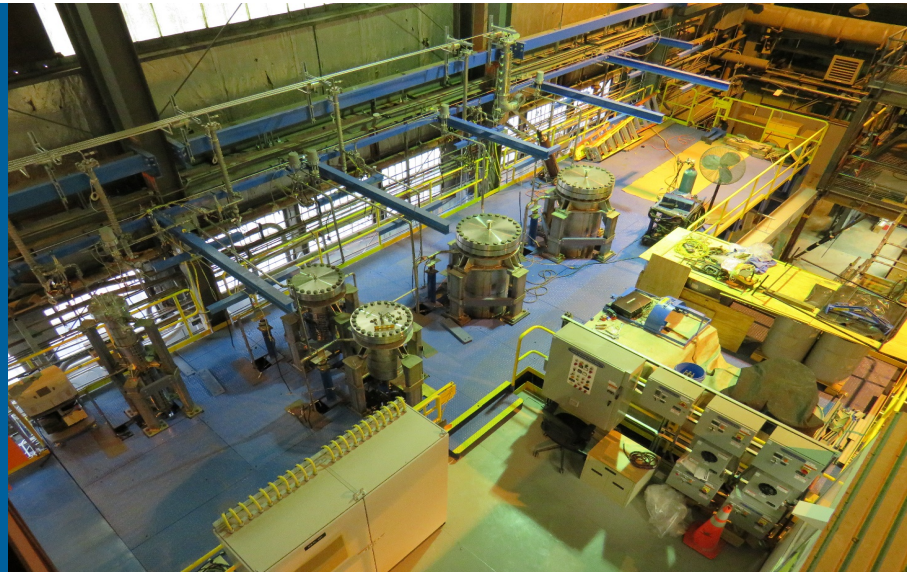
SODIUM TECHNOLOGY INFRASTRUCTURE



DAVE GRABASKAS

ARGONNE NATIONAL LABORATORY

March 26, 2019
Fast Reactor Technology Training
U.S. Nuclear Regulatory Commission

ANL INFRASTRUCTURE

Major testing programs

- Materials R&D – fuels, cladding, and structural materials
- Sensors and I&C
- Advanced systems and components testing
- Fuel cycle R&D (including used fuel)

