

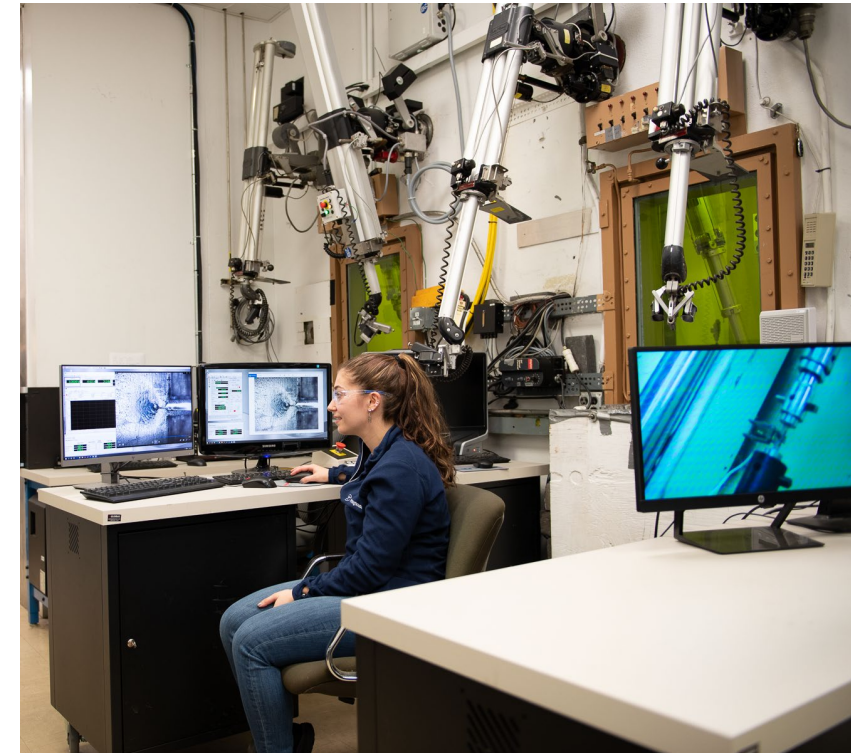
NSUF Collaboration at Westinghouse: *Capabilities and Highlights*

Catou Cmar – *Senior Materials Engineer, NSUF Technical Lead*

NSUF Annual Program Review 2025

Introduction

- Catherine “Catou” Cmar
- Senior Materials Engineer at the Westinghouse Churchill Site
 - B.S. in Chemical Engineering and pursuing M.S. in Materials Science and Engineering (<2 weeks from graduation!)
 - 6 years of industry experience – focus on degradation of materials in nuclear environments
 - Materials research and innovation
 - Failure analysis
 - Hot cell and hands-on radiological facility
 - Standard and miniature sized sample preparation
 - Specialty/ unique irradiated materials testing
 - Microscopy analysis
- NSUF Technical Lead for Westinghouse since 2023



Westinghouse Churchill Site

- Testing and research capabilities in support of operating plants, innovation activities, advanced reactor design, and advanced fuel and cladding development
- 36 different laboratory areas in two primary buildings
- Supported by 60+ Westinghouse employees
- 6 hot cells
- Extensive collection of materials irradiated in light water reactors



