



Idaho National Laboratory Fuel Cycle Science & Technology Overview

August 2022

Changing the World's Energy Future

Michael Anthony Norato



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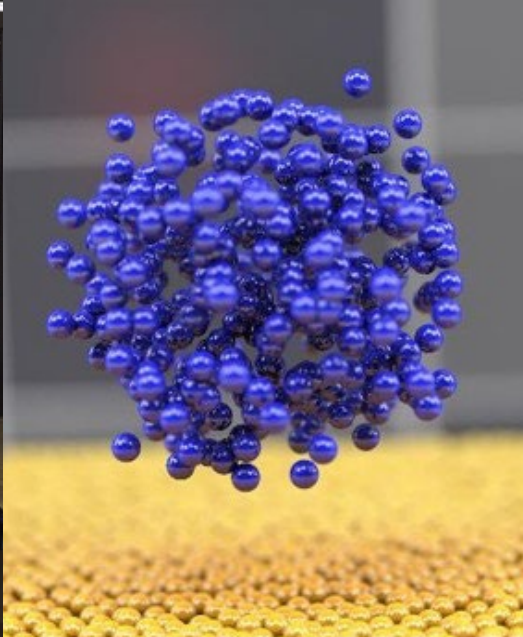
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August 2022

**Idaho National Laboratory
Idaho Falls, Idaho 83415**

<http://www.inl.gov>

**Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517**



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Nuclear Science & Technology Directorate

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University of Wyoming Visit
August 16, 2022

INL is managed by Battelle Energy Alliance
for the US Department of Energy



Addressing the world's most challenging problems



VISION

INL will change the world's energy future and secure our critical infrastructure.

MISSION

Discover, demonstrate and secure innovative nuclear energy solutions, clean energy options and critical infrastructure.

VALUES

Excellence, Inclusivity,
Integrity, Ownership,
Teamwork, Safety

Leveraging INL site, infrastructure, and facilities to enable energy and security R&D at scale

\$1,572 M FY21 Total Operating Cost

5,400+ Employees

569,178 Acres

890 Square Miles

- Primary INL Campus Important to NE and other Mission Accomplishment
- Presently EM Owned and Operated
- Supporting INL Multiprogram Missions



128 Miles high-voltage transmission lines

17.5 Miles railroad for shipping nuclear fuel

4 Operating reactors

12 Hazard Category II & III non-reactor facilities/activities

50 Radiological facilities/activities

3 Fire Stations

Creating a secure, resilient, clean energy future



Advanced
Test Reactor
Complex



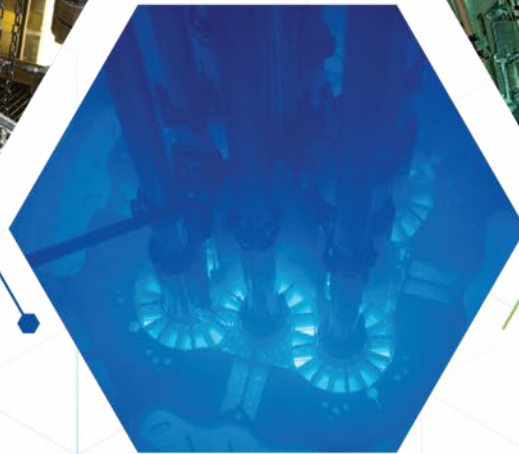
Energy &
Environment
Science &
Technology