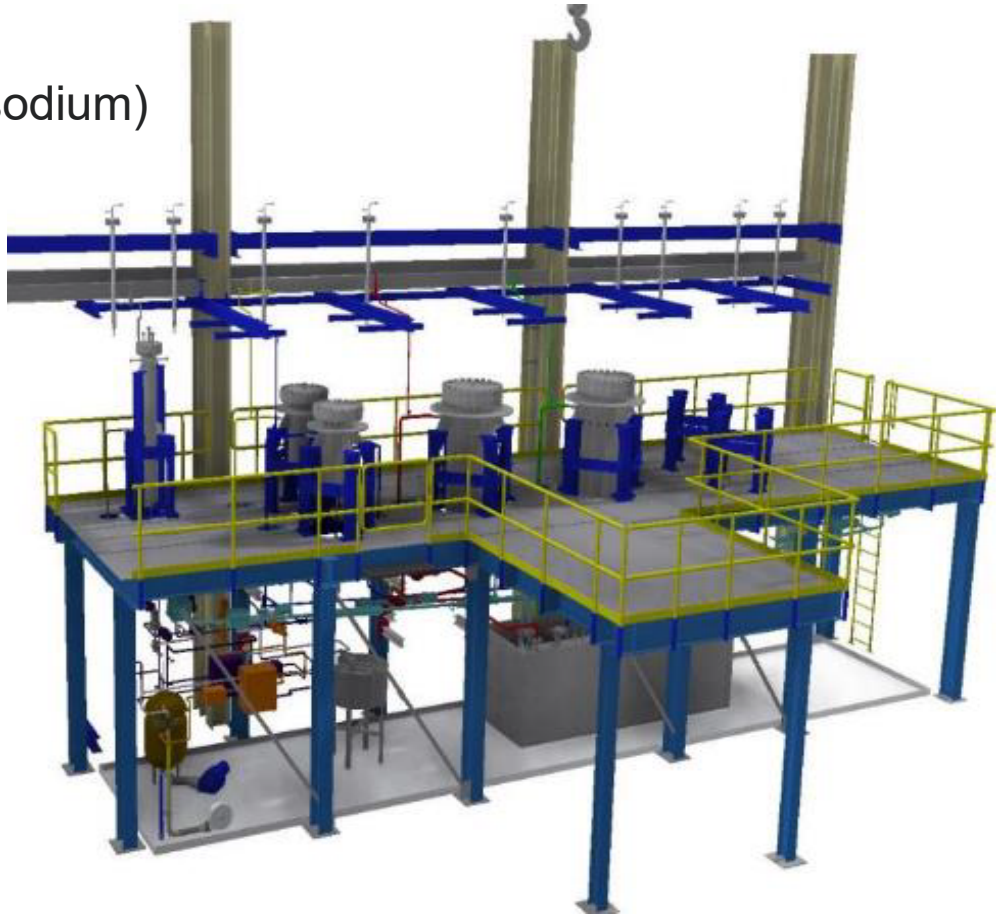
Major Facilities

- Mechanisms Engineering Test Loop (METL)
- NSTF
- IVEM-Tandem
- Materials Research Labs
- Engineering Development Labs
- Inspection technology R&D
- Fuels development workshop
- Irradiated materials laboratory (IML)

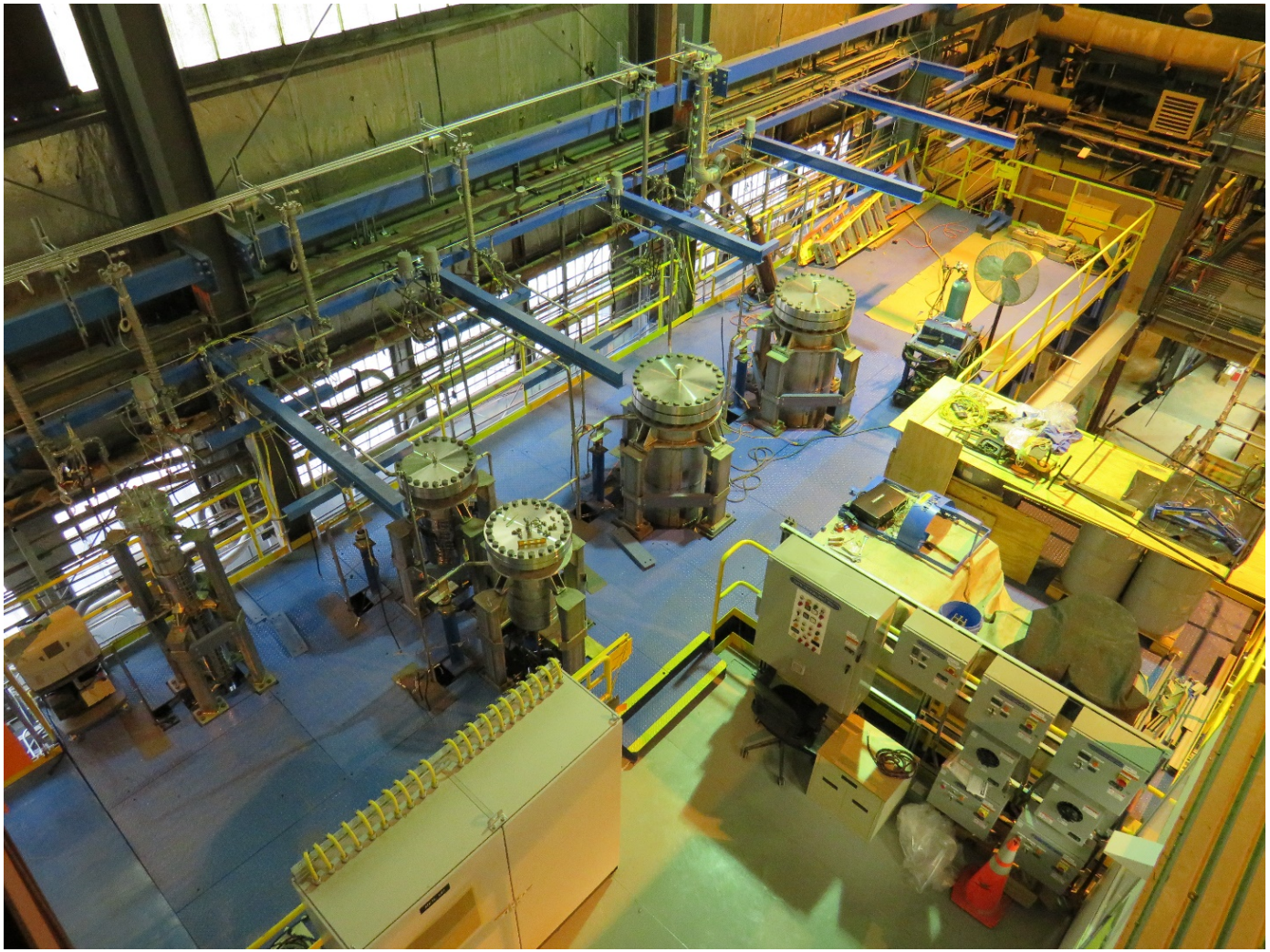
MECHANISMS ENGINEERING TEST LABORATORY (METL)

