Savannah River National Laboratory®

We put science to work.™

SRNL Update

Citizens Advisory Board

Vahid Majidi

SRNL-MS-2024-00178

May 2024

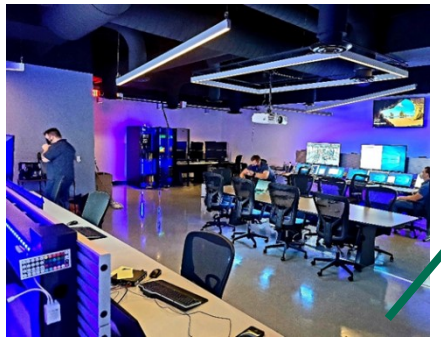
Celebrating 30 Years CAB

SRNL Footprint

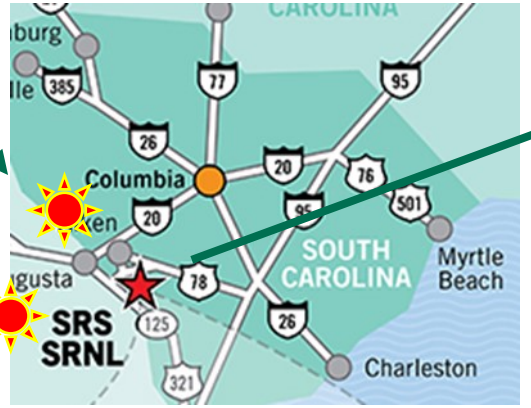
Physical Assets Summary:
750,000 sq. ft., 59 buildings
Replacement plant value: $2B
63,000 sq. ft. in leased facilities

