

# SRNL Update

## Citizens Advisory Board

Vahid Majidi

SRNL-MS-2024-00178

May 2024



# SRNL Footprint



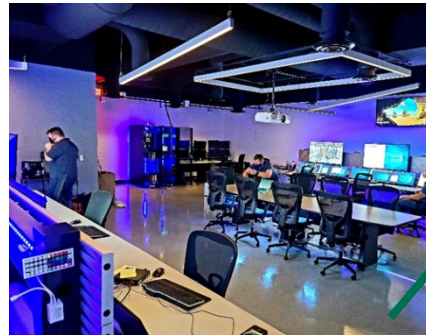
**Aiken County Leased Facilities**



**Aiken County Technology Laboratory**



**Hydrogen Technology / Energy Materials Research Labs**

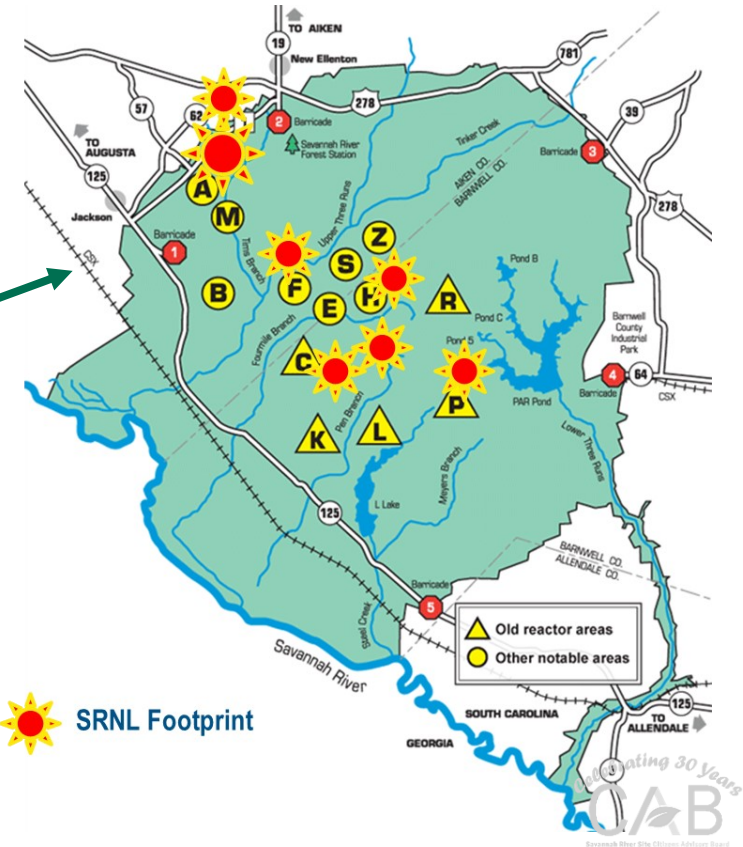


**Georgia Cybersecurity Center**

**Future- Advanced Manufacturing Collaborative at USC-Aiken**



**Physical Assets Summary:**  
750,000 sq. ft., 59 buildings  
Replacement plant value: \$2B  
63,000 sq. ft. in leased facilities



# Transforming to Meet Future Challenges



- Evolving emphasis on environmental remediation, tritium processing and nonproliferation.
- Strong efforts to share expertise beyond SRS.



- Recognized expert in environmental technologies.
- Emphasis on advanced manufacturing for DOE and NNSA missions.

**Cold War**

**SRS Clean Up**

**Multi-program**

**Independent National Lab**

- AMC

- Established in 1951.
- R&D for the production of nuclear materials needed for weapons – primarily tritium and plutonium-239.



- National Laboratory.
- Growth of National Security and Materials Science programs.
- Focus on deployable solutions.



