

**MPACT Annual Review Meeting
June 26-28, 2023**

Presented by Ammon Williams

Safeguards & Security by Design (SSBD) of an Electrefiner (ER)

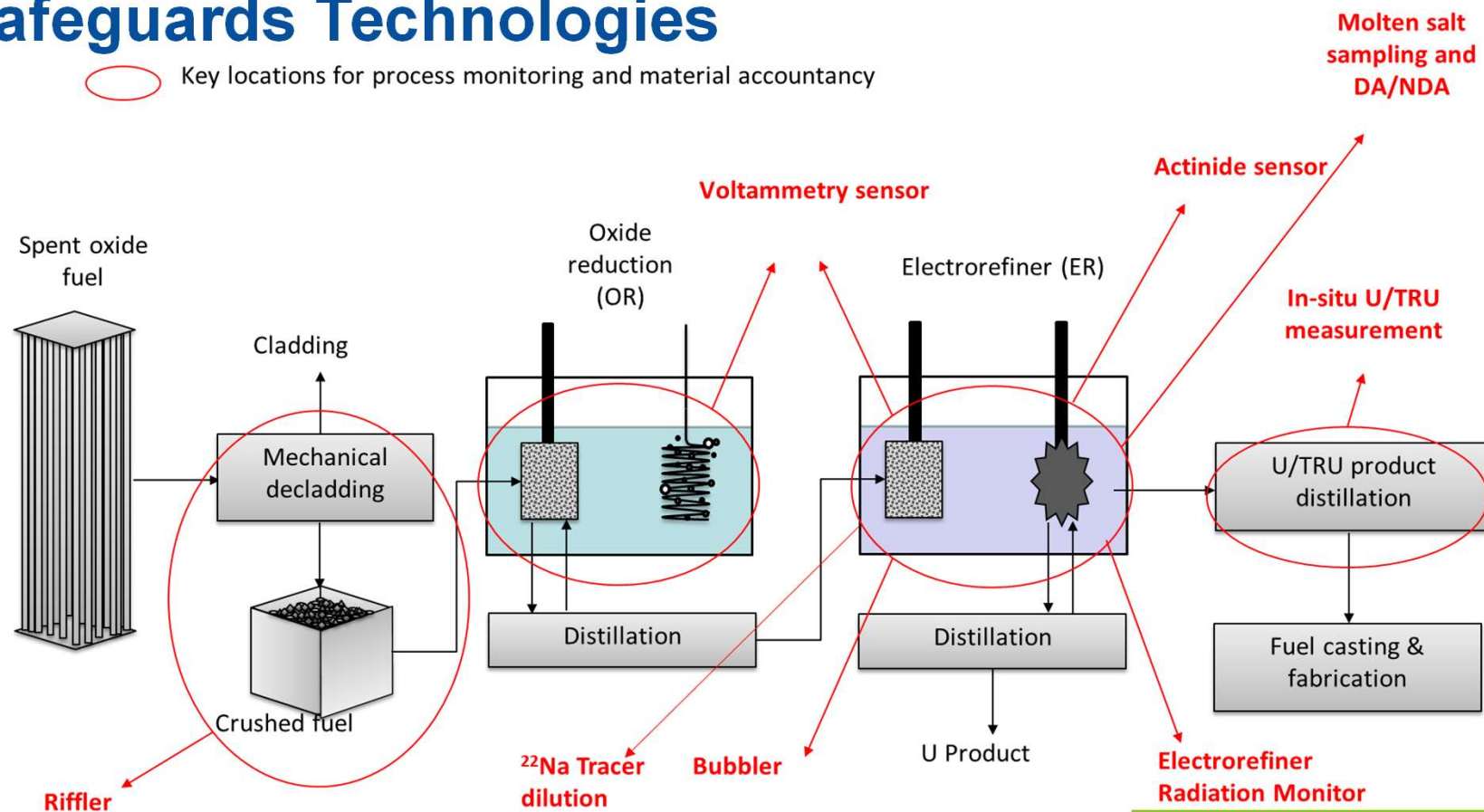
**Joint Project with MPACT & MRWFD in
collaboration with INL, SNL, ANL, & LANL**