Largest operating sodium test loop in the U.S.

- Four Test Vessels (18 and 28 inch)
- Dump Tank (750 gallons of R-grade sodium)
- Expansion Tank
- Purification System
- Plugging meter
- Vapor trap
- Inert gas system
- Sodium Valves
- Connected piping system
- Mezzanine
- Catchpan
- Heat Tracing
- Heater and Valve control cabinets
- Instrumentation and Control
- 530°C rated operation (650°C in large test vessels)



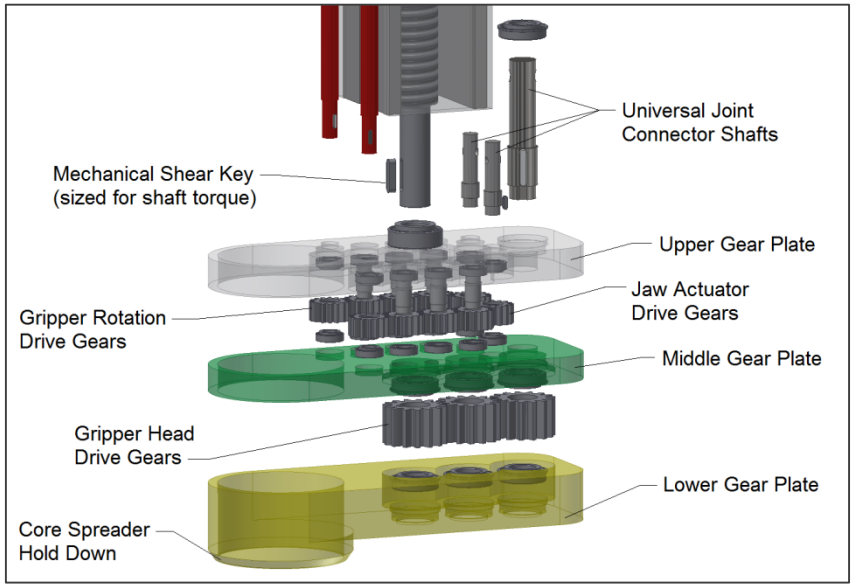
MECHANISMS ENGINEERING TEST LABORATORY (METL)



MECHANISMS ENGINEERING TEST LABORATORY (METL)