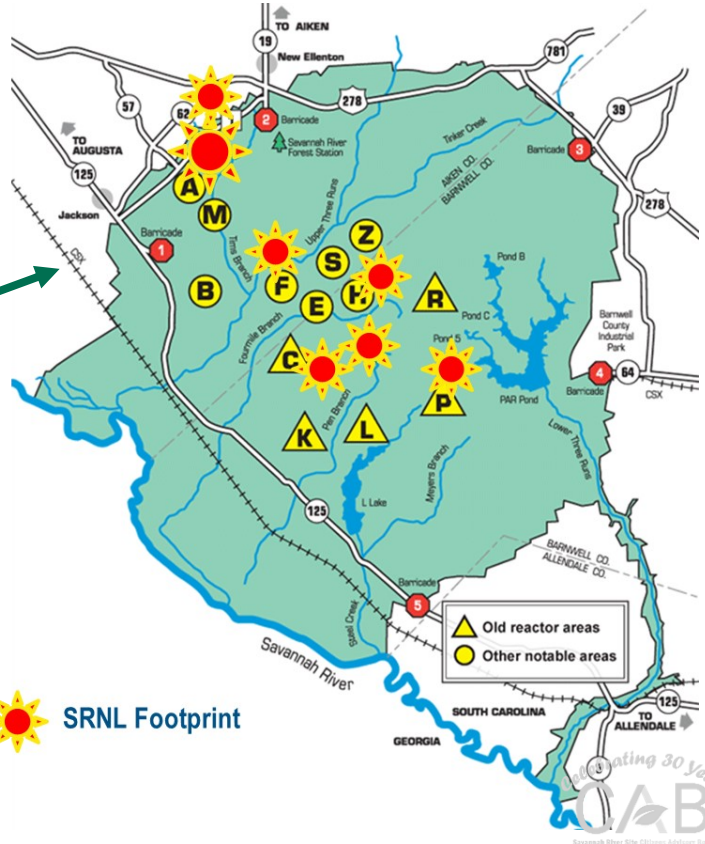
Aiken County Leased Facilities

Future- Advanced Manufacturing Collaborative at USC-Aiken



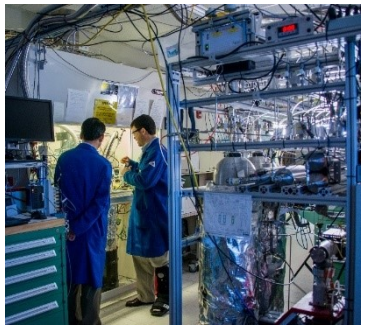
Georgia Cybersecurity Center





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

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

SRS Clean Up

Multi-program

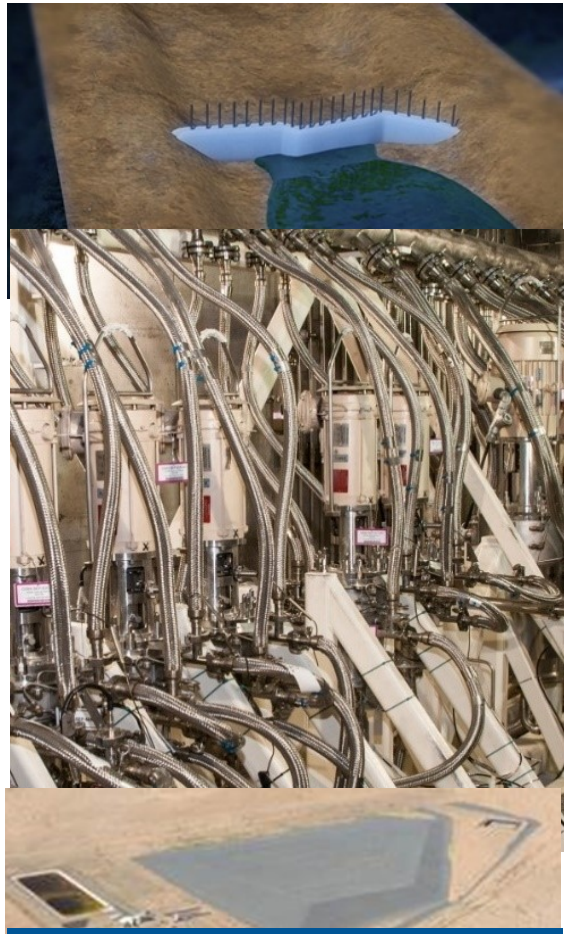
- National Laboratory.
- Growth of National Security and Materials Science programs.
- Focus on deployable solutions.