INL/MIS-23-73138

Project Overview: FY23

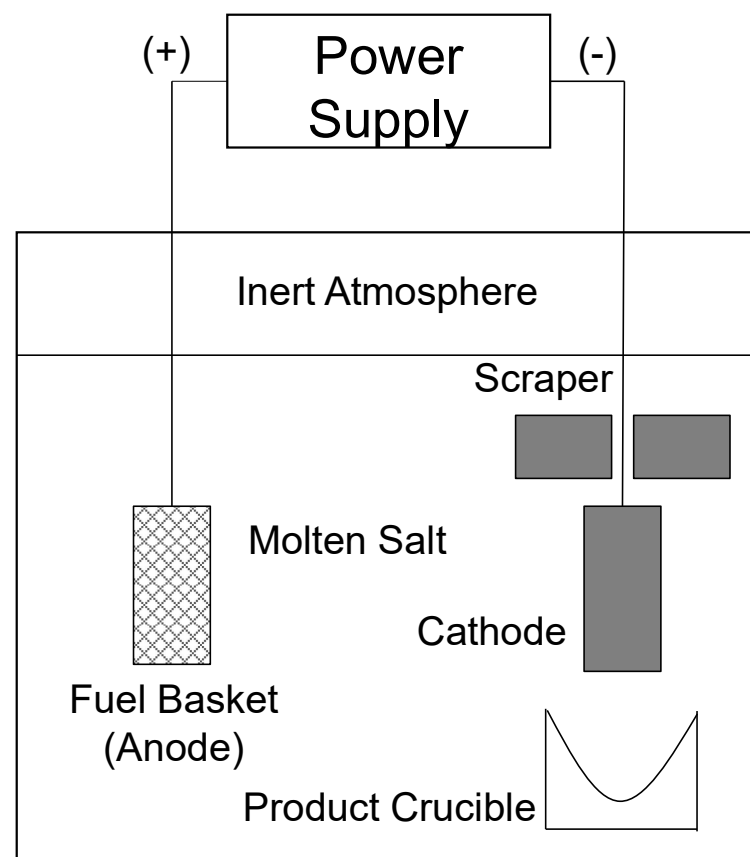
- **Scope:** MPACT and MRWFD have agreed to jointly perform a SSBD exercise on the redesign of an ER
- **FY23 Objectives:**
 1. Identify potential SSBD ER design elements based on previous work
 2. Incorporate elements into an ER redesign
 3. Evaluate process and domestic safeguards improvements from these design changes
- **FY23 Deliverables:**
 - **MPACT Milestone:** M3FT-23IN040103152-Preliminary SSBD Assessment of Electrochemical Fuel Reprocessing (*Due 9/30/2023*)
 - **MRWFD Milestone:** M3FT-23IN030401027-Develop technical and functional requirements for safeguards-by-design electrorefiner (*Completed on 5/15/2023*)

Introduction to Pyroprocessing: Approach & Safeguards Technologies



Typical ER Operation

- Metallic fuel loaded into an anode basket and submerged in LiCl-KCl- UCl_3 salt
- Current & voltage controlled via a power supply to drive U to the cathode
- Periodically U metal is scraped from the cathode into a product crucible
- Transuranic (TRU) material is removed occasionally in a U/TRU alloy
- Salt samples are acquired to monitor U and TRU concentrations



Objective 1: Identify potential ER design elements for SSBD

- In March 2023, representatives from INL, LANL, SNL, and ANL met to brainstorm aspects of current ER concepts and designs that could benefit from a SSBD evaluation on redesign.
- The meeting resulted in the identification of:
 - ~8 hardware related aspects that could benefit from SSBD
 - ~4 operational aspects that may improve safeguards
 - Developed a prioritized list for FY23



Objective 1 Results:

List of ER Features & Operation Modes for SSBD Design

Features

- **Load cells on ER components for mass tracking**
- **Access ports into the ER for safeguards instrumentation**
 - location, size, frequency, etc.
- Salt sampling
- Scraping mechanisms
- Electrode designs
- U/TRU extraction design
- Anode residues
- Radiation measurements (neutron/gamma)

Operations

- **Atmosphere & oxidation control**
- Product consolidation after OR and before ER
- Input accountancy
- U/TRU operations

MRWFD Milestone Results

- Developed a Functional and Operational Requirements (F&OR) document
 - Outlines the design space and required operation for the designed ER
- Similar F&OR to existing ERs
- Added descriptions of each of the SSBD aspects listed
 - Conceptual designs developed for some cases