National &
Homeland
Security Science
& Technology

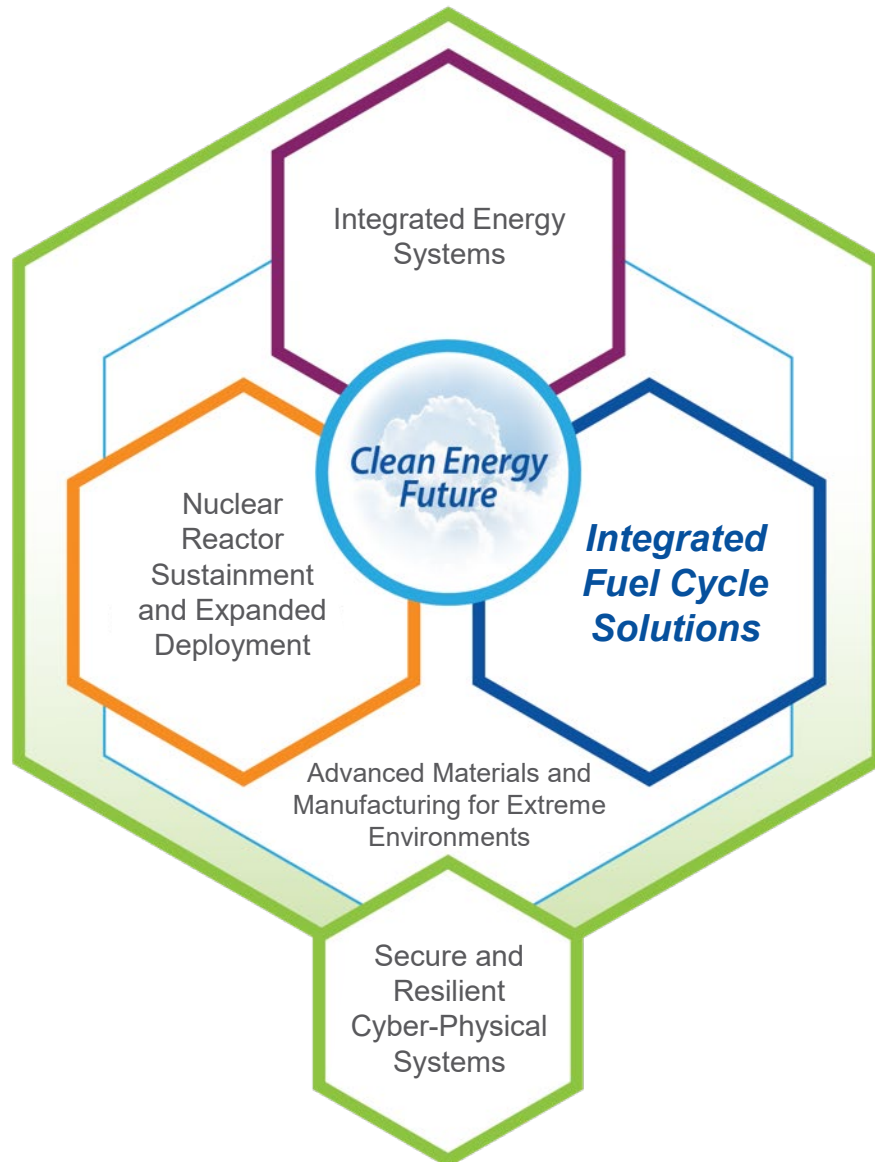


Materials and
Fuels Complex



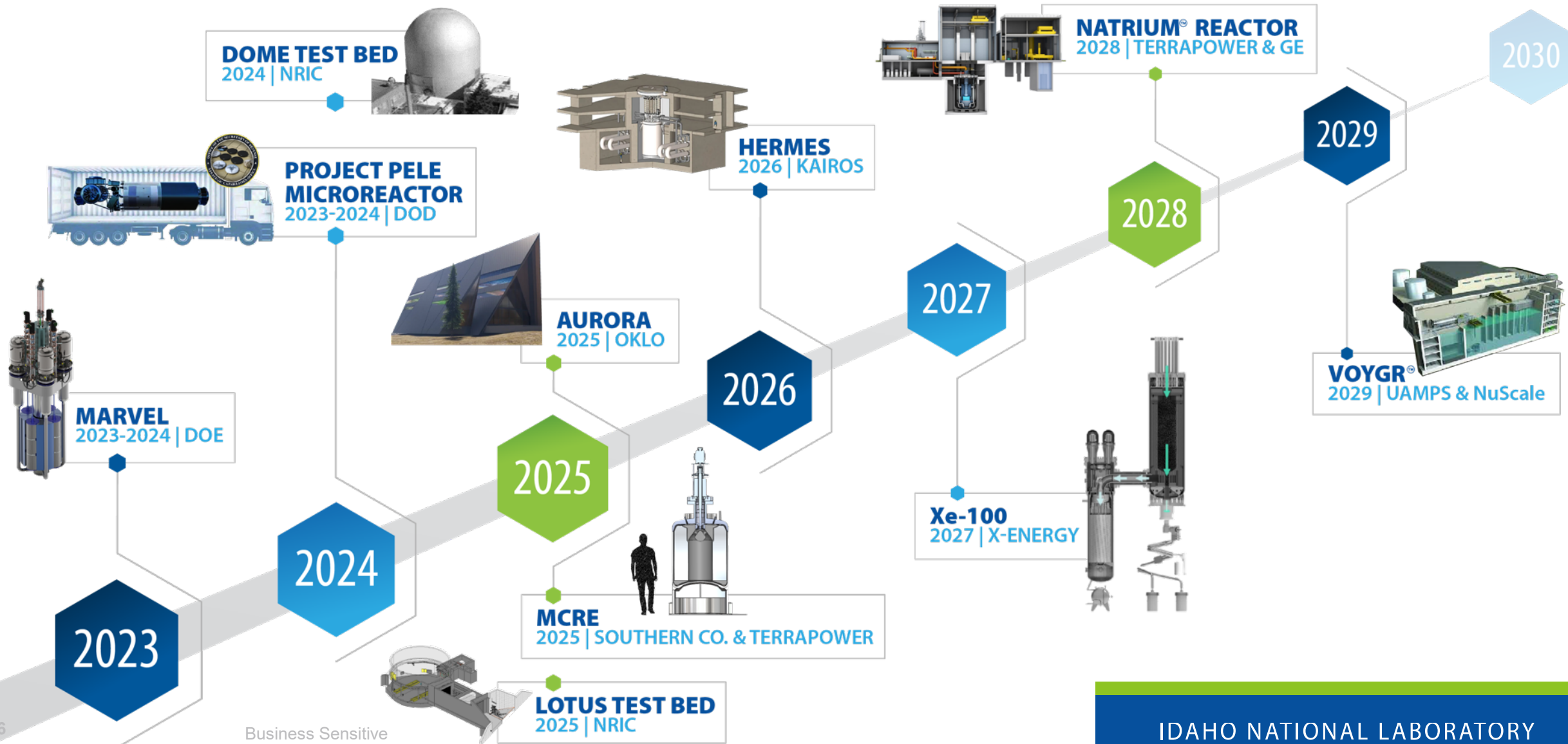
Nuclear Science
& Technology

Innovation for the clean energy future



INL strategic S&T initiatives support transforming the world's energy future and securing our critical infrastructure

Accelerating advanced reactor demonstration & deployment



FCS&T Division Strategy and Priorities

Mission

The Fuel Cycle Science & Technology Division delivers innovative leadership in the development and assessment of science and engineering-based solutions for the integrated nuclear fuel cycle, critical materials recovery, national security and space related applications through world-class staff and research capabilities.

Scope

Perform world-class aqueous and electrochemical separations research, from fundamentals to applied engineering demonstrations.

Leverage molten salt expertise to develop deeper understanding of molten salt chemistry and process monitoring in support of advanced reactor concepts.

Provide comprehensive and innovative solutions to the challenges of storage, transportation, and disposition of used nuclear fuel.

Advance separation science, especially for lanthanides and actinides, supporting all three mission areas of the laboratory:

- NS&T – nuclear fuel cycle, waste management, feed for advanced reactors, isotopes and medical applications, and radiation chemistry

- N&HS – non-proliferation, signatures, training, and classified programs

- EES&T – critical materials (e.g., rare earth recovery and recycling)