Westinghouse's NSUF Partnership

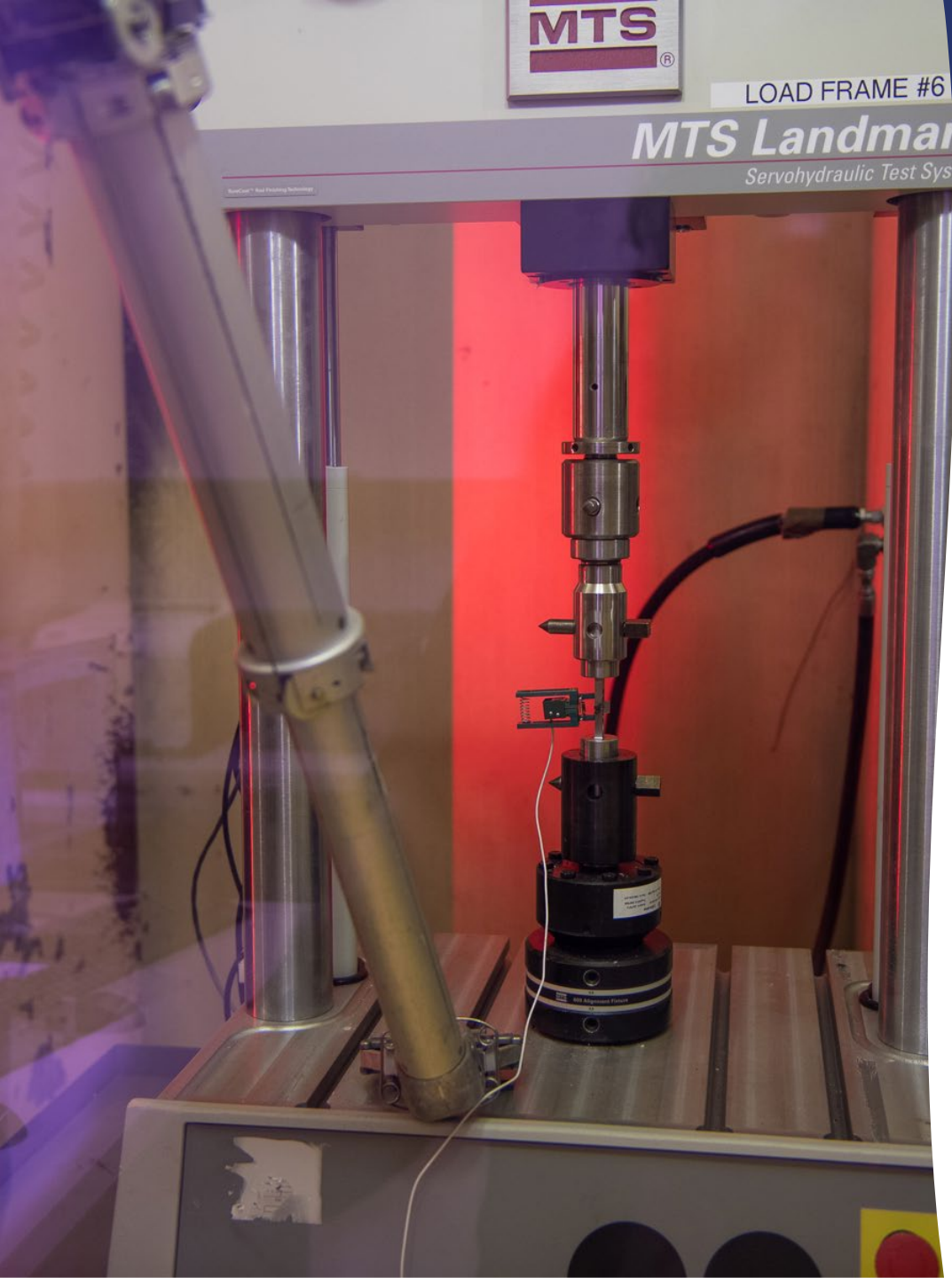
- Partner facility since 2019
- Only industry partner
- Enables us to leverage decades of expertise in research, innovation, testing, and evaluation of irradiated materials
 - Knowledge, experience, and materials
- Store thousands of irradiated specimens at our facility
 - Some of these are part of the NSUF library, others are owned by various entities that are open to the idea of collaboration on research
- Various hot cells – each with their own specialty
- Extensive radioactive material characterization techniques

Hot Cell Overview

High Level	Low Level	A	M	Shielded Box	Clean
Machining (lathe, mill, CNC), photography, ultrasonic measurements	Multi-functional and routinely reconfigured, some testing includes Charpy, tensile, light optical microscopy, immersion density	Multi-functional, tasks such as hydrogen analysis, laser welding	Multi-functional, metallographic sample mounting, grinding, polishing, etching, CNC machining	Small multiple use work area, currently has a VHX-5000 Keyence light optical microscope	Provides irradiation services for R&D and for equipment qualification, sealed Co-60 source

