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Integrating Waste Management Planning into the Design Process for Small Modular Reactors at the Idaho National Laboratory

LLW Forum Fall 2026 Meeting

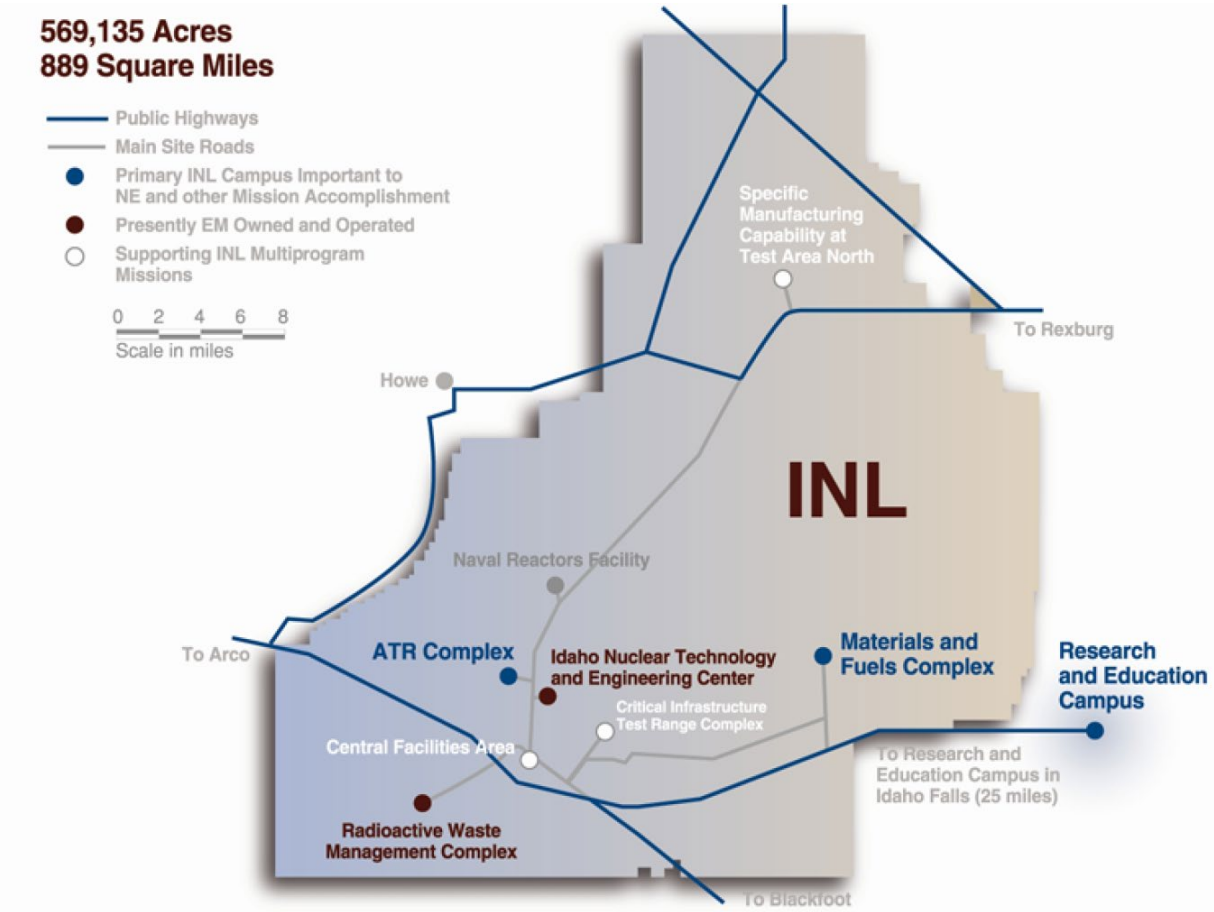
Battelle Energy Alliance manages INL for the
U.S. Department of Energy's Office of Nuclear Energy

Idaho National Laboratory

Idaho National Laboratory

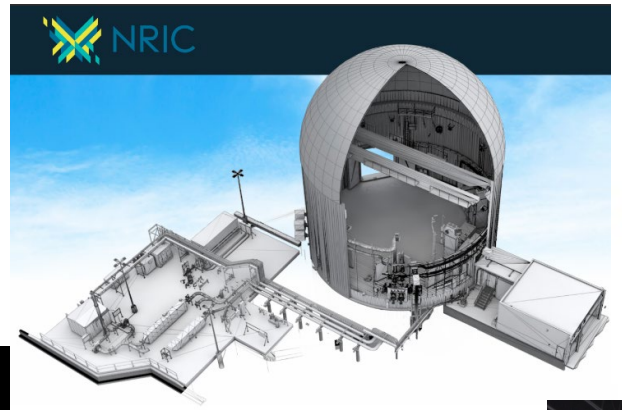
Managed by Battelle Energy Alliance, LLC (BEA) to discover, demonstrate and secure innovative nuclear energy solutions, other clean energy options and critical infrastructure