Independent National Lab

- AMC

Fundamental and Discovery Science

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

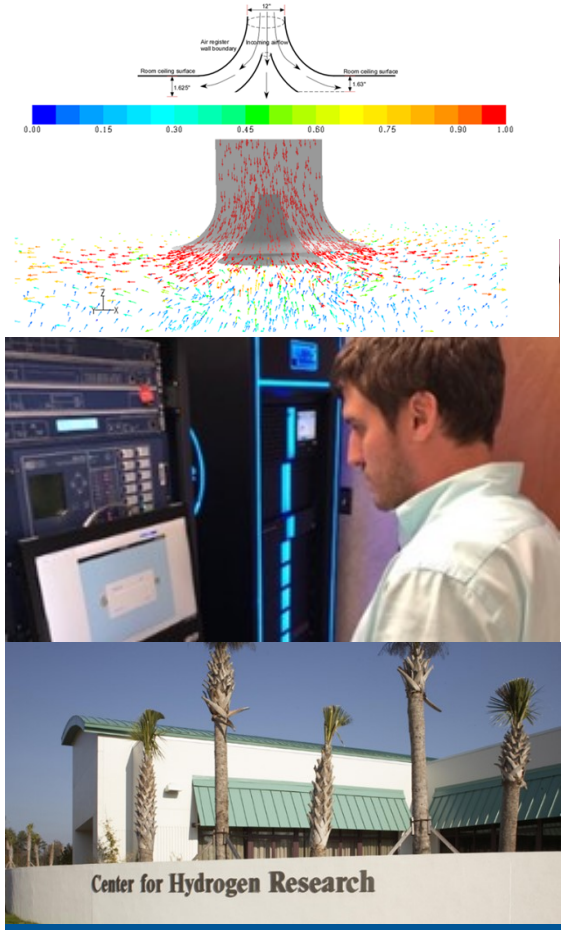


Environmental Stewardship

- Environmental Management
- Legacy Management
- Technology Deployment

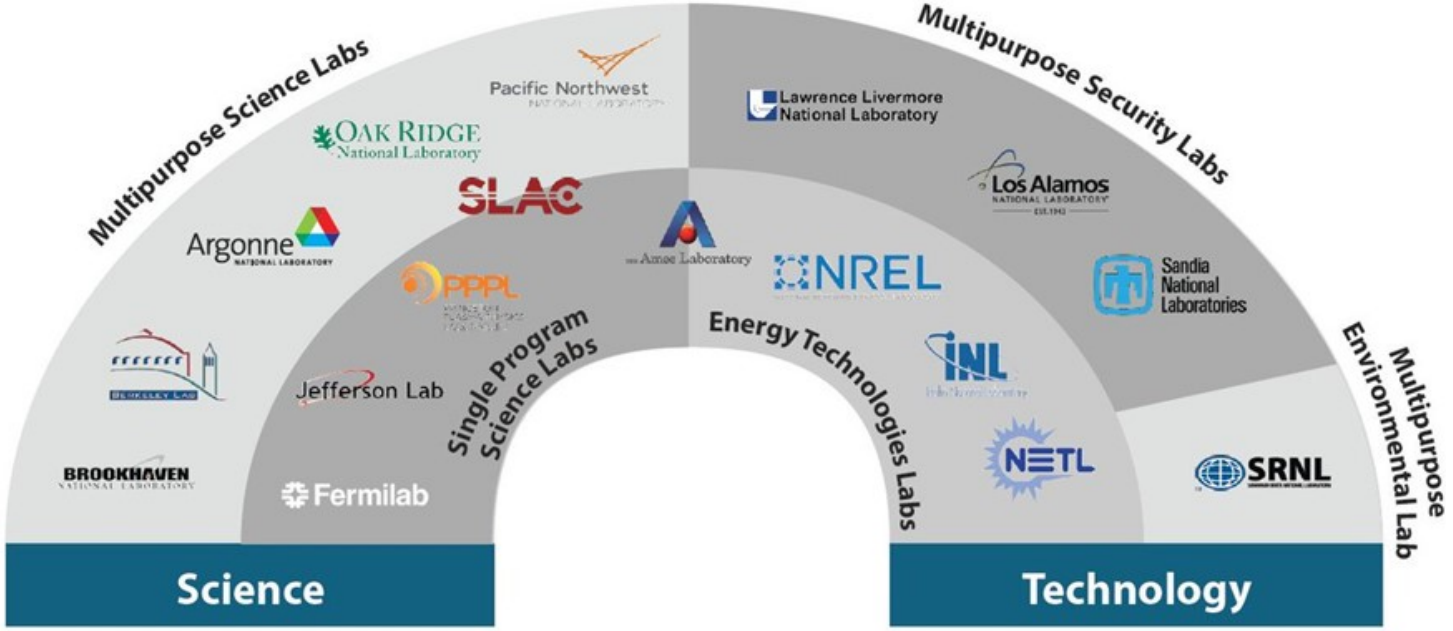
National Security

- Supporting Nuclear Deterrent
- Preventing Proliferation
- Nuclear Material Management

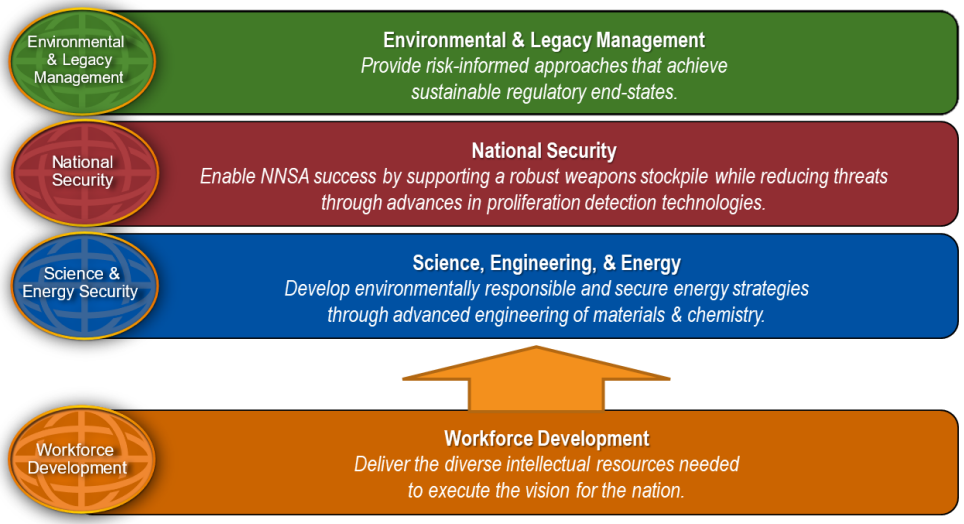


Science, Engineering, & Energy

- Clean Energy Research
- Securing Connected Systems
- Advanced Manufacturing



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:

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

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SRNL Support to NA-24 in FY22

Programs To Advance International Nuclear Safeguards via NPAC

PVT Working on Calder Hall

SRNL staff at CYCLOPS in Cyprus

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SRNL Support to NA-22 in FY22

Programs To Advance Nuclear Nonproliferation via Research and Development

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

SRNL staff explain the MK-18 program to Secretary of Energy Jennifer Granholm

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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