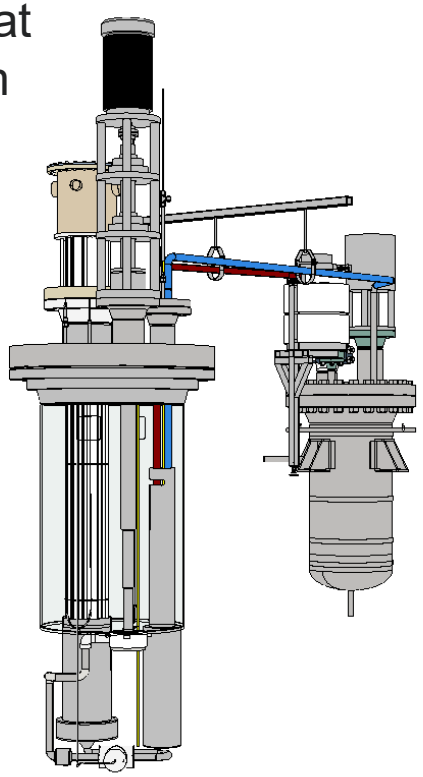
GEAR TEST ASSEMBLY

- Information on how gears will work in sodium under prototypic loads
- Supports the advanced fuel handling system development
- First test article in METL



TH TEST ARTICLE

- Thermal tests in 28” and 18” test vessels to simulate SFR primary heat transport system and natural circulation

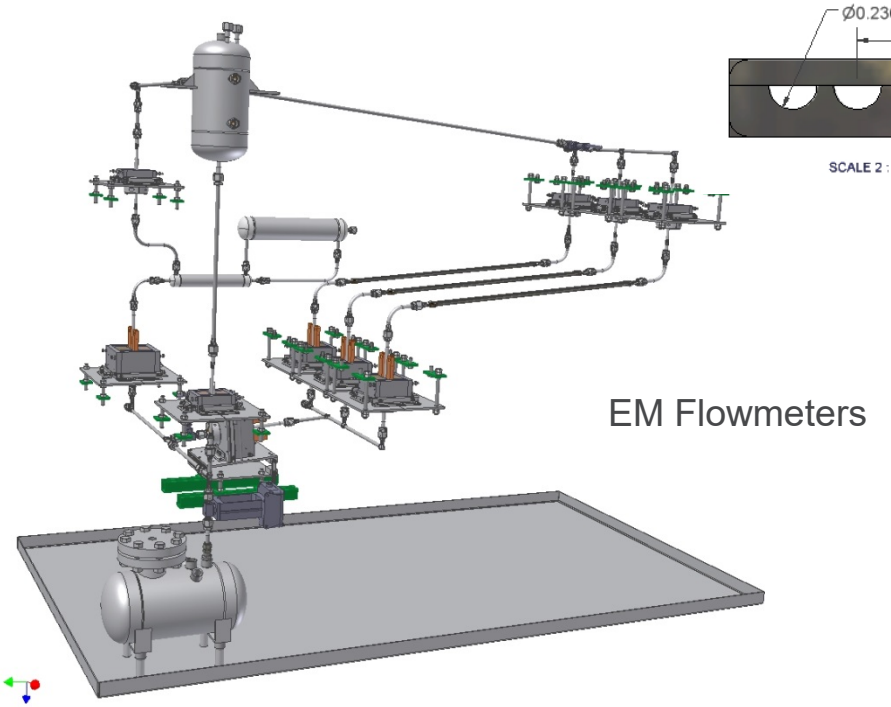


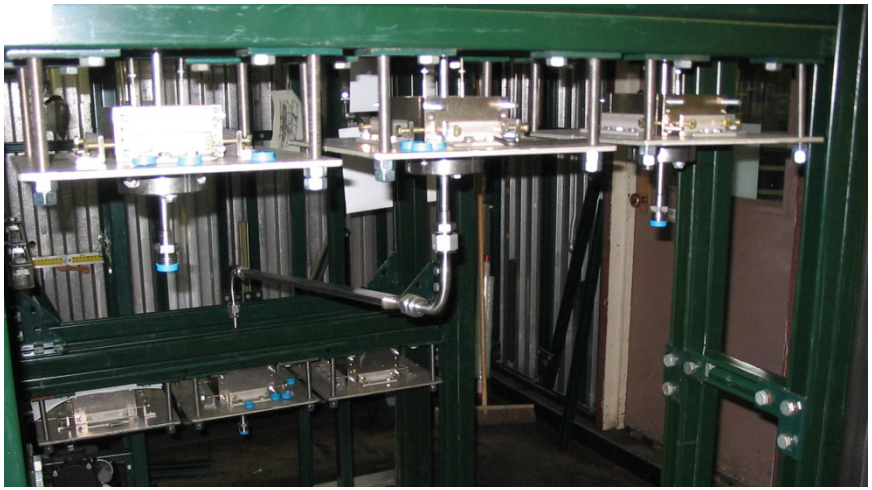
SNAKE (S-CO2 NA KINETICS EXPERIMENT)