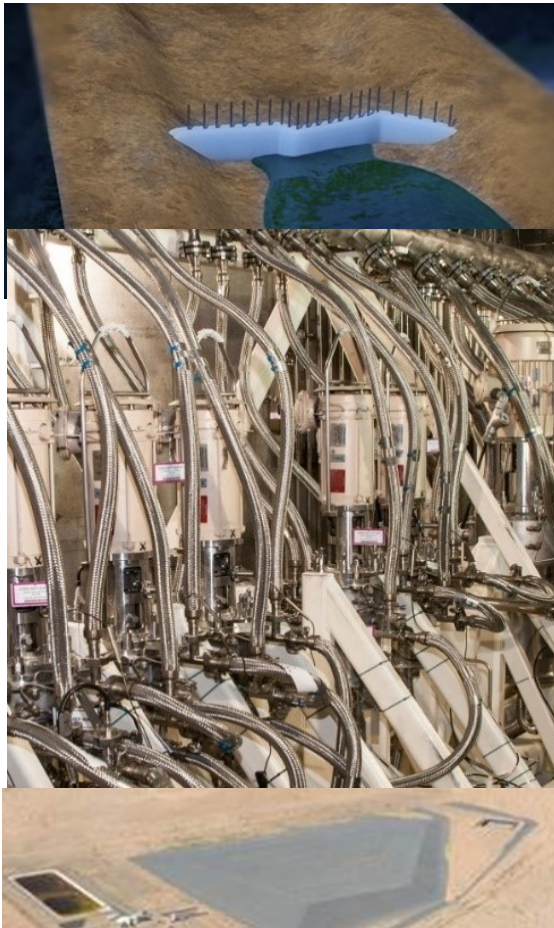
**Fundamental and Discovery Science**



Savannah River National Laboratory®

*Celebrating 30 Years*  
**CAB**  
Savannah River Site Climate Action Board

# SRNL: A Multi-Program National Laboratory (3 mission outcomes)



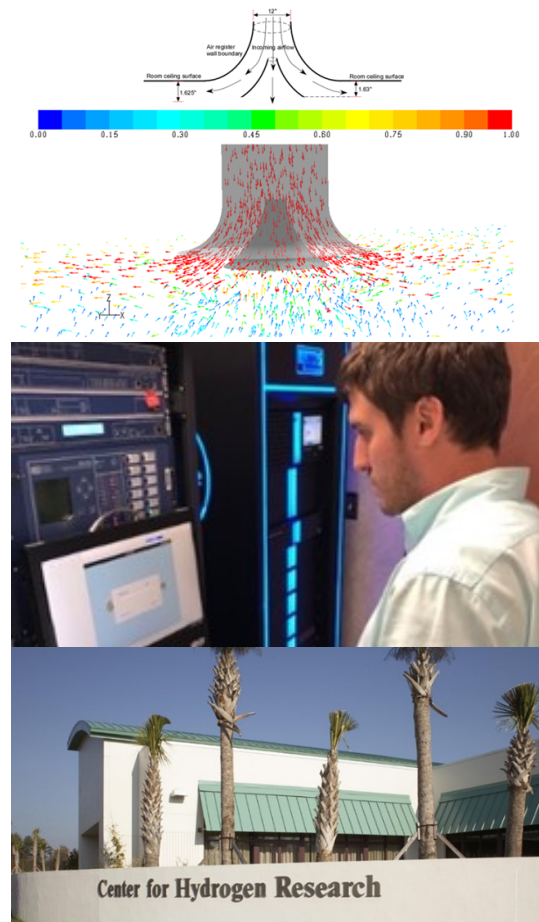
## Environmental Stewardship

- Environmental Management
- Legacy Management
- Technology Deployment



## National Security

- Supporting Nuclear Deterrent
- Preventing Proliferation
- Nuclear Material Management



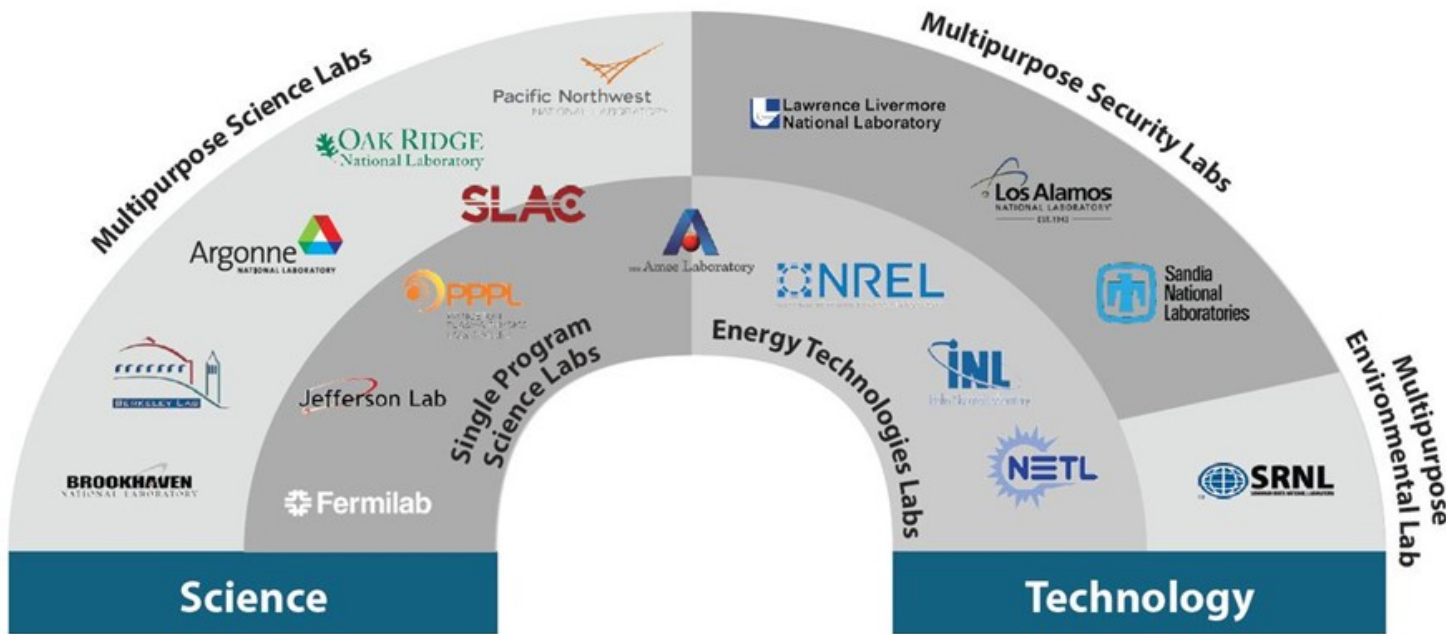
## Science, Engineering, & Energy

- Clean Energy Research
- Securing Connected Systems
- Advanced Manufacturing

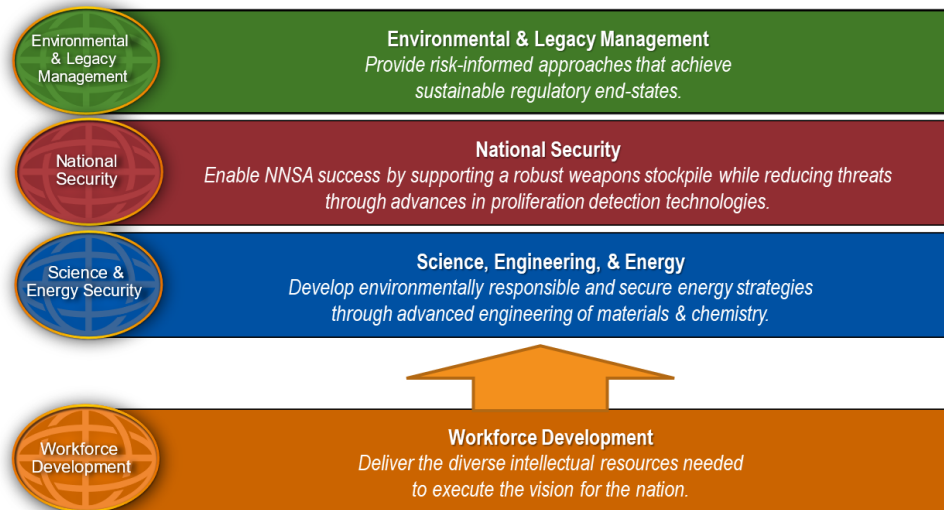


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Celebrating 30 Years  
**CAB**  
Savannah River Site Climate Action Plan