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

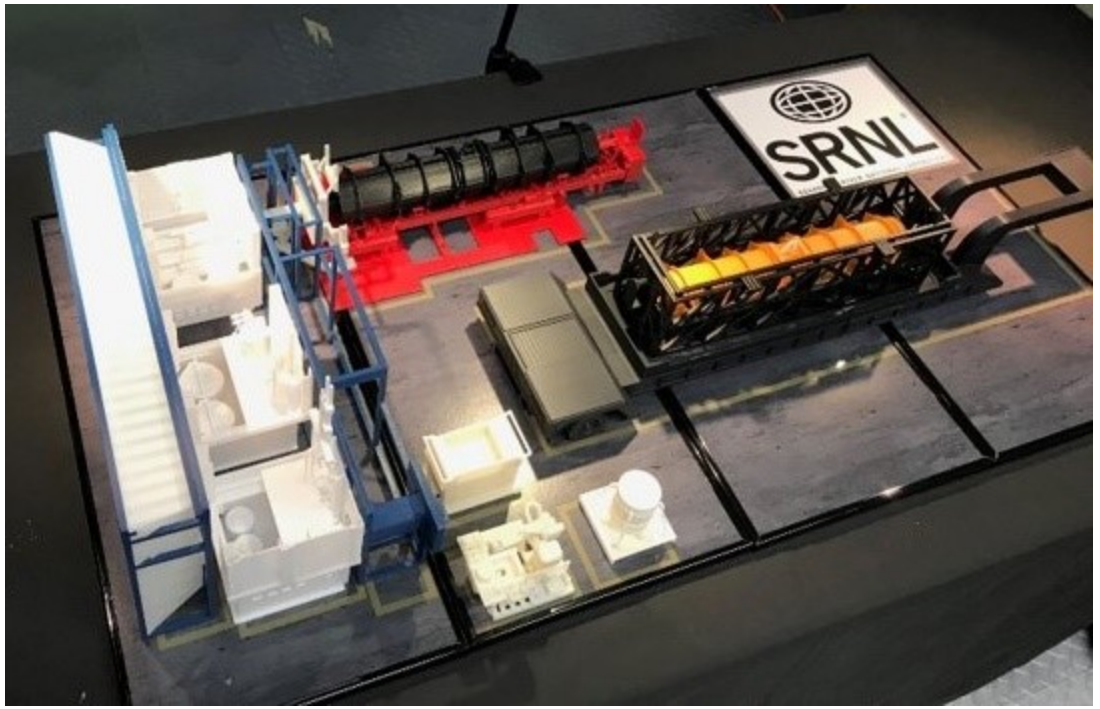
NA-23 Mobile Plutonium Facility

MPF Team at Dark Sleeper Exercise

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



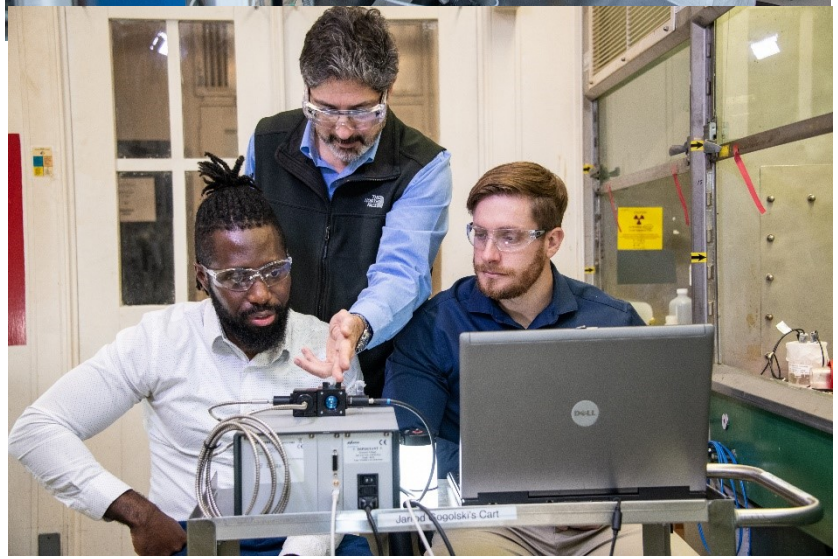
Scope & Objectives

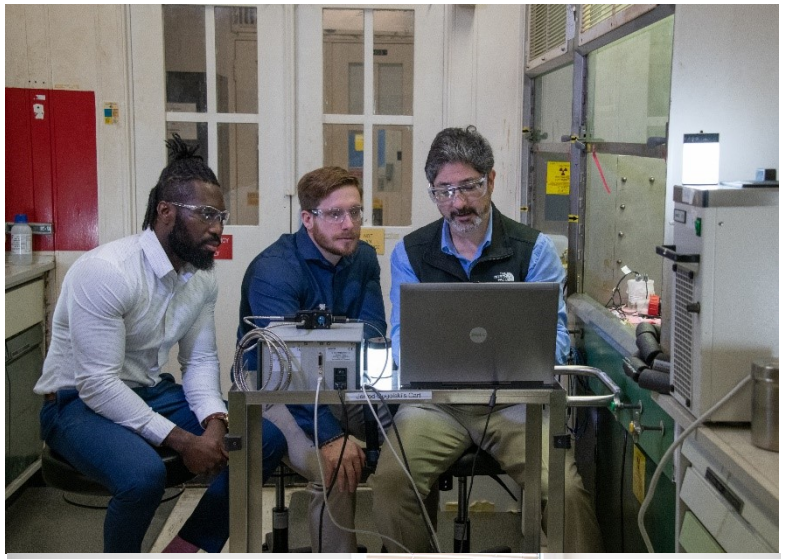
- Design, build, install, and utilize specialized equipment to recover approximately 20 g of Pu-244 from 65 Mk-18A targets inside SRNL's Shielded Cell facility

