



Uranium Processing Facility Technology Maturation: Microwave Casting Lessons Learned

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This document has been reviewed and confirmed to be UNCLASSIFIED and contains no UCNI.

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FPD Bottom Line Up Front

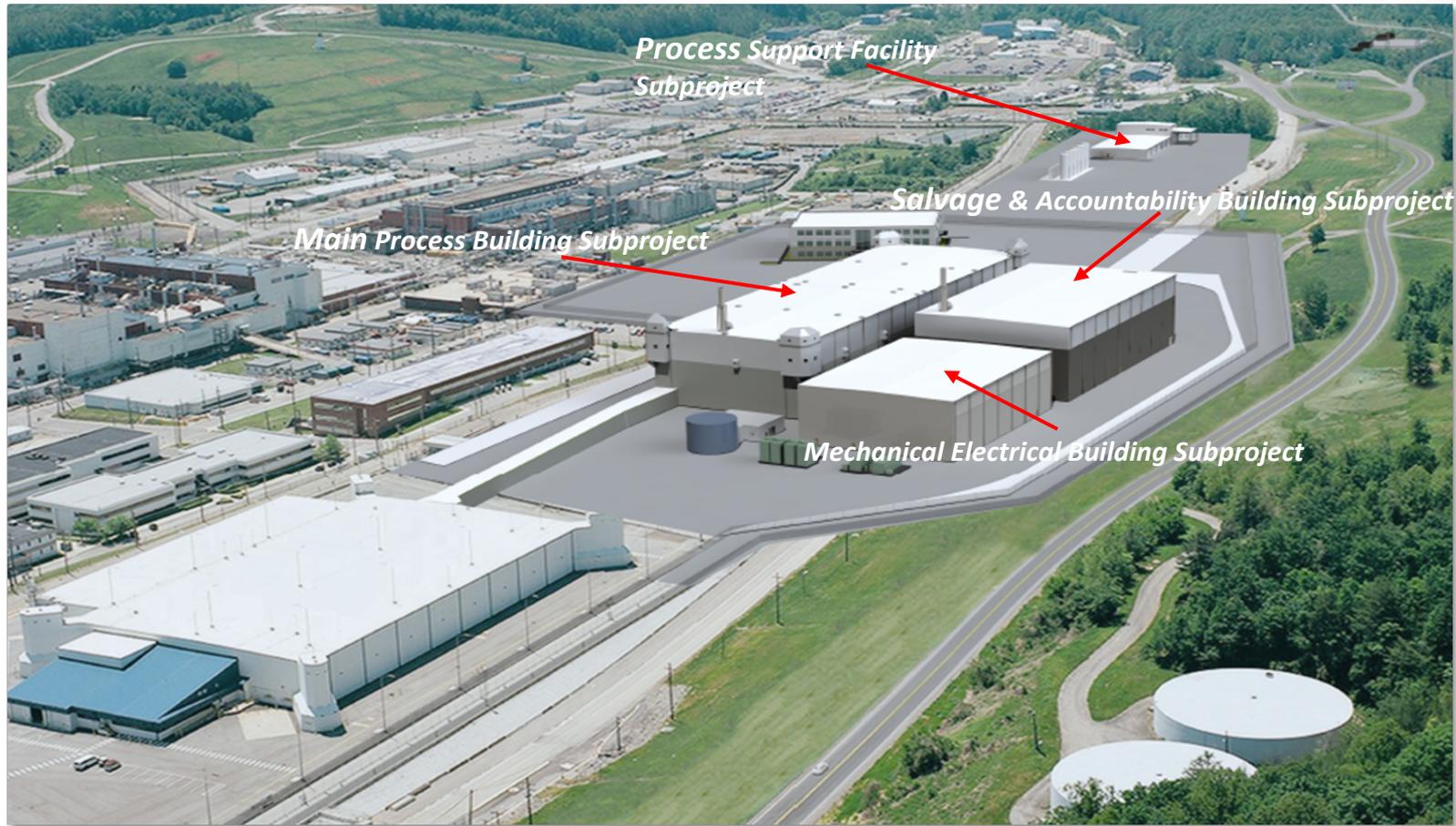
- **Timely investments in technology maturation minimizes both project and programmatic risk.**
- **Early planning is essential:**
 - Planning must start **PRIOR** to CD-1 and continue through CD-2.
 - Define clear roles and responsibilities between the organizations responsible for early technology development and the Project.
 - Determine a logical point during the technology development process for the Project to assume responsibility.
 - Early ownership by the Project reduces design risk and increases the probability of obtaining a timely and accurate project baseline.
 - Ensure adequate resources and funding for the technology development both on and off the project.
 - Logically link technology maturation scope performed by others (such as R&D) with the Project schedule.
- **Establish a dedicated team for technology development execution.**
- **Evaluate continued operations of full-scale prototype(s) after TRL-7.**