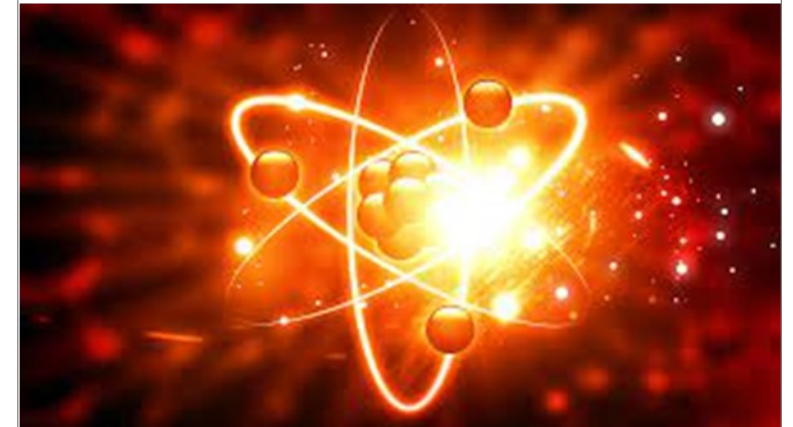


## Department of Energy National Laboratories



## Bringing fusion to the nation's electricity grid

**Approach:** Support demonstration & deployment of fusion by providing innovations in the tritium fuel cycle



# SRS Transition to NNSA:

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SRNL has three directorates:

- Environmental Management and Legacy Management
- Global Security
- Weapons Production Technology

We have a strong and productive NNSA portfolio:

- NA-10 is the primary sponsor for nuclear deterrence activities
  - Weapons Production Technology is aligned with NA-10
- NA-20 is the primary sponsor for nonproliferation activities
  - Global Security is aligned with NA-20
- + Other NNSA Sponsors



# We enable missions by stewarding core competencies



Accelerating remediation,  
minimizing waste, &  
reducing risks



Creating manufacturing &  
energy solutions for EM,  
NNSA, and other sponsors



Enabling next-generation  
**nuclear materials  
processing** & disposition



Assuring production &  
supply of strategic  
materials & components



**Sensing, characterizing,  
& assessing materials  
production** &  
environmental impacts



**Securing connected  
control systems &  
associated data**



# Global Security (NA-20)

## Nuclear materials processing

- Mobile systems, plutonium lab
- Packaging, logistics, and transportation
- Technical support to H Canyon (provided by EM experts)
- ASET utilizing Mark-18

## Sensing, characterizing, assessing, and deterring nuclear proliferation

- Environmental sampling and analysis (air, swipe, soil, etc.)
  - Collections
  - Analysis
- Atmospheric Center
- Particle production

## Securing connected systems & associated data

- Cyber-physical
- Electrical energy grid
- Interconnected manufacturing



# Interface with NA-IM

## Yearly NA-IM Exercise

- SRNL and NNSS supports both NA-IM and NA-121.4 in a yearly cyber assurance exercise that tests our ability to detect adversarial activities on OT networks
- Provides an opportunity to test incident handling and new Defense Programs OT oriented policy.



# Cybersecurity R&D at SRNL – Unique Expertise

SRNL engineers have extensive experience operating, developing, and conducting research on both modern and legacy Industrial Control Systems and cybersecurity-related technologies in the areas of:

- **National Security and Defense**
- **Critical Infrastructure**
- **The Industrial Base**



# NA-20 Programs

## NA-21 Global Material Security

## NA-22 Defense Nuclear Nonproliferation Research and Development

## NA-23 Material Management and Minimization


## NA-24 Nonproliferation and Arms Control

### SRNL Support to NA-24 in FY22 Programs To Advance International Nuclear Safeguards via NPAC

Several areas of unique expertise and capability in nuclear operations, nuclear processing activities, arms control experts, and others. SRNL supports Nonproliferation (NPAC) missions to strengthen nonproliferation and arms control, prevent proliferation, ensure peaceful nuclear uses, and nuclear reductions.

SRNL supports NPAC missions include:

- viewing export licenses and technology for proliferation and developing next generation safeguards.
- U.S. Russia Plutonium Production Reactor Agreement, a Nuclear Compliance Verification, Plutonium Verification NL.
- International Atomic Energy Agency's Network of Authorities to aid in the early detection of misuse of nuclear providing credible assurances that states are honoring obligations.



PVT Working on Calder Hall

**Accomplishments and Associated Impacts**

**Verification Team**

Part of the Nuclear Compliance Verification, Plutonium Verification, which conducted numerous training exercises. This is the Idaho National Laboratory (INL) learning about various technologies, conducting familiarization, characterization, and safety at the Moran facility; improving proficiency with handheld metrology tools, and the waste tank headspace sampler. The Dark Sleeper Exercise, which was hosted by NA-23, Management and Minimization. The PVT exercised their roles at two nuclear facilities and practiced their interaction with agency colleagues. These events build readiness during a nuclear weapons program monitoring and in a foreign country in support of a negotiated agreement.



SRNL staff at CYCLOPS in Cyprus

**Work in Vietnam**

Initial instructors of a four-day training event for Vietnamese officers. The workshop's objective was to enhance capabilities to recognize and interdict CBRNE if concern to prevent their use in terrorist activities. The is the non-state actor and weapons of mass destruction highlights CBRNE-related equipment and materials of concern production, acquisition, and delivery methods.

**Work at CYCLOPS**

14 as lead instructors for the NA-242 (Office of Nuclear Chemical, Biological, Radiological, Nuclear and Explosives) Identification Training (CIT) course for the Center for Nonproliferation and Security (CNS) in Cyprus to Cyprus laws. This training provided Cyprus participants with tools to identify sensitive CBRNE dual-use commodities and technologies, as well as the skills to identify shipments and transactions of CBRNE concerns. Training efforts will build capacity at CYCLOPS toward becoming a regional training hub for providing partners with enhanced technical assistance related to safety and security.

**Versatile Test Reactor**

SRNL supported the Nonproliferation Assessment of the Versatile Test Reactor. The Department of Energy's Office of Nuclear Energy (DOE-NE) is planning to use plutonium-bearing metal alloy fuel for the Versatile Test Reactor (VTR), the planned next-generation experimental facility intended to provide unique testing capabilities for U.S. advanced reactor technologies. As the VTR will be a reactor owned and operated by the U.S. Government, a Nonproliferation Assessment (NPA) was conducted to evaluate nonproliferation considerations, with a focus on whether the reactor or its associated fuel cycle processes will be perceived globally as consistent with past and current U.S. nonproliferation policy. Specifically, the NPA considered whether the activity would result in a significant increase of the risk of proliferation.