Modular Process

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

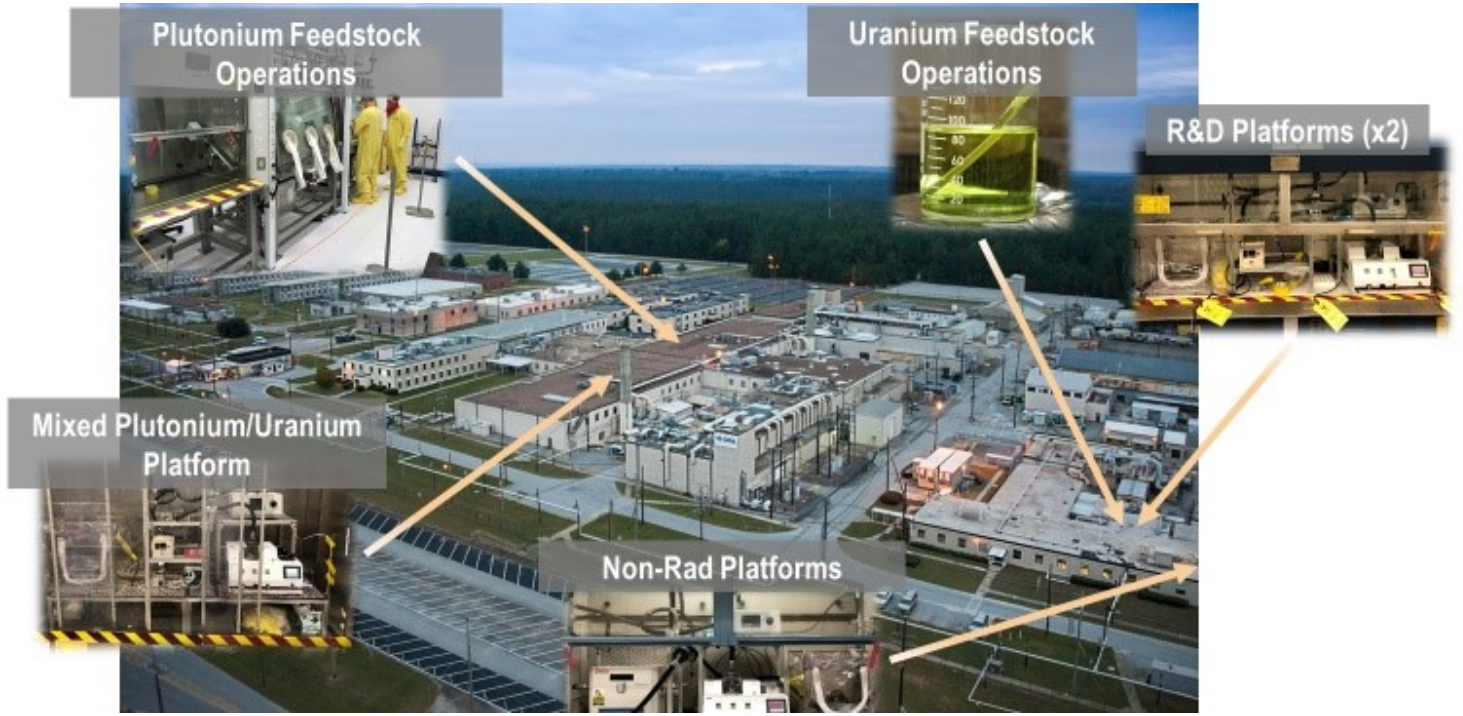
ASET – part of Athena (Nonproliferation Stewardship Program)

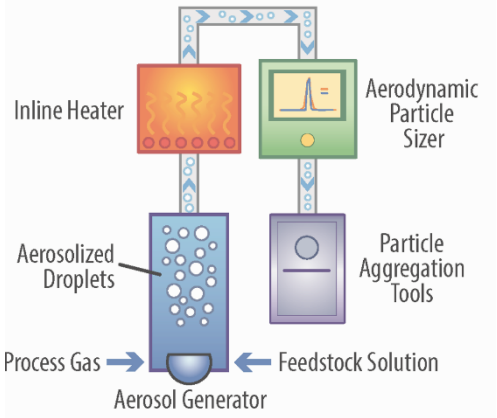




Technology Development to Support IAEA

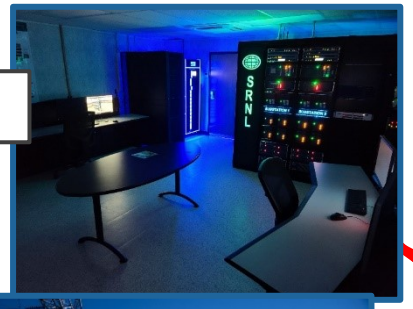
- Engineered particulate development efforts
- Environmental sample collection and processing technology
- Network of Analytical Laboratories (NWAL)
- Coincidence Counter Signal Splitter



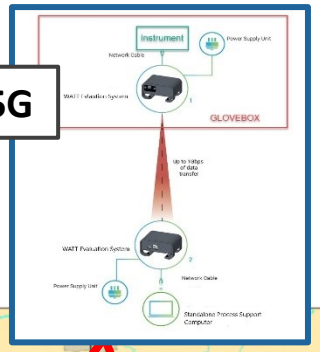


Advanced Technology Proving Ground (ATPG)