- For studying chemical interactions between liquid sodium and S-CO_2 for Brayton-cycle energy conversion applications
- Successfully detected chemical reactions (generation of heat, CO, and solid products) at low temperature
- Ongoing experiment & modeling to study impact of temperature, pressure, interaction time, gas mixtures, etc.

SODIUM PLUGGING TESTS

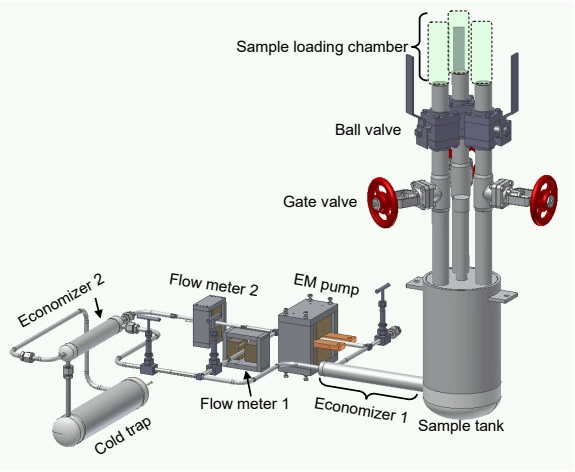
- Facility to investigate the potential for sodium plugging in the small (few mm diameter) flow channels of the PCHEs considered for S-CO_2 Brayton-cycle power conversion systems

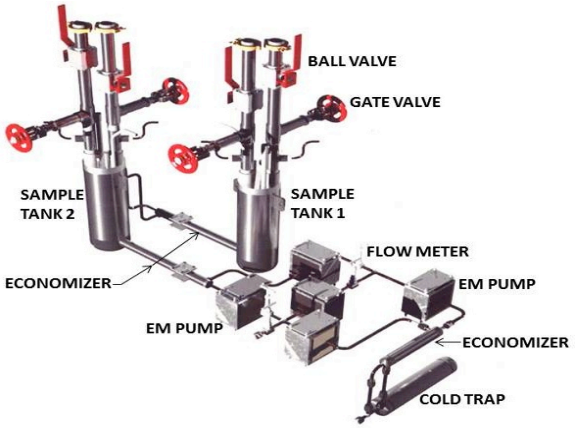


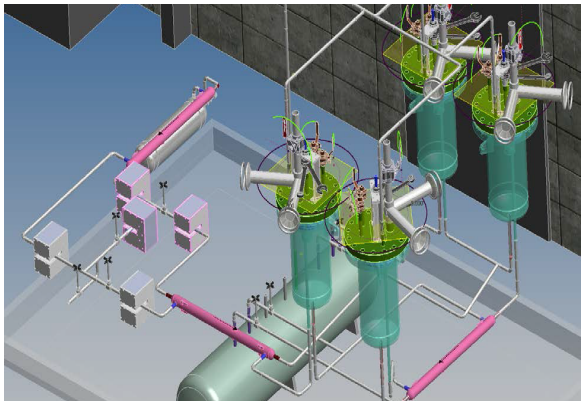


SODIUM MATERIALS TESTING LOOPS

- Two forced-convection sodium materials testing loops with controlled oxygen contents for studies of corrosion and its effect on tensile properties of advanced alloys in sodium (using subsized specimens)
- A new forced-convection sodium materials testing loop for studies of sodium effects on creep, fatigue, and creep-fatigue properties (using ASTM-standard sized specimens)
- Temperature rating for 700C