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### SRNL Support to NA-22 in FY22

#### Programs To Advance Nuclear Nonproliferation via Research and Development

The Savannah River National Laboratory (SRNL) plays an instrumental role in detecting and deterring illicit transfers of weapons-usable materials and equipment, preventing the spread of sensitive nuclear weapons technology and developing cutting-edge nuclear detection technologies.


Examples of how SRNL supports NA-22 missions include:



SRNL staff configuring equipment for an NA-22 CSI campaign.

Developing algorithmic prototype system tools for the detection of proliferation.

Performing research and development to improve hydrodynamic models for U.S. waterways during radiological incidents to fill gaps in emergency response predictions of public health consequences.



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### SRNL Support to NA-23 (M3-Materials Management & Minimization)

#### Programs and Partnerships to Minimize the Need, Presence and Production of Weapons-usable Nuclear Material

SRNL delivers integral support to the NNSA Office of Material Management and Minimization (M3) mission by leading key programs related to HEU (high enriched uranium) and plutonium minimization. SRNL, through research, innovation and technology deployment, supports M3 initiatives in research reactor conversion, fissile material removal, and fissile material disposition designed to minimize the need for, the presence of, and the production of weapons-usable nuclear material around the world.

SRNL supports the M3 mission activities by:

- Leading irradiated HEU and separated plutonium removal programs including the Gap program and foreign research reactor spent fuel return programs.
- Jointly leading NNSA's new PRO-X initiative to enhance proliferation resistance frameworks for research reactor and other nuclear systems.
- Innovating and developing novel, agile nuclear material processing technologies and systems including mobile, modular platforms e.g.:
- Mobile Plutonium Facility (MPF) for rapid recovery of plutonium materials from foreign weapons programs
- Mobile Melt Consolidate (MMC) technology for minimization of HEU materials through melt processing
- Developing and applying new technologies supporting NNSA's Surplus Plutonium Disposition (SPD) program that helps to improve safety, life-cycle cost/schedule and reduce worker dose.
- Developing and leading cross-cutting technologies necessary for the conversion of HEU-fueled research reactor to LEU (low enriched uranium) fuel and for the conversion of Mo-99 production facilities to LEU targets.

**Key Accomplishments and Associated Impacts**

**Mobile Plutonium Facility (MPF) – Dark Sleeper**

SRNL successfully readied, deployed and successfully completed the MPF to NNSA/NA-20 led and the multi-agency Dark Sleeper Exercise in the United Kingdom in the Spring of 2022 culminating with demonstrations for senior U.S. and U.K. government officials in late May 2022.


The Dark Sleeper exercise challenged the SRNL MPF team with new scenarios for:

- Receipt and unpackaging of host country nuclear materials, which required glove bag fabrication.
- Package preparation for first-time air transport of 9975 Type B packages.

The team successfully redeployed staff and equipment, performed post-exercise equipment maintenance and refurbishment, and reset the equipment modules at SRNL in June – July, 2022.



MPF Team at Dark Sleeper Exercise




Meet the Mobile Packaging capability:  
One way NNSA supports nuclear material  
removals anywhere in the world

2021-06-01



NA-23 Mobile Plutonium Facility

NNSA's Office of Defense Nuclear Nonproliferation (ODNN) is responsible for removing and/or securing high-risk nuclear and radioactive materials around the world that pose a potential threat to the United States and the international community. To support this mission, the Office of Material Management and Minimization has developed a variety of capabilities to ensure highly enriched uranium and plutonium security and safety, including the Mobile Packaging (MPF) program.



Mobile Plutonium Facility (MPF) rendering

# Mark-18 Program Overview

## Why do we care about Mark-18A Targets?

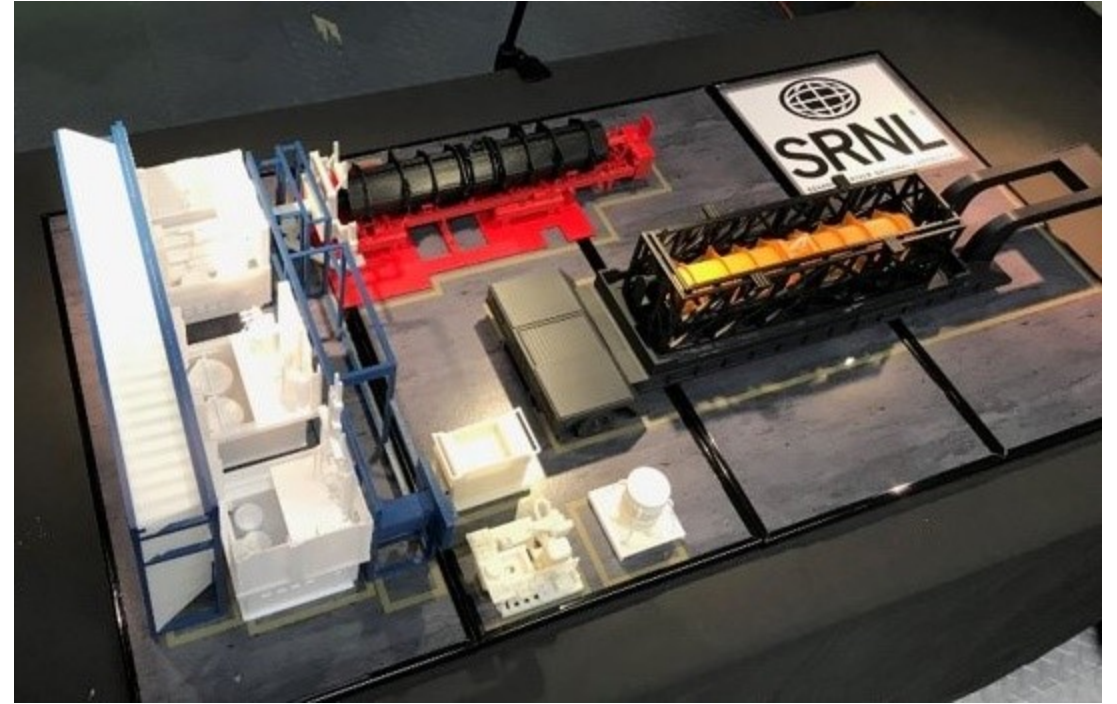
- Only remaining U.S. source Pu-244 available for recovery
- Pu-244 is a Certified Reference Material with wide-ranging uses in nuclear forensics and medical research
- ~20 g of Pu-244 in the remaining 65 Targets
- Capability will be leveraged for future Nonproliferation R&D