Cyber/ICS



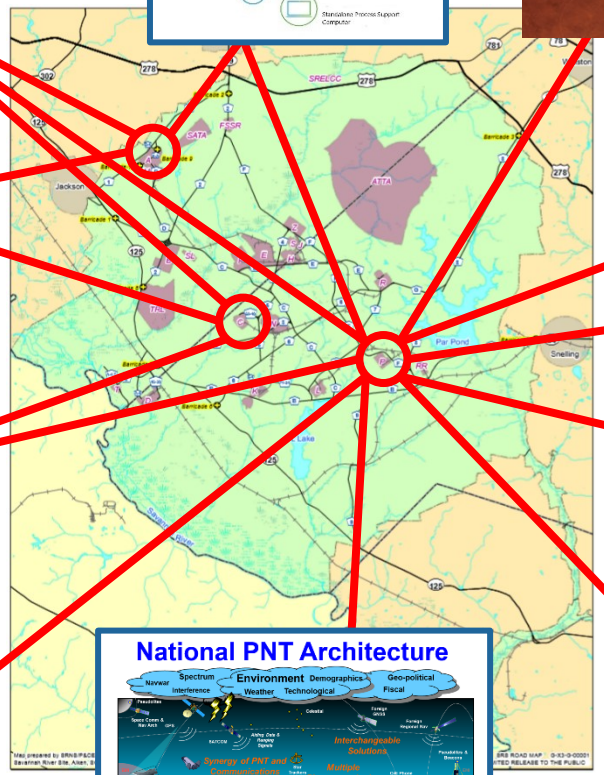
Wireless/5G



UGFs

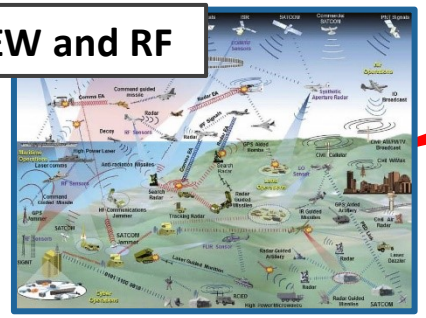
Waterways

Grid /EMP

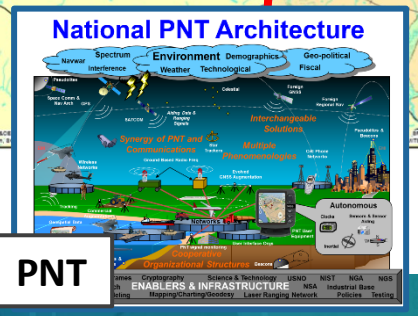


Drone/Counter Drone

EW and RF



CBRNE & CWMD



PNT

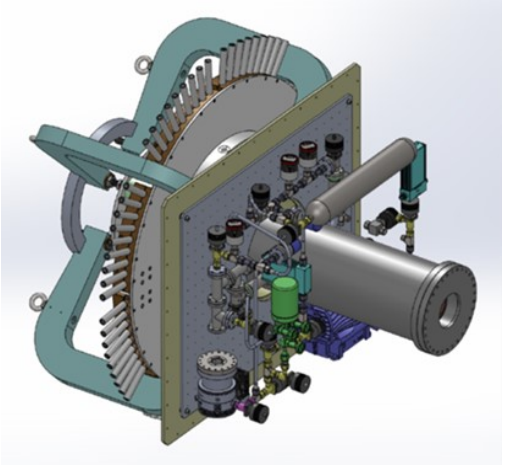
ISR

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}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

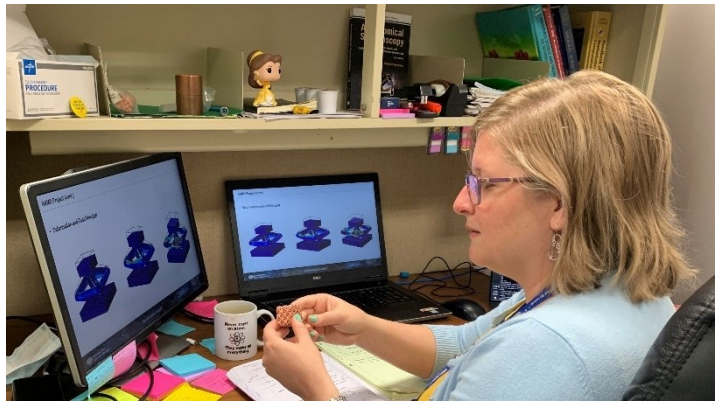
Artist Rendering of W80-4 Warhead
Source: National Nuclear Security Administration; GAO-20-409

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

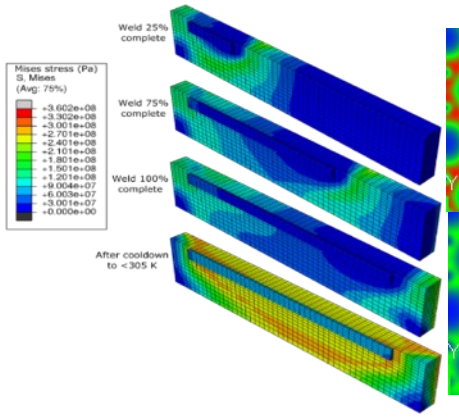
Applied Research Center



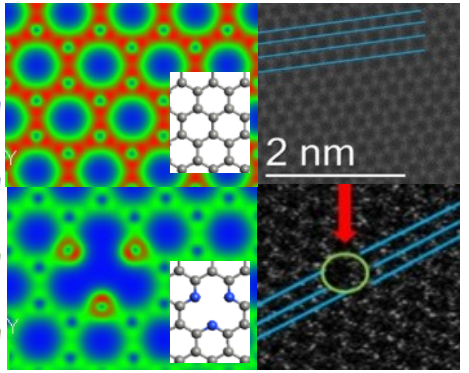
Material Science & Technology for Tritium Applications