Sir Bananas

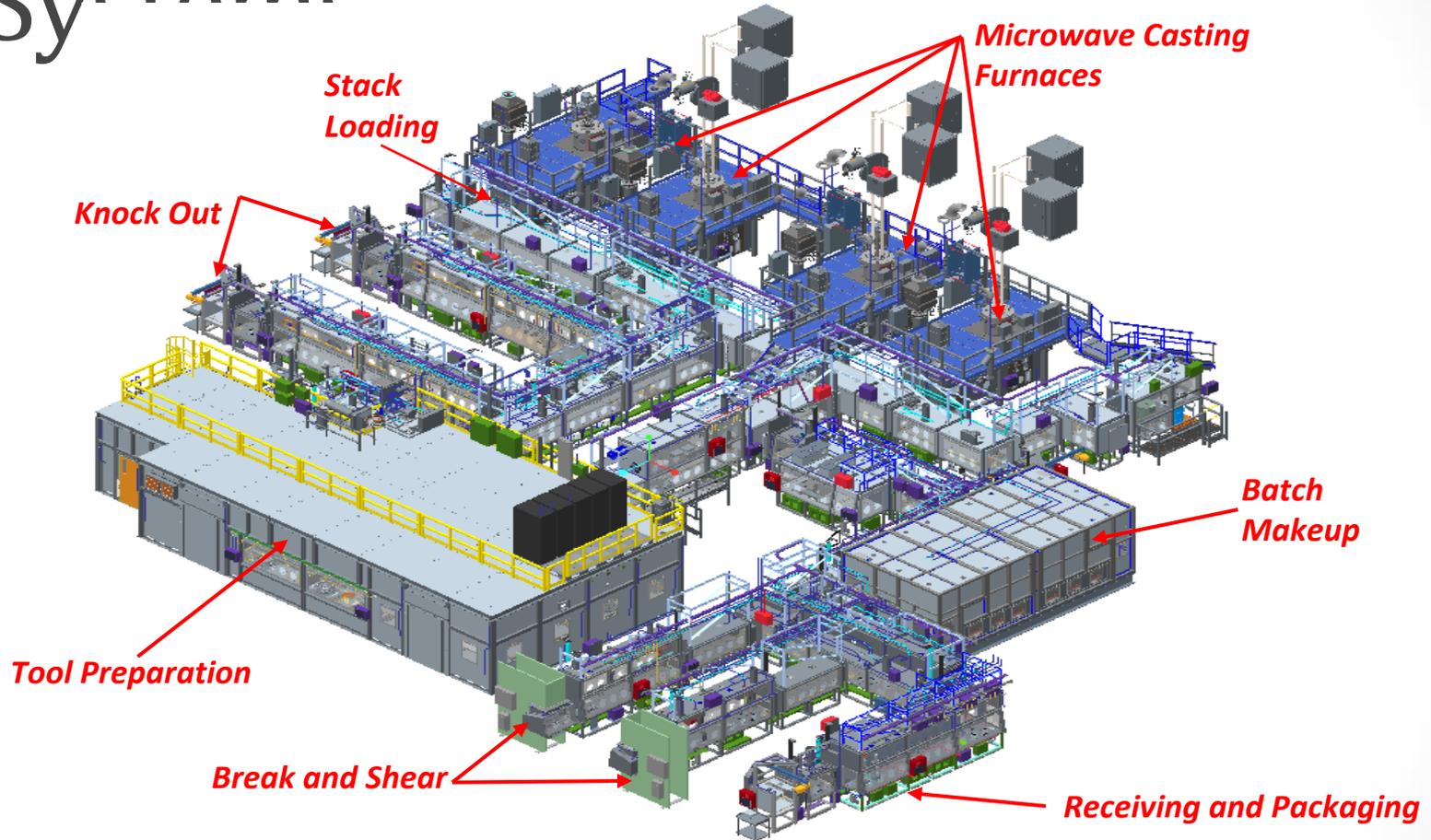
- Start early or suffer greatly
- Invest in technology development or you will end up eating termites without your favorite stick
- Make sure you have enough bananas before you start
- If you don't have well-defined roles and responsibilities, all you end up with is a lot of chest thumping and howling
- Assemble a good team...flingers, groomers, pickers, and singers

What is the UPF Project?