## Scope & Objectives

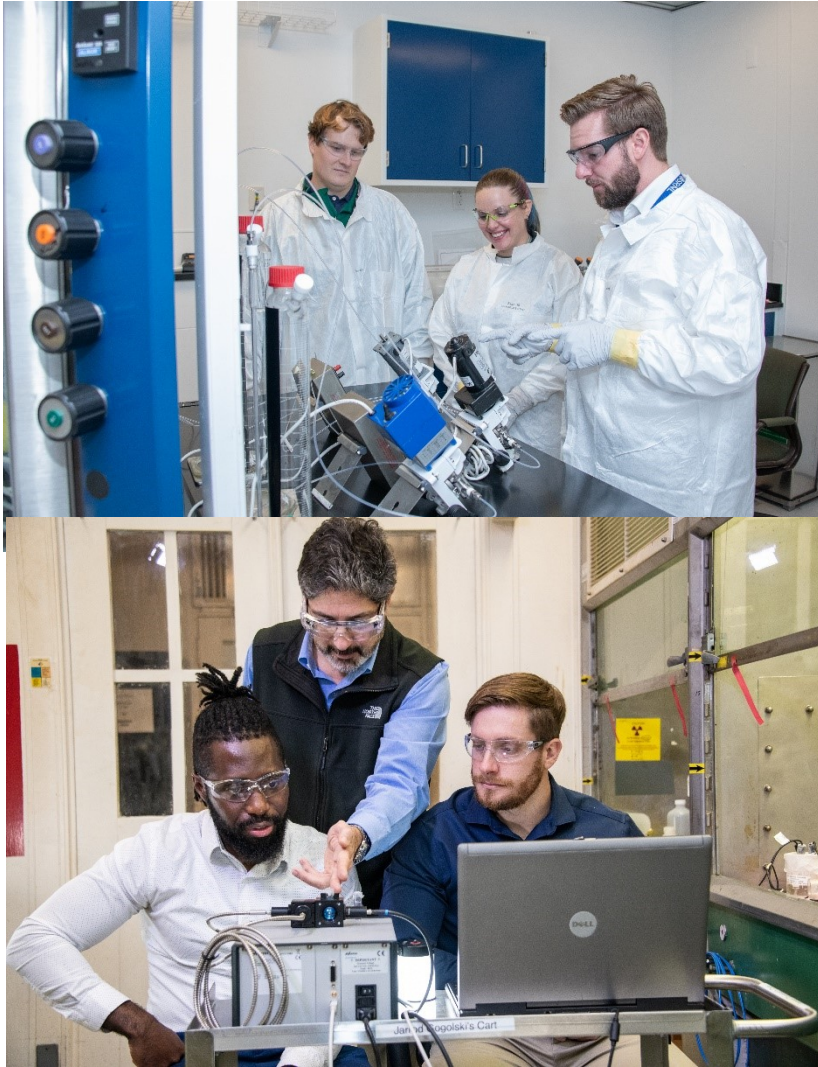
- Design, build, install, and utilize specialized equipment to recover approximately 20 g of Pu-244 from 65 Mk-18A targets inside SRNL's Shielded Cell facility

## Modular Process

- Established Modular Cold Mock-Up in August 2019
- Utilized to test all equipment and train Shielded Cell Operators

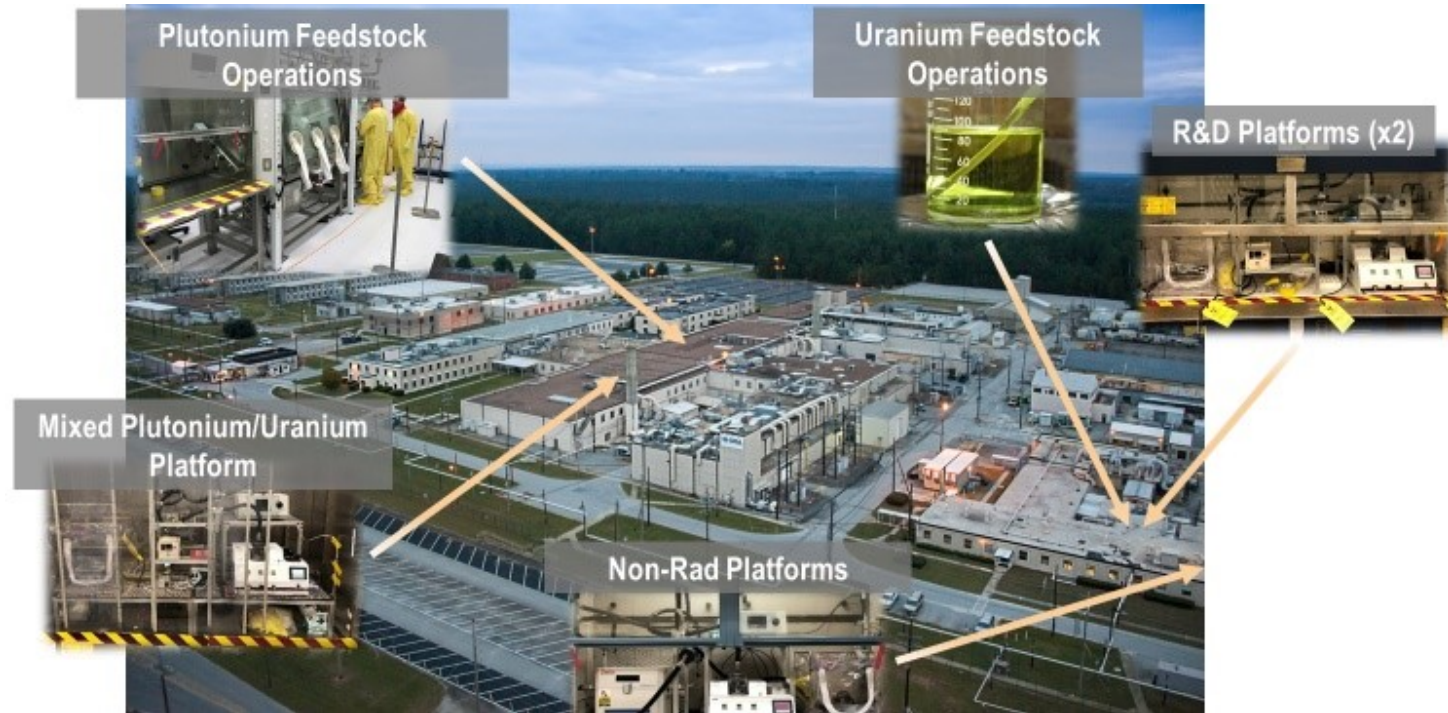
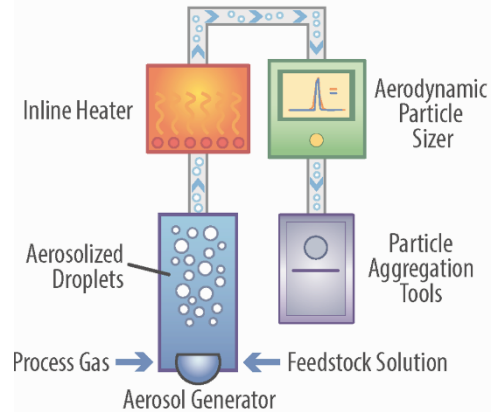