- **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

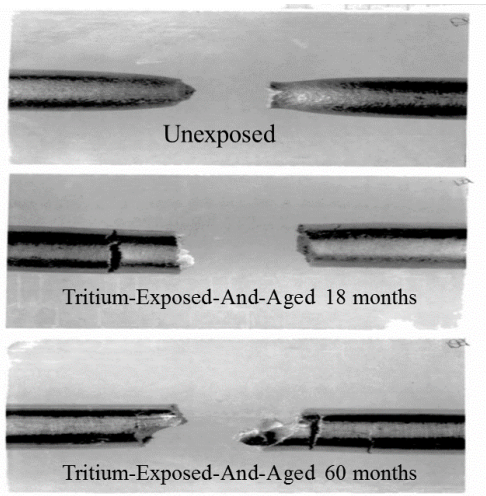
Fracture Mechanics

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

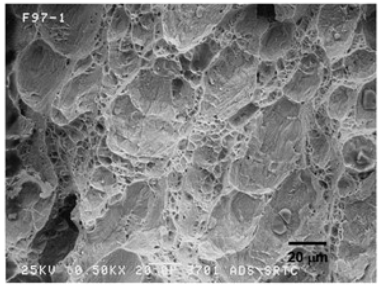
Polymer Characterization

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

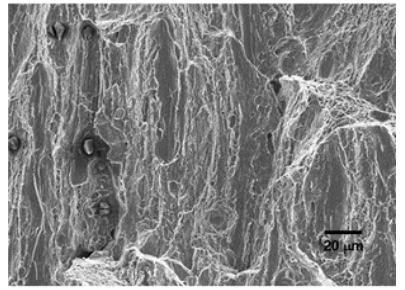
Sandia National Laboratories | Pacific Northwest National Laboratory



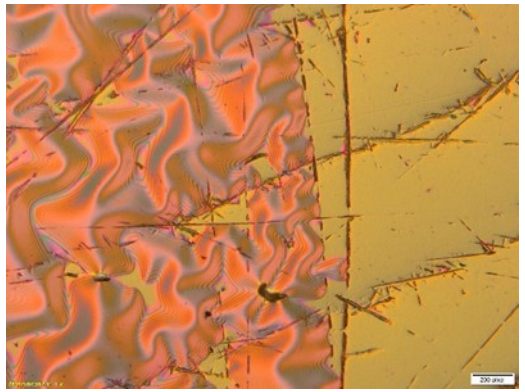
Source: SRL Notebook
Dave Rawl, 11/7/1979