Level of shielding and contamination decreases, and typical flow of samples

Multi-functional and routinely reconfigured to meet customer needs

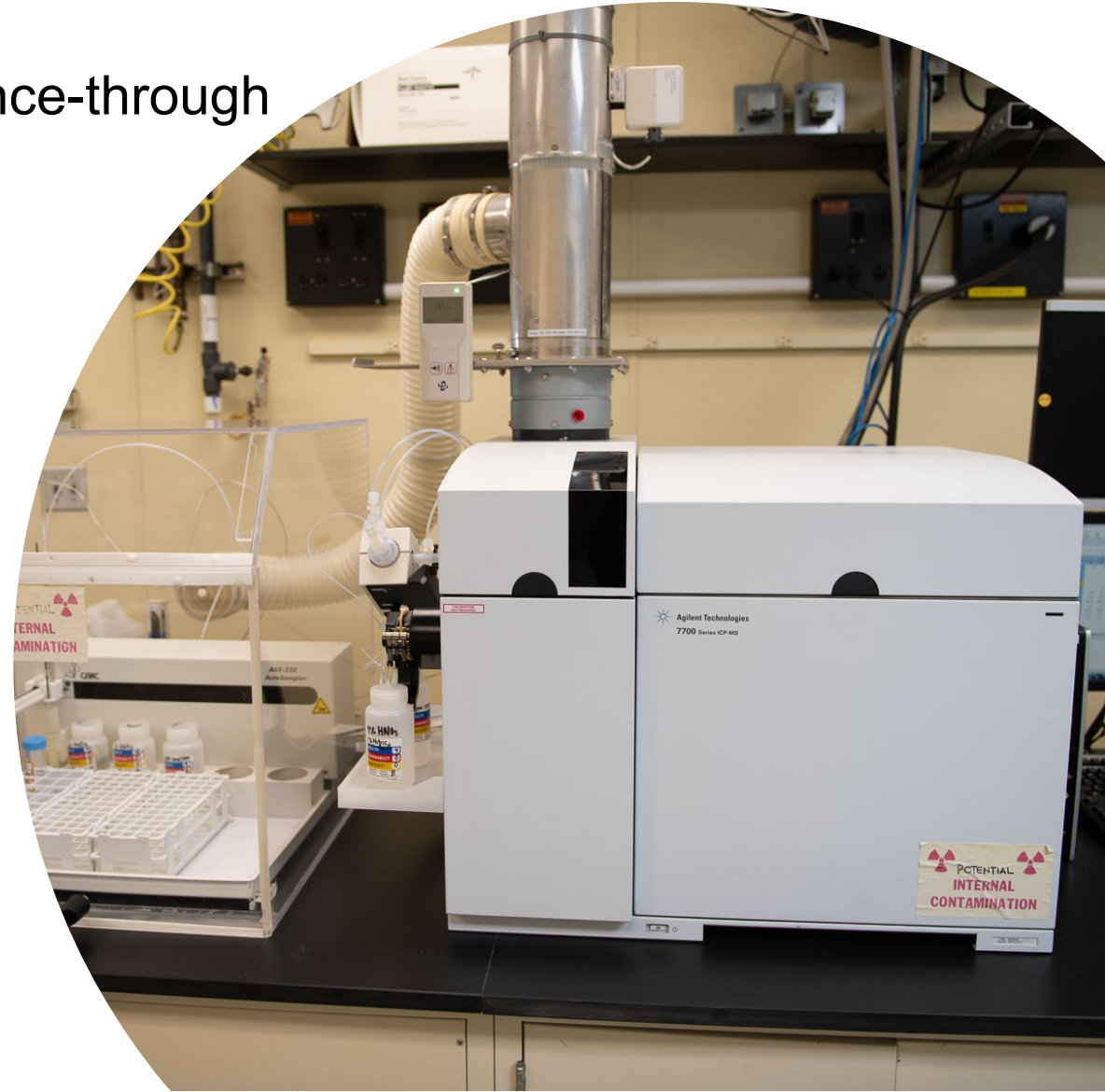


Radioactive Materials Characterization

- SEM hot cell (Tescan Vega-3 XMU SEM)
- Contaminated SEM/FIB with EDS/EBSD capabilities (Tescan Lyra GMU dual beam FIB/SEM)
 - 3D-FIB tomography
- Ex-situ Lift Out
- TEM (FEI Talos F200X)
- Mechanical testing
 - Charpy impact, 250 kN load frame, 98 kN load frame with environmental chamber, DIC, and video extensometer
 - Standard size and miniature sample testing
- X-ray diffraction