# ASET – part of Athena (Nonproliferation Stewardship Program)



# Technology Development to Support IAEA

- Engineered particulate development efforts
- Environmental sample collection and processing technology
- Network of Analytical Laboratories (NWAL)
- Coincidence Counter Signal Splitter

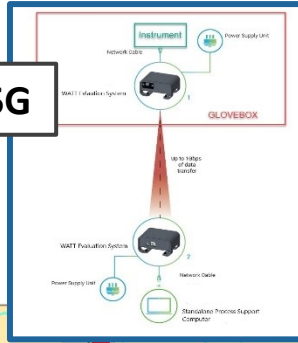


# Advanced Technology Proving Ground (ATPG)

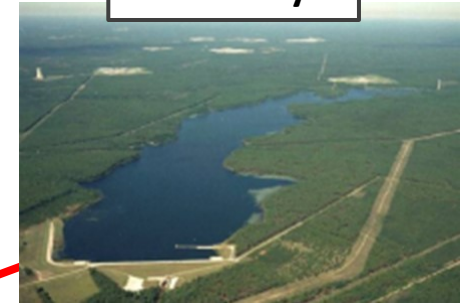
Cyber/ICS



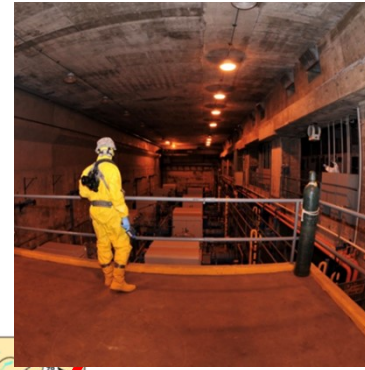
Wireless/5G



Waterways



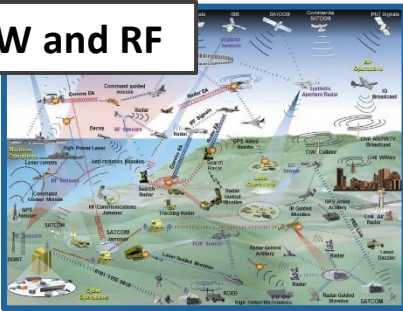
UGFs



Grid /EMP



EW and RF



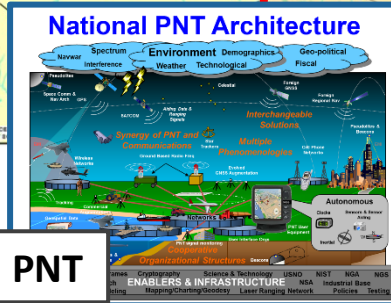
CBRNE & CWMD



Drone/Counter Drone



PNT



ISR



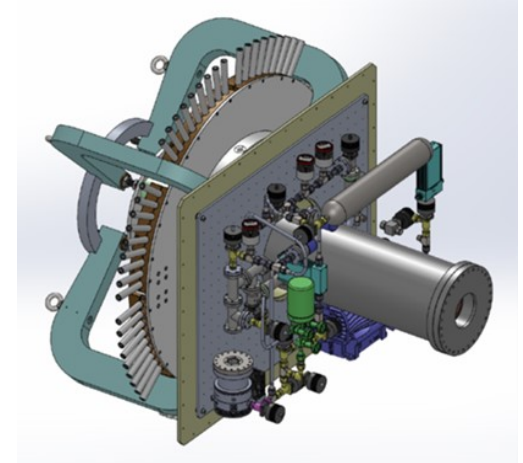
Training/Exercise



# Weapons Production Technologies at SRNL working with NA-10

**SRNL provides the science and engineering expertise that enables NNSA's only tritium and  $^3\text{He}$  processing facilities:**

- SRNL performs collaborative R&D with the Design Laboratories (LANL, SNL) and is a technical bridge between those laboratories and SRS Tritium Operations for the Gas Transfer System (GTS) loading
- SRNL is the technology provider for SRS tritium processing and GTS loading and testing.
- SRNL manages the GTS surveillance program at Savannah River
- SRNL provides tritium subject matter expertise to support the Neutron-Diagnosed Subcritical Experiments (NDSE) program at the Nevada National Security Site.
- SRNL performs tritium R&D and expertise in support of fusion energy, tritium batteries, medical isotopes and other customers



*Z-pinch Experimental Underground System (ZEUS) Dense Plasma Focus (DPF) neutron source with nested tritium handling system*



*Artist Rendering of W80-4 Warhead  
Source: National Nuclear Security Administration;  
GAO-20-409*

# Enabling Facilities and Competencies

- **Tritium Technology**

- Materials Test Facility
- Gas Transfer Systems Technology
- Hydrogen Isotope Process Science

- **Materials Technology**

- Applied Materials Research
- Materials Evaluation & Non-Destructive Evaluation
- Advanced Materials

- **Sensing & Metrology**

- Nuclear Measurements
- Spectroscopy, Separations & Material Characterization

- **Advanced Engineering**

- Mechanical Systems & Custom Development
- Instrumentation and Electronics Development
- Imaging, Robotics and Radiation Systems