Fuel Cycle Science and Technology Org Chart

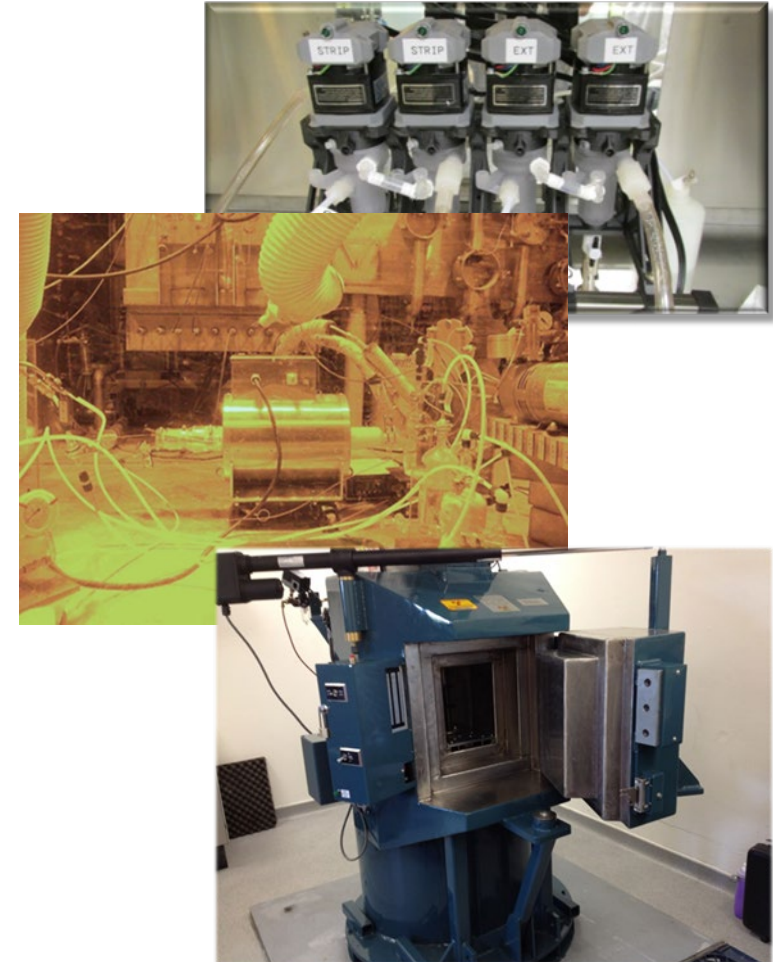


Headcount - 70

Aqueous Separations and Radiochemistry

Melissa Warner– Department Manager

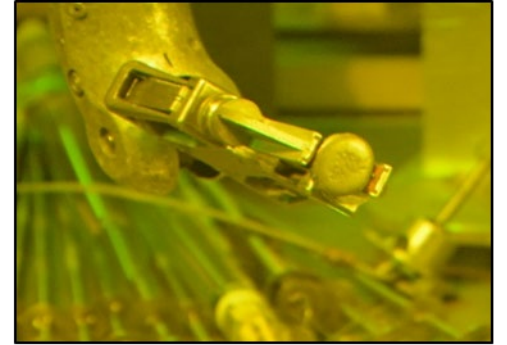
- Flowsheet development and testing for advanced fuel cycles and critical materials recovery/separation
- Off-gas capture (I and Kr)
- Radiation chemistry
- Solvent degradation chemistry
- Complexation chemistry
- High-assay LEU recovery from zirconium and aluminum fuels
- HEU/HALEU polishing/down-blending/conversion
- National security missions
- Critical Materials Institute.



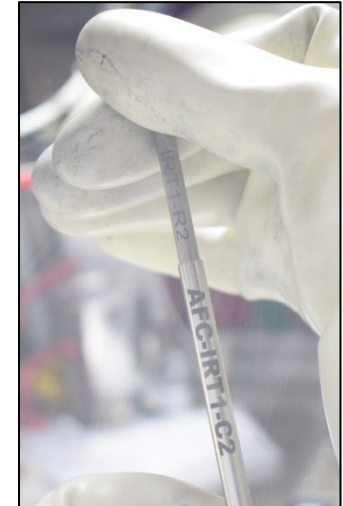
Pyrochemistry and Molten Salt Systems

Josh Jarrell – Acting Department Manager

- Pyrochemical processing of oxide and metal fuel
- Molten salt reactor – salt characterization and monitoring
- Immobilization processes and waste forms
- Base and strategic metal recovery/recycle/purification
- Safeguards and material accountability
- Process modeling
- EBR-II spent fuel processing technical support



Recycled U/TRU button recovered from irradiated FFTF fuel

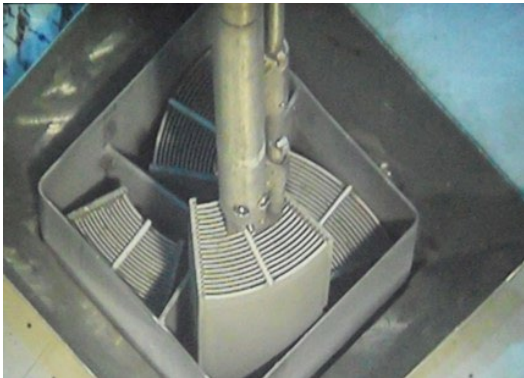


Recycled Fuel Rodlet during Insertion into Test Capsule.

