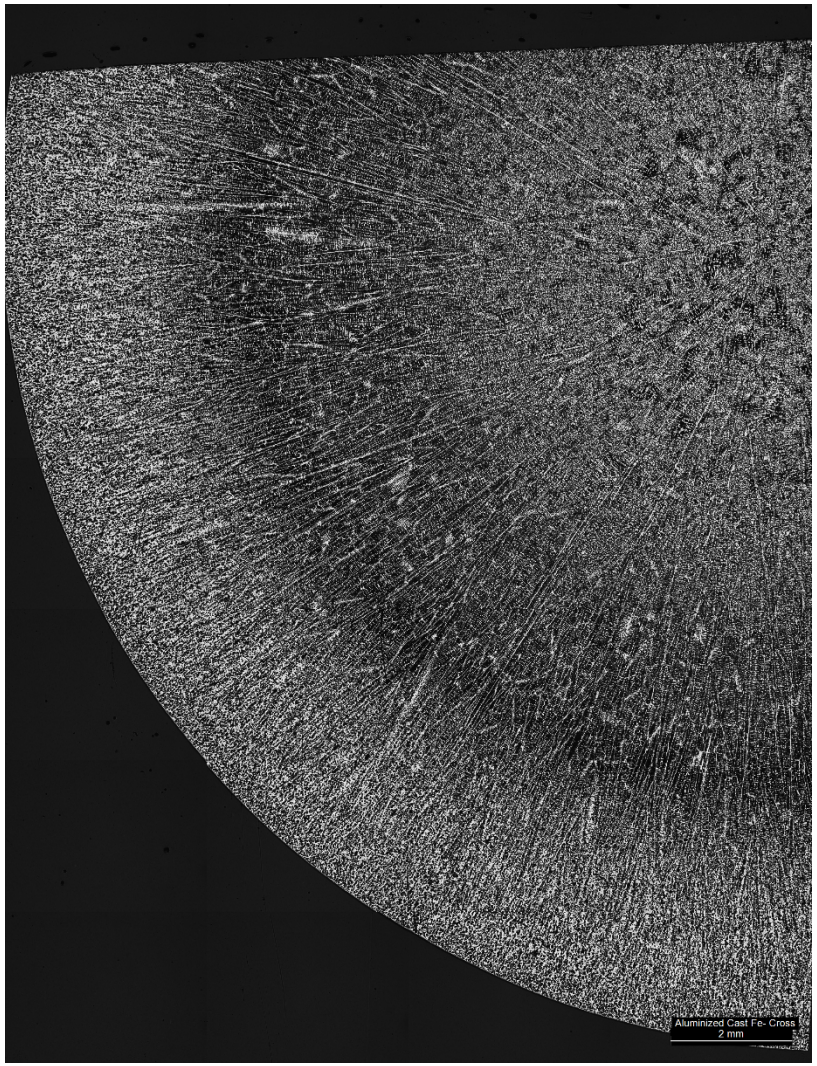
Process*:

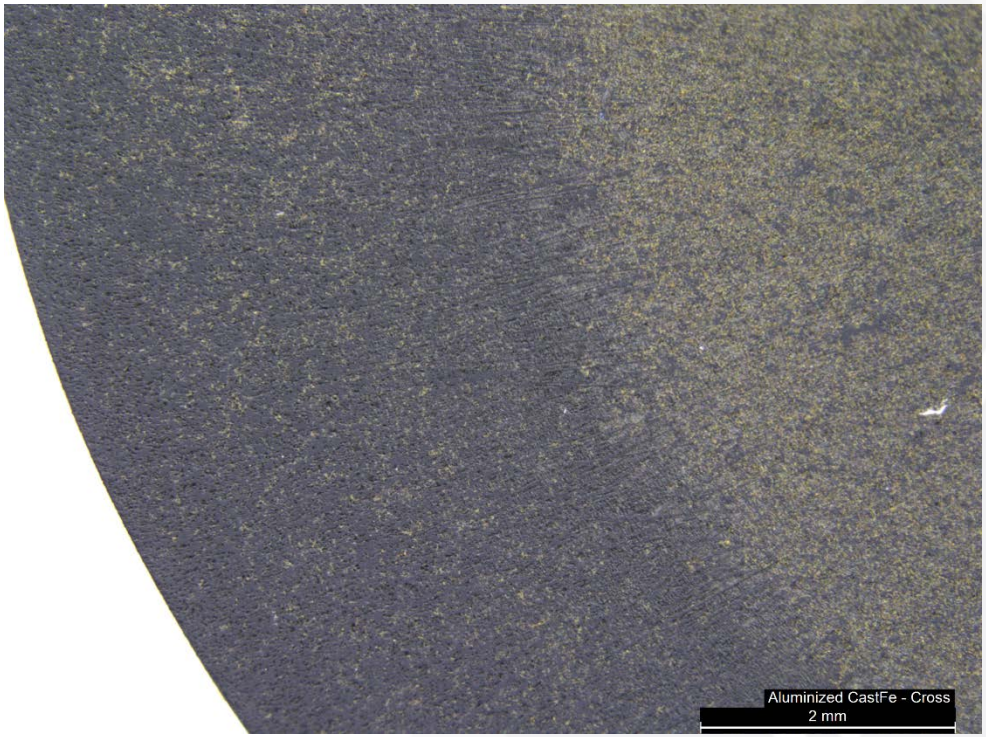
Pack aluminizing is a diffusion process

1. Diffusion of Al halides ($AlCl_3$, $AlCl_2$, AlCl) through the vapor phase in the porous pack medium
2. Reaction of Al halide $AlCl_2$ with the substrate at temperatures <1000°C
3. Diffusion of Al in the solid phase to form aluminide coating layer

* M.E. Abd El-Azim, et.al., “Pack Aluminizing of Copper” J. Mater. Sci. Technol., Vol. 13, 1997

Metallography (Cast Iron Aluminum Coating)





Additional Capabilities

- Swaging
- Annealing (Heat Treatment or In-Mold)
- Precision Machining
- Dimensional Inspection (CMM)
- Analytical Chemistry
- Metallography

TRANSPORTATION

- Numerous options exist for near-term U transportation packages including both Type A or B packages.
- Some packages may require minimal license amendments primarily for packing/insert design
- Long-term, efficient sipping options are dependent on foil packing requirements, configuration, & other limitations.

A Few Examples of Potential Transportation Options

Shipping Container	Shipping Container Type	Allowable Loading [1] (kg ^{235}U)	Equivalent Foils [2] (# foils)	Equivalent Slab *t* (inches)
TN-BGC1	**Fissile Type B**	**7**	**93**	**0.93**
ES3100	**Fissile Type B**	**17**	**227**	**2.27**
5X22	**Fissile Type B**	**9**	**--[3]**	**--[3]**
NNFD-10	**Fissile Type A**	**0.35**	**--[3]**	**--[3]**

1. **Allowable loading limits will vary depending upon the corresponding package Criticality Safety Index (CSI) and the desired mode of transportation.**
2. **Assumes stacked foils within primary container.**
3. **Package internal usable length will not allow stacking of full length foils.**

Questions ?