*Hydrogen Processing Demonstration System*



*Applied Research Center*

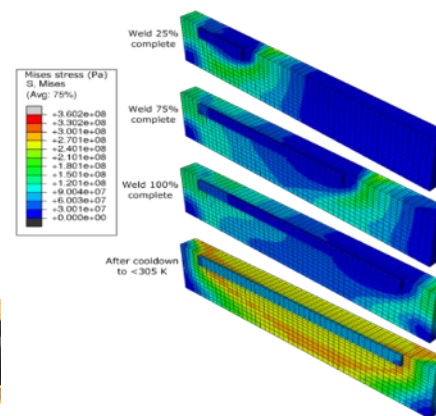


# Material Science & Technology for Tritium Applications

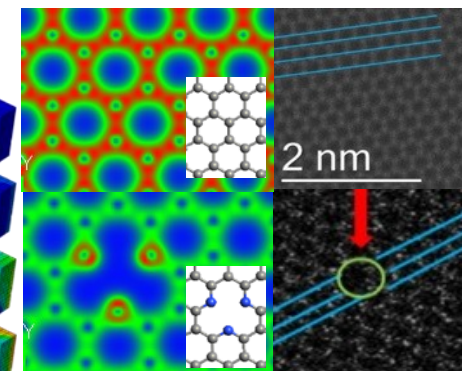
- **Surveillance of Existing Technologies and Components**
  - $H_2/T_2/^3He$  Effects on Structural Materials
  - Custom Welding/Joining Methods (i.e. – pinch welding)
  - TPBAR Materials Analysis
  - Tritium Damage to Polymeric Materials
  - Precision EDM for Tritium Applications
- **Tritium Science & Advanced Characterization**
  - Hydride Structure Characterization in Zr-Alloys Using Neutron Scattering
  - Development of Tritium Permeation Barriers
  - Tritium Isotope Sieving Using 2-D Materials
  - Tritium Permeability Characterization
  - $^3He$  Gas Bubble Imaging by TEM and Neutron Scattering
- **Development of New Tritium Processing Technologies**
  - Additive Manufacturing for Tritium Technologies
  - Bronze Gettering of  $^{65}Zn$
  - Custom Passivation of Components for Tritium Service
  - Glovebox Gloves with Reduced Permeability for  $O_2$  and  $H_2O$
  - Betavoltaic Batteries
  - Spray Atomization for Catalyst Synthesis



*Low Permeability  
Glovebox Gloves*



*Modeling of Wire-Arc  
Additive Manufacturing*



*Nanomaterials for  
Isotope Sieving*



# Tritium Effects on Materials Characterization and Mitigation

## Metallurgy / Welding & Joining

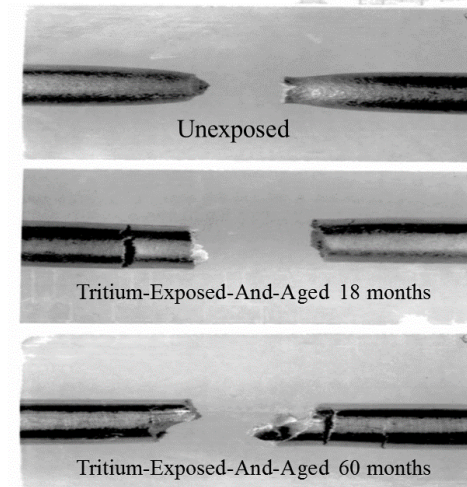
- Metallurgical examination and analysis of components is a foundation of tritium effects on materials research programs
- Utilize knowledge of metallurgy to maintain and improve welding technologies
- SRNL developed the pinch weld method utilized for sealing tritium reservoirs

## Fracture Mechanics

- Examine relationships between tritium exposure and He in-growth on toughness
- Informs lifetime assessments of GTS

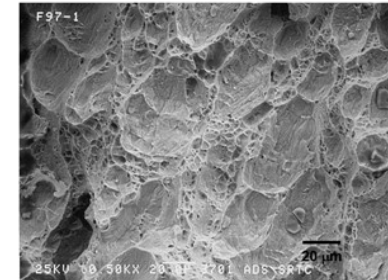
## Polymer Characterization

- Characterize tritium effects on polymer materials using FTIR, DMA, TGA, NMR to understand degradation mechanisms

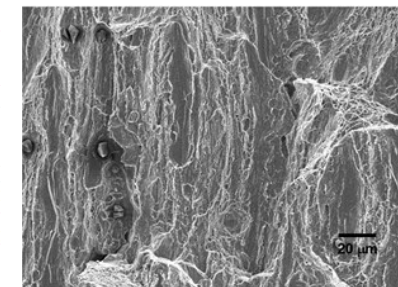


Source: SRL Notebook  
Dave Rawl, 11/7/1979

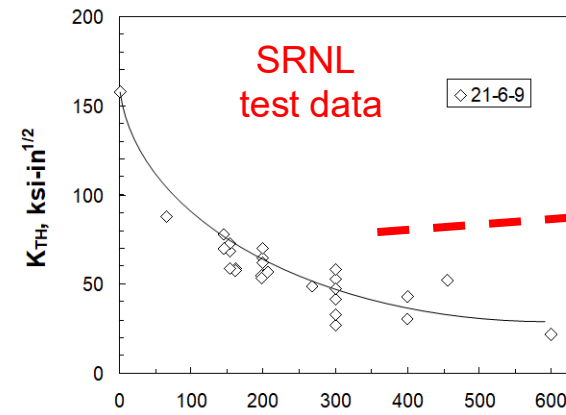
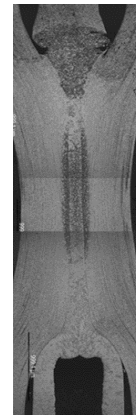
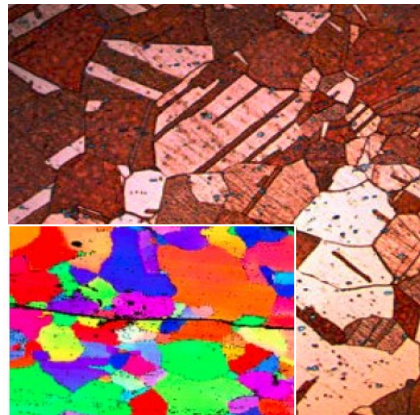
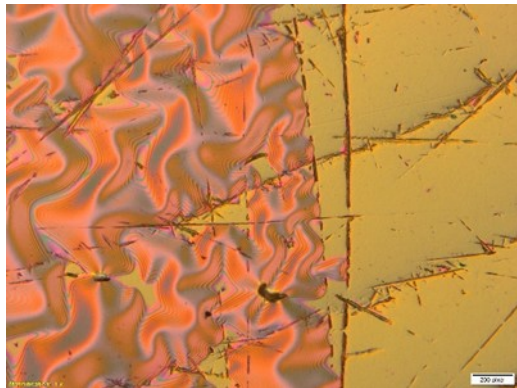
Nitronic 40