Document ID: FOR-892
Revision ID: 0
Effective Date: 05/15/23

Functional and Operational Requirements

SAFEGUARDS-BY- DESIGN ELECTROREFINER

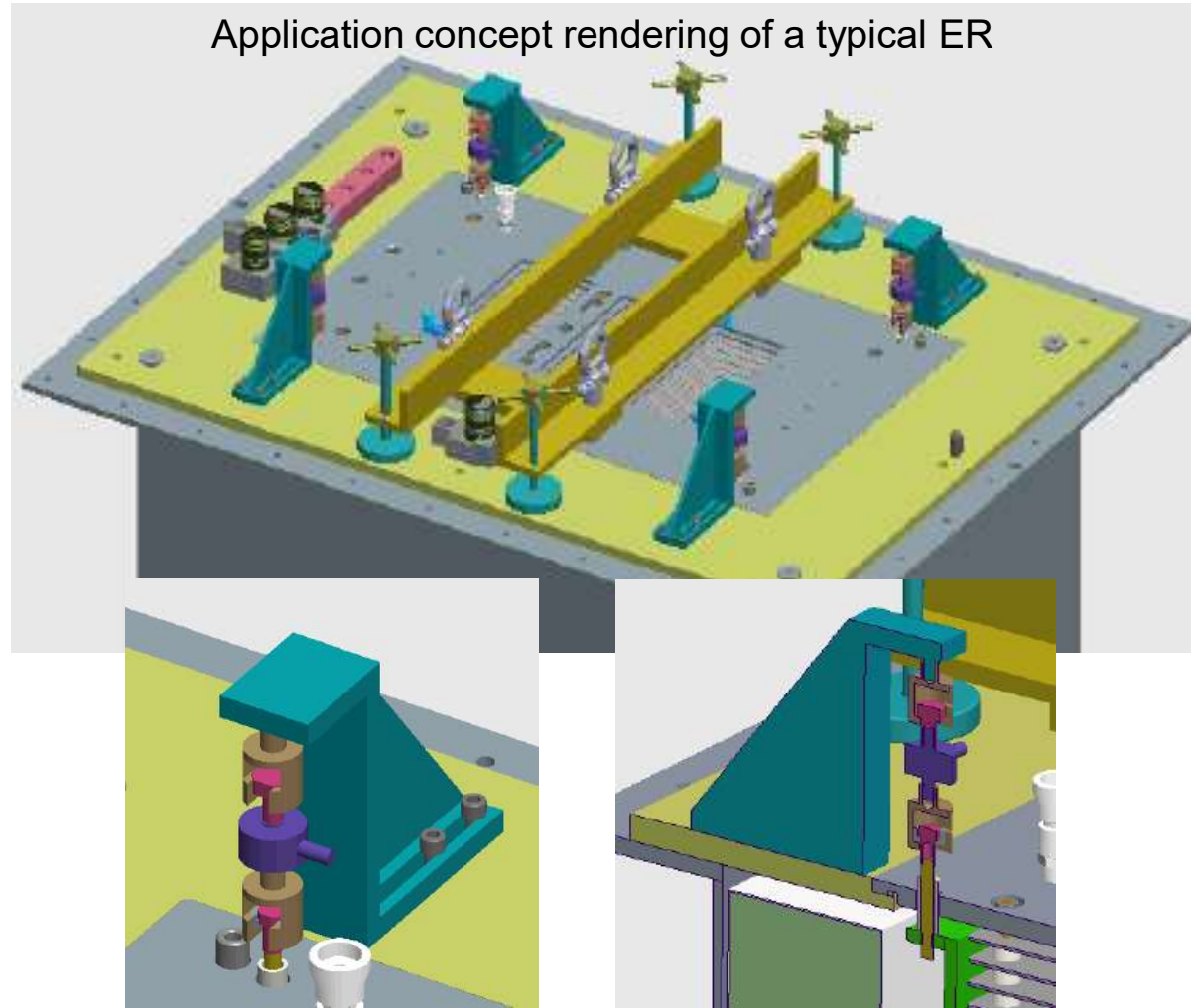


The INL is a U.S. Department of Energy National Laboratory
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Crucible Load Cells

- Ability to track the total mass of material in the ER
- Four load cells
 - One on each corner
- Passes through the head plate (supporting equipment) and attaches directly to the crucible
- Maintenance operations to replace individual load cells possible
- Will require an algorithm to monitor all four load cells and generate a single mass number

Application concept rendering of a typical ER



Remaining Focus for FY23

- Explore & potentially draft a Fundamental Nuclear Material Control (FNMC) Plan for an ER
 - Engage with SMEs with experience writing FNMCs
 - Generic or SPYRE ER?
- Continue to work with MRWFD group to design hardware concepts that can improve safeguards
 - Access ports and instrumentation
 - Atmosphere control
- Perform an evaluation of the improvements from the design changes

Scope for FY24?

- Continue working on FY23 hardware design aspects to improve safeguards or select additional hardware features to focus on from the generated list
- Look more in-depth at operational aspects of the ER that could improve safeguards

Questions?



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