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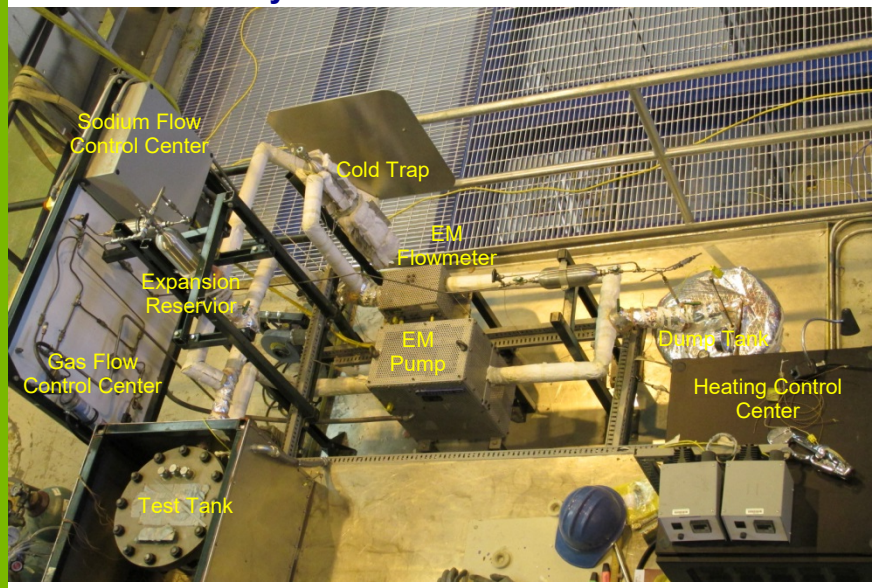
ULTRASONIC WAVEGUIDE TECHNIQUE FOR UNDER SODIUM VIEWING (USV)

USV Test Facility



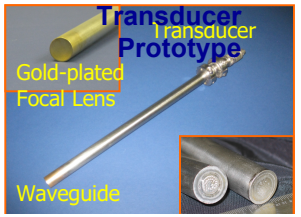
The Challenges

- Opaque coolant (molten sodium)
- Hostile Environments (high temperature, highly corrosive, high-level radiation)

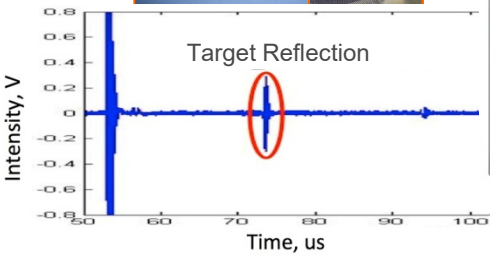
UWT Advantages

- Suitable for opaque media such as liquid metals
- Applicable to high-temperature, corrosive, and radioactive media
- Real-time and in-situ non-destructive evaluation
- Maximize the signal to noise ratio
- Minimize the waveguide attenuation
- Create a clear window to detect target reflection
- Demonstrated resolution: 0.5mm in depth and lateral

Ultrasonic Waveguide Transducer Prototype

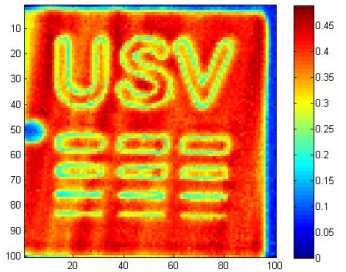


Ultrasonic Waveguide Phased

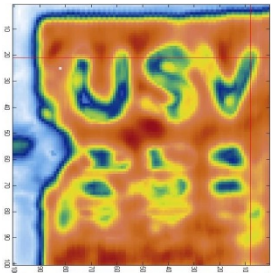


Crack Detection

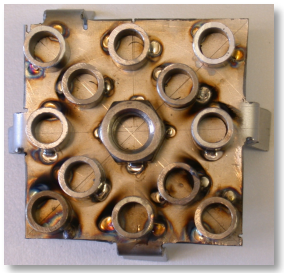
Water Test



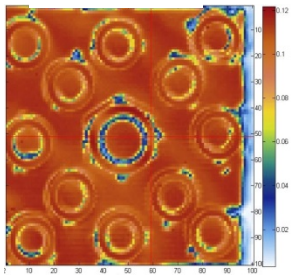
Sodium Test (350 °F)