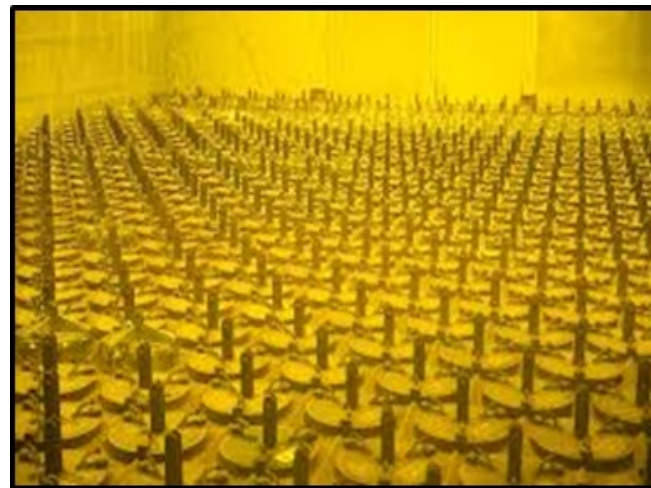
Used Nuclear Fuel Management

James King – Acting Department Manager

- Used nuclear fuel transportation, packaging, and interim storage
- Disposition of DOE-EM legacy materials
- Commercial and non-commercial used fuel disposition
- Used nuclear fuel monitoring and instrumentation



Advanced Test Reactor
fuel elements



Building CPP-603 dry
storage system at the INL
site



Integrated Fuel Cycle Solutions

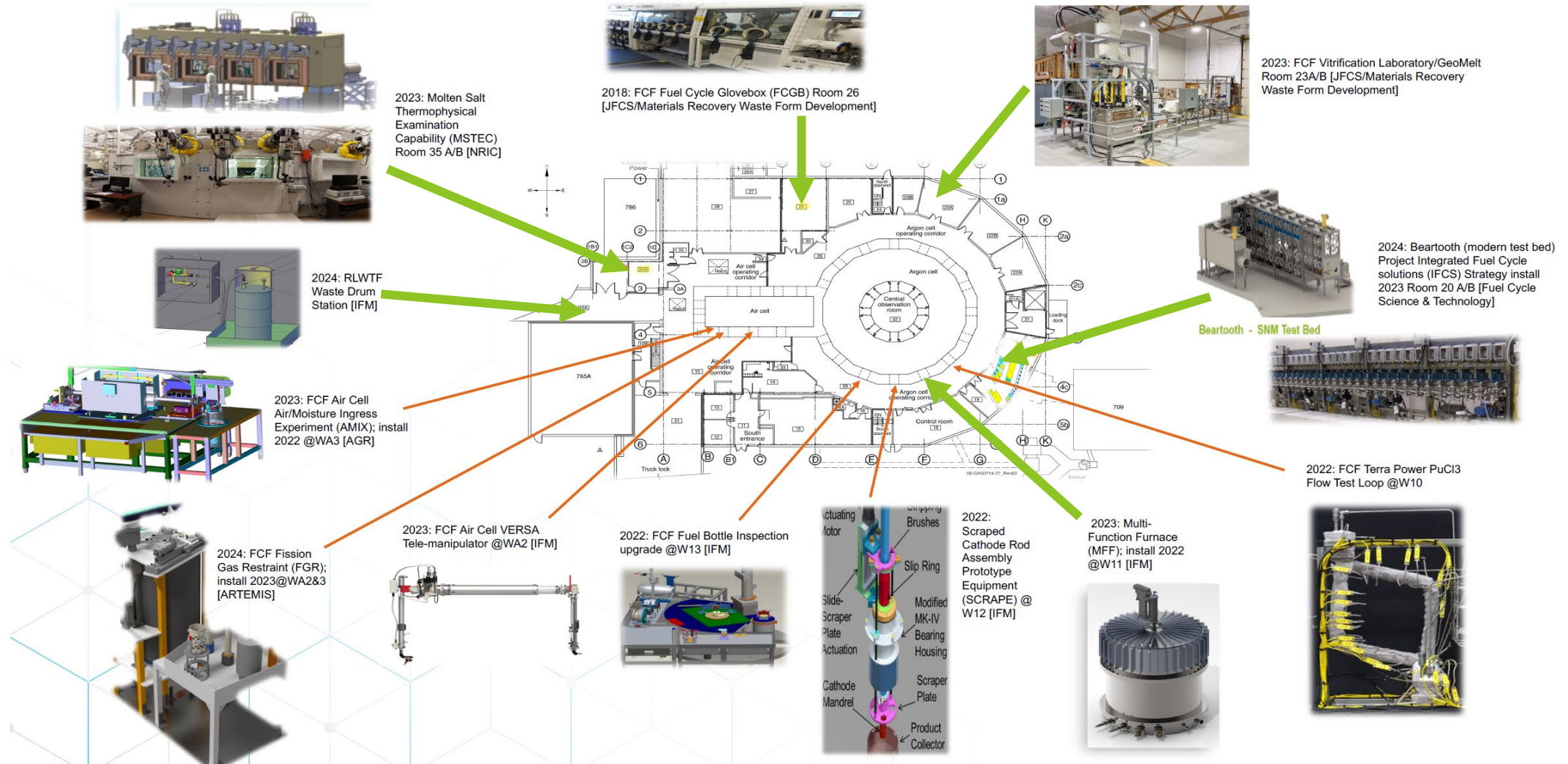
Supports the safe, secure, and economic management of nuclear materials from inception to final disposition