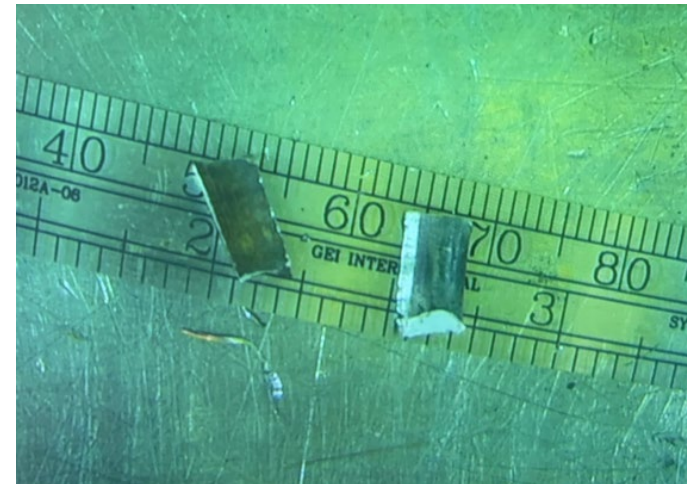
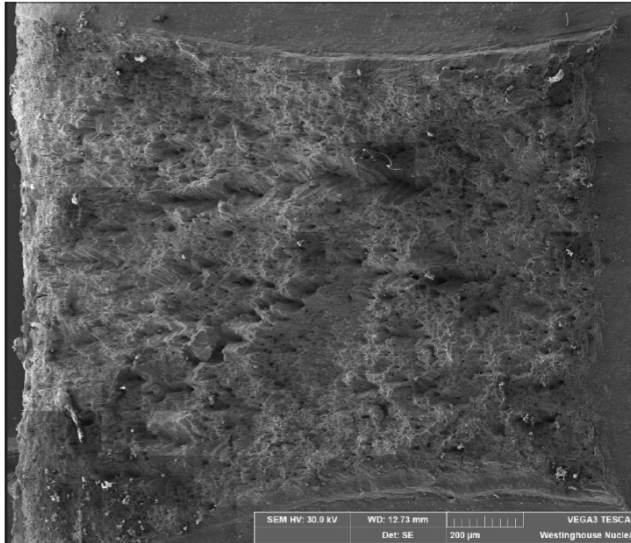
Radioactive Materials Characterization

- Warm autoclaves
 - Two 2-gallon autoclaves (recirculation or once-through modes)
- Hardness and microhardness
- Hot machine shop
- Non-Destructive Examinations
- Radioactive chemistry analysis
 - ICP-QQQ-MS
 - ICP-OES
 - Anion and Cation IC
 - TGA
 - Autotitration
 - Hydrogen analysis
 - Combustion C/S analysis
 - FTIR and IR microscopy
- In-cell immersion density equipment
- Library of Irradiated Material



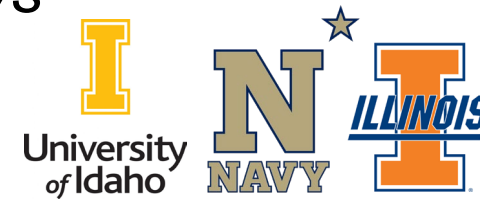
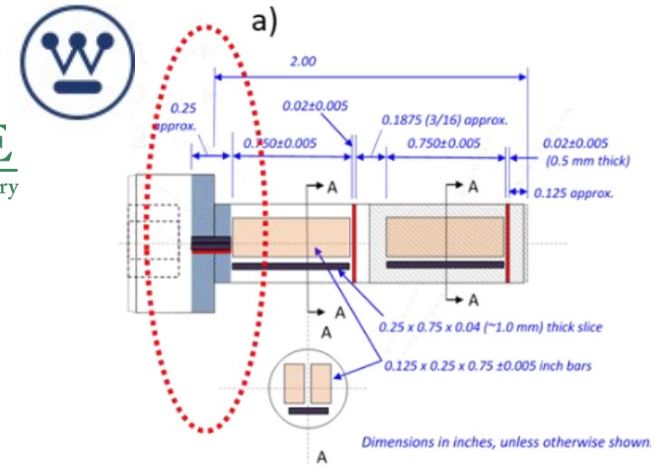
Past Project Highlight – WEC's Role

- CINR 23-29009: *Investigation of intergranular cracking of highly irradiated austenitic stainless steels in ambient conditions*
 - Hot cell SEM to image the fracture faces
 - In-cell magnetic measurements to determine ferrite content
 - Machining of materials stored at WEC; baffle plate and thimble tubes (thin wall tubes)



Upcoming NSUF PIE at Churchill

- Super RTE 24-5016: *Detailed characterization of in-service IASCC in 316 and 347 stainless steel baffle-former bolts*
 - Precision machining of baffle-former bolts
 - Interested in the region where the head meets the shank of the bolt
 - 1 mm slice with minimum disruption to oxide
- Super RTE 24-5069: *Influence of laser welding on deformation mechanisms in irradiated and weld-repaired Ni-Cr alloys*
 - Sample preparation in high-level cell
 - Non-irradiated mockups
 - Laser welding irradiated samples together in the A cell
- Super RTE 24-5082: *Interactions between Neutron Irradiation and Oxide Based Inclusions in Additively Manufactured Austenitic Stainless Steels*
 - TEM disc sample preparation from ends of tested tensiles
 - TEM analysis to characterize samples at the nano-scale



Maximize characterization of irradiated samples





Thank you for your attention!

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Catou's Virtual Business Card