Component Identification



Water Test



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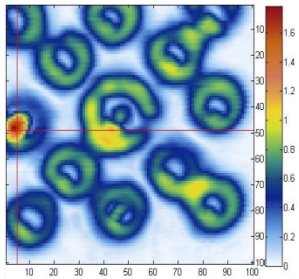
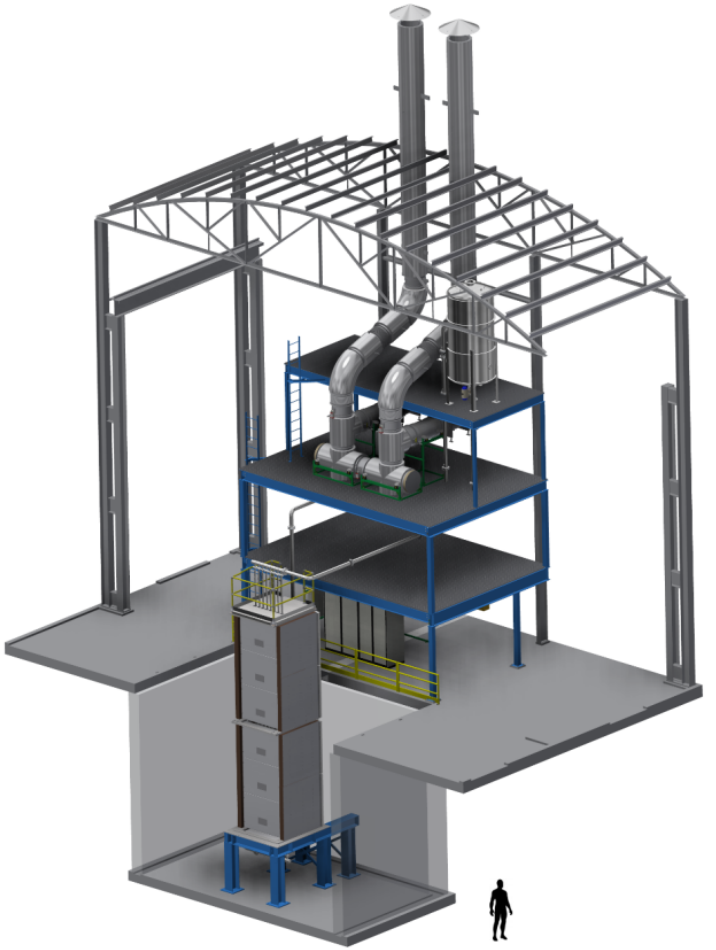


ALKALI METAL PASSIVATION FACILITY

- To test small or intermediate scale advanced liquid metal components to develop and provide performance data on components used in sodium and reduce the risk of failures during reactor plant operations
- Protected by an alkali metal passivation booth with permitted treatment rates for 300 lbs/hr – normal and 600 lbs/hr in emergency (30,000 scfm scrubber blower capacity)

NATURAL CONVECTION SHUTDOWN HEAT REMOVAL TEST FACILITY (NSTF)

- Air- and water-cooled RCCS and RVACS testing facility to examine passive safety features of deca heat removal systems
  - Facility with flexibility to provide tests at multiple scales (½, ¼) for both air and water designs
- Current configuration reflects a ½ axial scale and 12.5° sector model of a full scale water-based RCCS concept
  - Facility height of 18 m (59-ft); heated length of 6.7 m (22-ft)
  - Operating modes of natural or forced
  - 4,260 liter water storage tank
  - H/D ratio of 2.0
  - ASME Sec. VII Div 1; rated at 2 bar over pressure