- Ensuring availability of special nuclear materials and strategic isotopes
- Reducing proliferation risk
- Managing radiological waste materials and used nuclear fuels
- Developing RD&D test beds



New and upcoming fuel cycle test bed capabilities at MFC-FCF

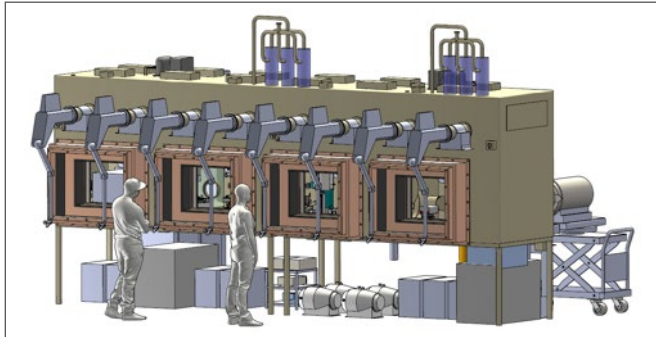
Strategic investments support development of new expertise and capabilities



Upcoming test beds available at MFC starting 2023

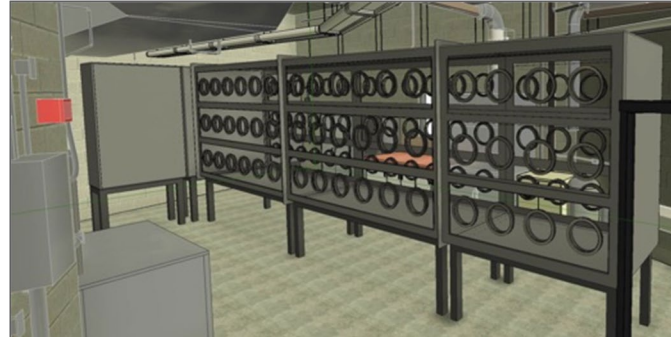
Modern facilities to engage and train the next generation of fuel cycle experts

All new fuel cycle test beds are designed with the ability to demonstrate innovative safeguards and security concepts applicable to advanced reactors and their fuel cycles in support of national security objectives.