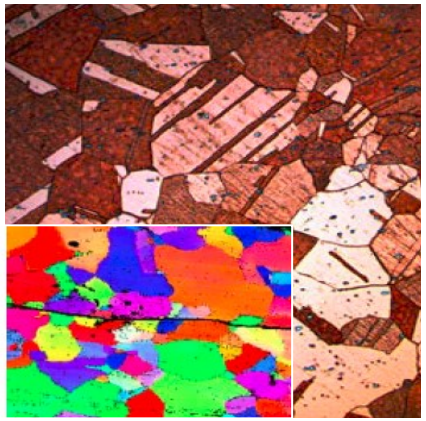


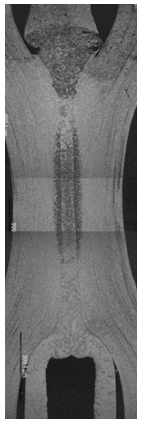
Non-charged

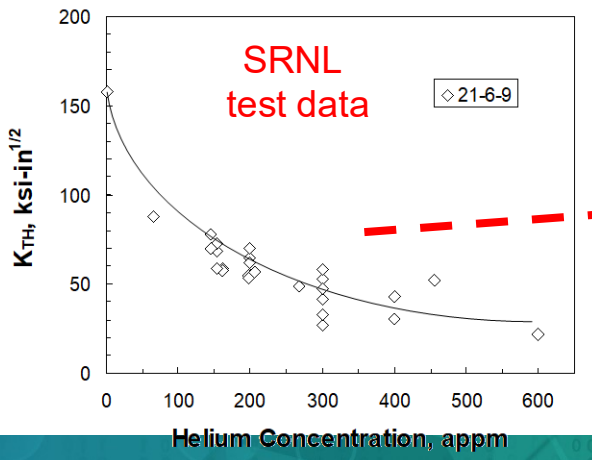


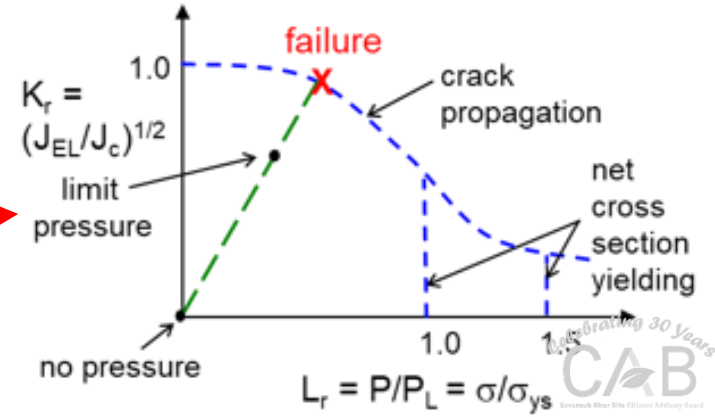
T_2 Charged-and-Aged





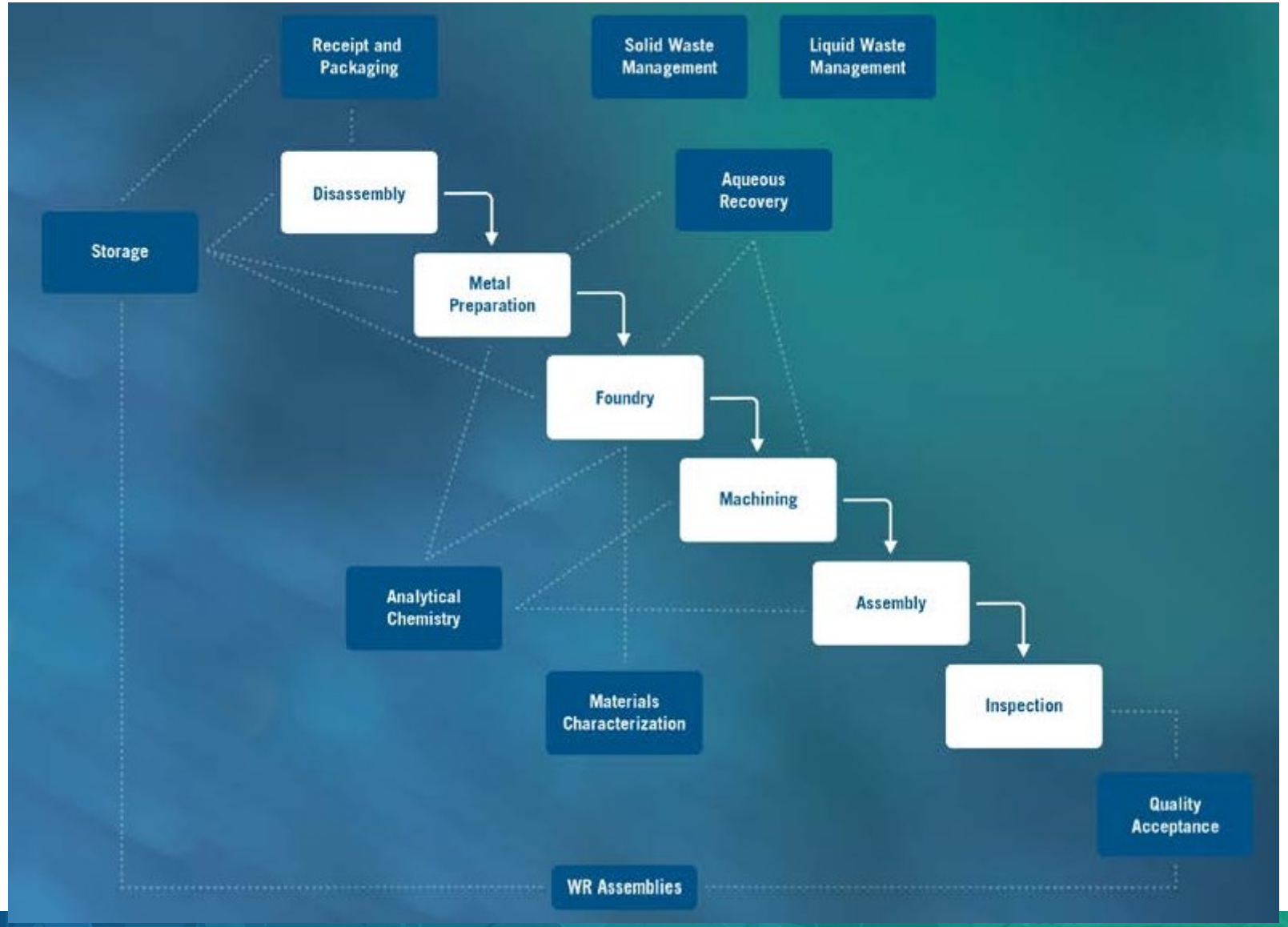






SNL/CA failure assessment diagram

SRNL is Providing Subject Matter Expertise for the Pit Production Process Flowsheet



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?

- Thank you.