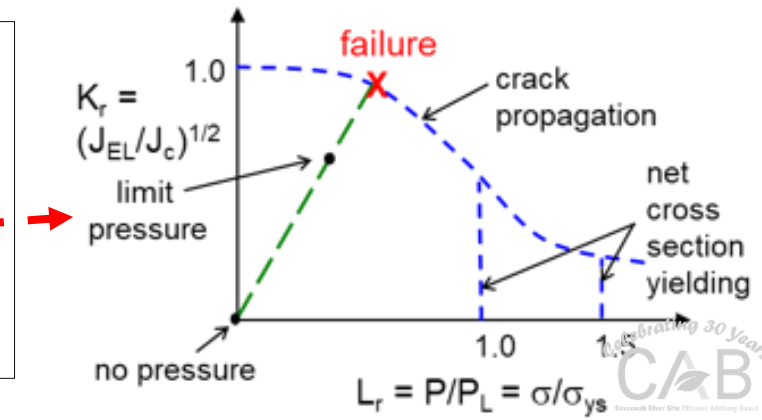
Non-charged



T<sub>2</sub> Charged-and-Aged



Helium Concentration, appm



```
graph TD; RP[Receipt and Packaging] --> Disassembly; Disassembly --> MP[Metal Preparation]; MP --> Foundry; Foundry --> Machining; Machining --> Assembly; Assembly --> Inspection; Inspection --> QA[Quality Acceptance]; QA --> WRAs[WR Assemblies]; Storage --> Disassembly; Storage --> MP; Storage --> Foundry; Storage --> Machining; Storage --> Assembly; Storage --> Inspection; Storage --> QA; Storage --> WRAs; SolidWM[Solid Waste Management]; LiquidWM[Liquid Waste Management]; AqueousRecovery[Aqueous Recovery]; AnalyticalChemistry[Analytical Chemistry]; MaterialsCharacterization[Materials Characterization];
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The flowchart illustrates the manufacturing process for a waste reactor (WR) assembly. The main process flow is as follows:

- Receipt and Packaging** (Dark Blue Box) leads to **Disassembly** (White Box).
- Disassembly** leads to **Metal Preparation** (White Box).
- Metal Preparation** leads to **Foundry** (White Box).
- Foundry** leads to **Machining** (White Box).
- Machining** leads to **Assembly** (White Box).
- Assembly** leads to **Inspection** (White Box).
- Inspection** leads to **Quality Acceptance** (Dark Blue Box).
- Quality Acceptance** leads to **WR Assemblies** (Dark Blue Box).

Support and management functions are shown in dark blue boxes and connected to the main process flow by dashed lines:

- Storage** (Dark Blue Box) is connected to **Disassembly**, **Metal Preparation**, **Foundry**, **Machining**, **Assembly**, **Inspection**, and **WR Assemblies**.
- Solid Waste Management** (Dark Blue Box) is connected to **Disassembly**, **Metal Preparation**, **Foundry**, **Machining**, **Assembly**, **Inspection**, and **WR Assemblies**.
- Liquid Waste Management** (Dark Blue Box) is connected to **Disassembly**, **Metal Preparation**, **Foundry**, **Machining**, **Assembly**, **Inspection**, and **WR Assemblies**.
- Aqueous Recovery** (Dark Blue Box) is connected to **Disassembly**, **Metal Preparation**, **Foundry**, **Machining**, **Assembly**, **Inspection**, and **WR Assemblies**.
- Analytical Chemistry** (Dark Blue Box) is connected to **Disassembly**, **Metal Preparation**, **Foundry**, **Machining**, **Assembly**, **Inspection**, and **WR Assemblies**.
- Materials Characterization** (Dark Blue Box) is connected to **Disassembly**, **Metal Preparation**, **Foundry**, **Machining**, **Assembly**, **Inspection**, and **WR Assemblies**.

# SRPPF Engineering and Technology Development

- SRS is following LANL's pit production process flowsheet technologies and equipment to the extent practicable, however, in some instances the technology is obsolete or detailed design information does not exist or is incomplete.
- SRNL engineering development efforts generate information and data that will inform SRPPF preliminary and final design.
  - Materials Transport System – Material movement systems are custom built for each application and none are designed to operate in a contained nuclear environment.
  - Casting Furnace – SRS is adopting LANL's VIM furnace approach however differences in operational environments will require configuration modifications that are not completely defined.
  - Pyrochemical Processing – SRS is closely following LANL's pyrochemical unit operations however advancements in controller automation are desired for SRPPF's production environment.
  - Hydec – SRS is adopting LLNL's proven hydride/dihydride technology for removing Pu from bonded substrates.
- Emerging Development Scope
  - Radiography
  - Weld Inspection
  - Disassembly
  - Press and shear



# Support to other Labs and NNSA

- Collaborations with LLNL
  - Hydride initiation and kinetics
  - Classified machining
- At risk material recovery and recycle
- Tritium support for LANL experiments at NNSS
- Science Council representative – Dr. Katie Heroux
- NA-11 Detailee – Dave Wilson
- SRS Lead for NNSA Digital Engineering Steering Committee (DESC)
- SRS Lead for Stewardship Capability Delivery Schedule (SCDS)
- SRS Lead for NA-121.4 Nuclear Enterprise Assurance – Core Team
- SRS Lead for DOE 410.2 Deliverables
  - Nuclear Materials (NM) Inventory Assessment (NMIA)
  - NM Management Plan (NMMP)
  - Material Balance Spreadsheet (MBS)



# Questions?

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- Thank you.