UPF supports phasing out of Building 9212 by the end 2025

Main Casting Glovebox Systems



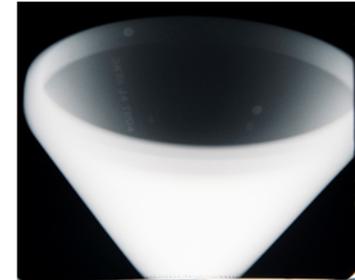
UPF Technology Maturation

- Demonstrated TRL-7 for all UPF Critical Technologies:
 - Microwave Casting
 - Calcination
 - Bulk Metal Oxidation
- Approved by Uranium Program Manager
- Met TRL-7 Requirements:
 - Full-scale prototypical system
 - Relevant operational environment
 - Depleted uranium (DU) as a representative simulant
- Microwave Casting Technology:
 - Established Technology Readiness Assessment Team, including Y-12, LANL, LLNL, and ORNL members
 - Completed extensive technology testing to defined acceptance criteria

Microwave Casting



Machined



Radiographed



Welded



MW Prototype

Microwave Casting History and TRL Requirements

- 2000s – Considered as an alternative to Vacuum Induction Melting (VIM).
- 2009 – First of five TRAs conducted. **Responsibility for TRA funding and execution resides off-project.**
- 2011 – DOE G413.3-4A: TRL-6 by CD-2 and TRL-7 by CD-3.
- 2013 – Decision made to deploy Microwave Casting on UPF.
- 2015 – NNSA directs UPF Contractor to obtain TRL-7 prior to CD-2. **Responsibility for funding and execution resides with the Project.**
- 2016 – DOE O 413.3B Chg2: TRL-7 prior to CD-2 for Major System Projects.
- 2017 – TRL-7 achieved. **Responsibility and operational control for full-scale prototype transferred off-project.** Program starts risk reduction activities.
- 2018 – UPF CD-2/3 approval obtained.
- 2022 – Planned use of prototype to support readiness preparation. **Labor funded by Project, but operational control of prototype remains off-project.**
- 2025 – UPF CD-4.

TRL-6 to 7: Full-Scale Prototype Testing

- Funded and executed by the Project. Effort cost approximately \$35M and took three years to complete.
- TRL-7 testing objectives:
 - Microwave performance – Throughput and temperature profile
 - Certified test object product evaluation – Machining, soundness, chemical impurities, chemical assay, density, and weldability
- Relevant operational environment included:
 - Microwave casting furnace
 - Human-machine interface
 - Operating platform
 - Glovebox enclosure with furnace loading area and cooling chamber
 - Automated pouring mechanism
 - Magnetic material transfer system and overhead crane
 - Recirculating argon system

Full-Scale Prototype: Furnace and Gloveboxes

Microwave Generators



Furnace-Loading Glovebox

Full-Scale Prototype: Operating Platform

Wave Guides



Furnace Chamber

Pre-CD-4 Programmatic Risk Reduction & Readiness Prep

- Business case supported continued use and operation of the full-scale prototype:
 - Reduces programmatic risk associated with achieving qualified products after CD-4
 - Project readiness preparation necessary to achieve CD-4
- Benefits:
 - Optimize operations
 - Identify tooling enhancements
 - Train craft workers and process engineers on full-scale system
 - Development of operating procedures
 - Evaluate waste streams

Recommended Technology Maturation Timeline

- **PRIOR to CD-1: Early Planning**

- Work with the Program to **MAXIMIZE** technology development scope.
- TRL-7 prior to CD-2 is required for a Major System Project. However, it is a best practice for all projects.
- Early Project responsibility for technology development reduces risk associated with design development and CD-2/3 approval.
- Preliminary Project Execution Plan, Technology Maturation Plan, and Design Management Plan:
 - Define clear roles and responsibilities between R&D and the Project.
 - Describe the plan for transitioning responsibility between R&D and the Project.
 - Define the relationship between technology maturation and design development.
- Schedule, cost, and funding documentation must clearly reflect the technology maturation scope necessary to reach CD-2 for **BOTH** Project and off-project organizations.

Recommended Technology Maturation Timeline (Cont.)

- **Between CD-1 and CD-2: Execute**
 - Charter a dedicated Project IPT to focus on technology development; include representatives from the Project, R&D, Program, Design Authority, Site Office, and Site Operator.
 - Charter a Technology Readiness Assessment (TRA) Team early. Conduct periodic mid-stream TRAs to measure TRL progress.
 - Maximize the investment on prototype and relevant operational environment when planning for TRL-7.
 - Logically link off-project development work into the Project Integrated Master Schedule. Focus on the key design development interfaces.
 - Develop a business case for continued use of the full-scale prototype(s) after TRL-7 and seek off-project funding as needed. Articulate the approach in the Project Execution Plan and Operational Release Plan.

Recommended Technology Maturation Timeline (Cont.)

- **Between CD-2 and CD-4: Conduct risk reduction and readiness preparation with full-scale prototype**
 - Optimize operations.
 - Conduct operator and system engineering training.
 - Write procedures.
- **Post CD-4: Implement Operational Release Plan**

Questions?