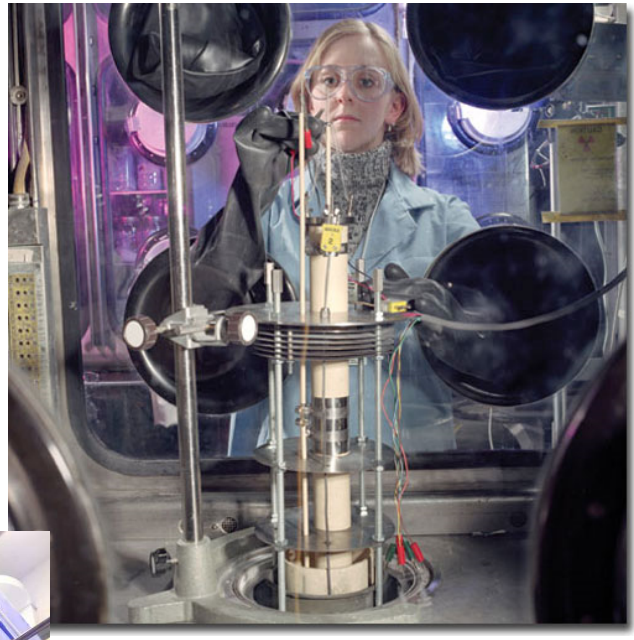
QUESTIONS?

BACKUP SLIDES

ELECTROCHEMICAL R&D FACILITIES

Engineering-scale electrorefining facility for demonstrating electrochemical separations

Evaluating oxide to metal conversion process



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TRANSURANIC FACILITY FOR SEPARATIONS PROCESS DEVELOPMENT

Researcher retrieving samples from electrochemical cell tests

Researchers reviewing data from in situ process monitoring tests for electrochemical process development

Researcher preparing new centrifugal contactor bank for use in aqueous separations process evaluation

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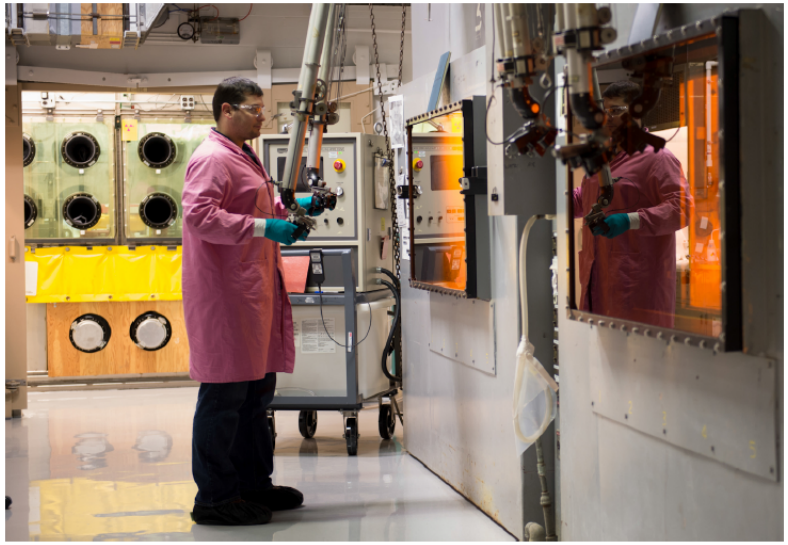
IRRADIATED MATERIALS LABORATORY (IML)

- Four beta-gamma hot cells and the glove boxes for fuel cladding, pressure vessels, and other in-reactor component research to determine mechanical properties degradation mechanisms due to long-time operation in corrosive and irradiation environments



Hot cells and glove box for LOCA and mechanical testing of LWR cladding

PROCESS ENGINEERING LABORATORY

Series of interconnected inert atmosphere gloveboxes for electrochemical process development

IVEM-TANDEM FACILITY

- An intermediate voltage TEM interfaced to two ion accelerators for in situ observation of ion beam modification and effects of irradiation
  - Testing range from low temperature studies using a liquid He stage to studies at high temperatures with hot stages