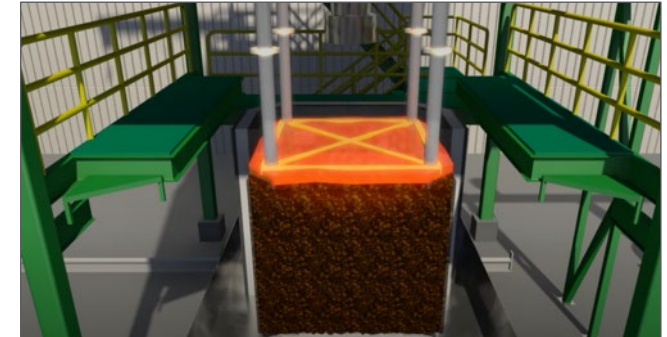
Molten Salt Thermophysical Examination Capability (MSTEC)

Platform to design, demonstrate, license, and operate MSRs



Beartooth - SNM Test Bed

Aqueous processing platform for demonstrating new safeguards and security concepts applicable to advanced fuel cycle operations

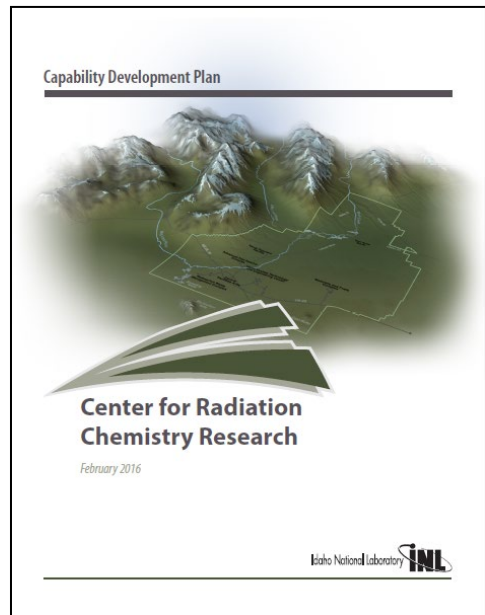


Sustainability – WM Test Bed

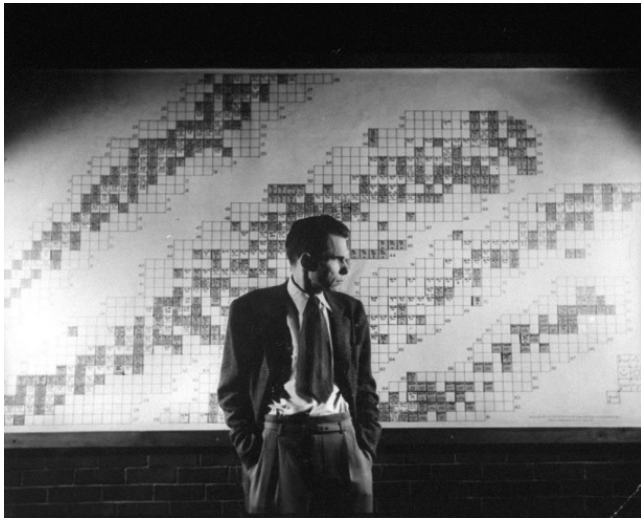
Platform to develop better more stable waste forms for final disposition in support of advanced reactor development and to address DOE legacy waste issues.

Center for Radiation Chemistry Research

- In 2016 we developed a Capability Development Plan to create the “Center for Radiation Chemistry Research” (CR2) to transfer and retain critical expertise in radiation chemistry related to the nuclear fuel cycle. The CR2:
 - Transfers expertise to earlier career INL staff
 - Provides a plan to grow R&D in this field, within nuclear energy and with outside organizations
 - Defines staffing and equipment investment needs



Glenn T. Seaborg Institute



...to create a focus for actinide science in order to foster and develop U.S. pre-eminence in the science of the chemical, physical, nuclear, and metallurgical properties of the actinide elements.

- INL's Glenn T. Seaborg Institute kicked off in late 2017
- 9 Distinguished Post-docs hired to date
- 2 - 3 more expected to onboard in 2022
- The deputy director of the GTSI is from the FCS&T division (Don Wood)



Idaho National Laboratory

Battelle Energy Alliance manages INL for the U.S. Department of Energy's Office of Nuclear Energy. INL is the nation's center for nuclear energy research and development, and also performs research in each of DOE's strategic goal areas: energy, national security, science and the environment.

WWW.INL.GOV