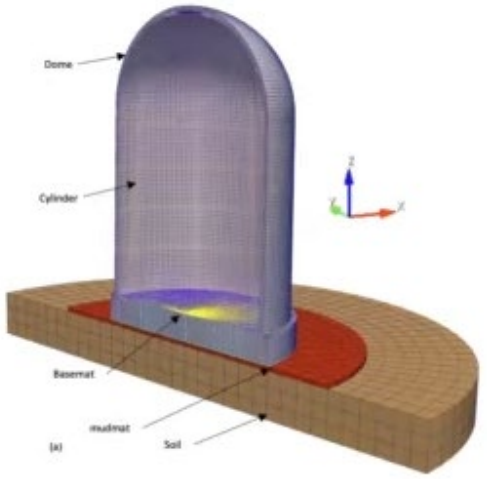
- INL National Reactor Innovation Center (NRIC)
  - Works with industry and other national laboratories
  - Bridges gap between concept, demonstration, and commercialization of advanced nuclear technology
- INL Waste Management Program (WMP)
  - Provides cradle-to-grave waste management services for INL and WFO generators
    - More than 600 active generators every year
    - Full cost recovery and chargeback system
    - More than 30 TSDF vendors
    - Dozens of active disposition paths for hazardous, radioactive, and mixed waste streams



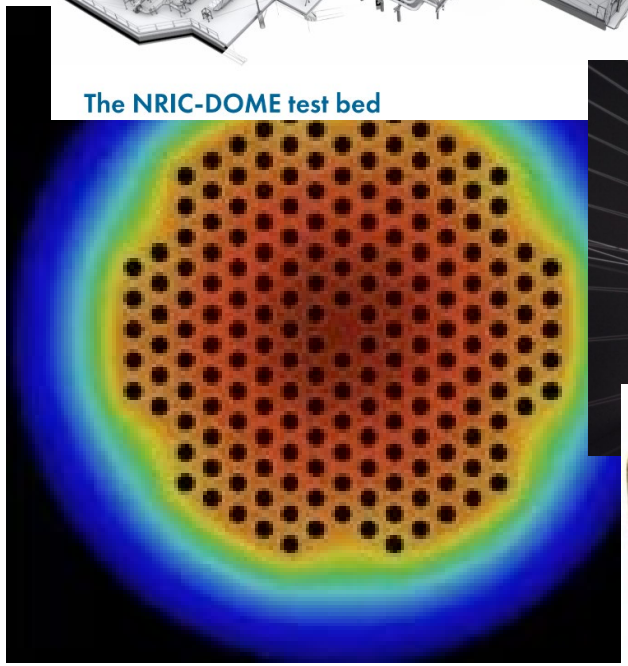
National Reactor Innovation Center (NRIC)

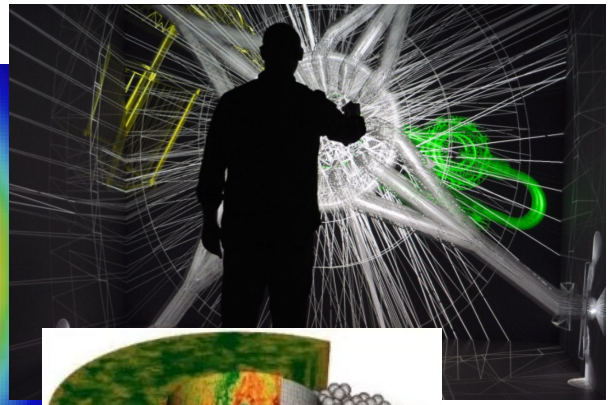
- Works with industry and other national laboratories to bridge gap between concept, demonstration, and commercialization of advanced nuclear technology
- Multi-faceted program supporting a wide variety of initiatives associated with advanced nuclear technology development and reactor demonstration projects
  - Project and program management
  - Test bed construction
  - On-site demonstration
  - Fuel qualification and irradiation testing
  - Three-dimensional modeling and design tools
  - Digital twinning
  - Partners with other INL organizations for safety basis development, criticality safety evaluations, and regulatory and economic risk analysis

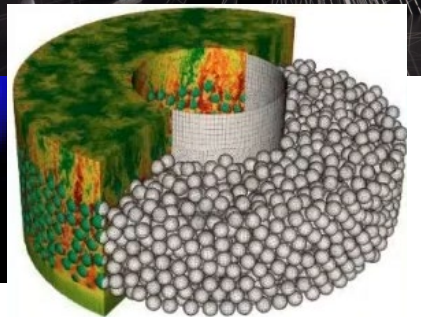




The NRIC-DOME test bed





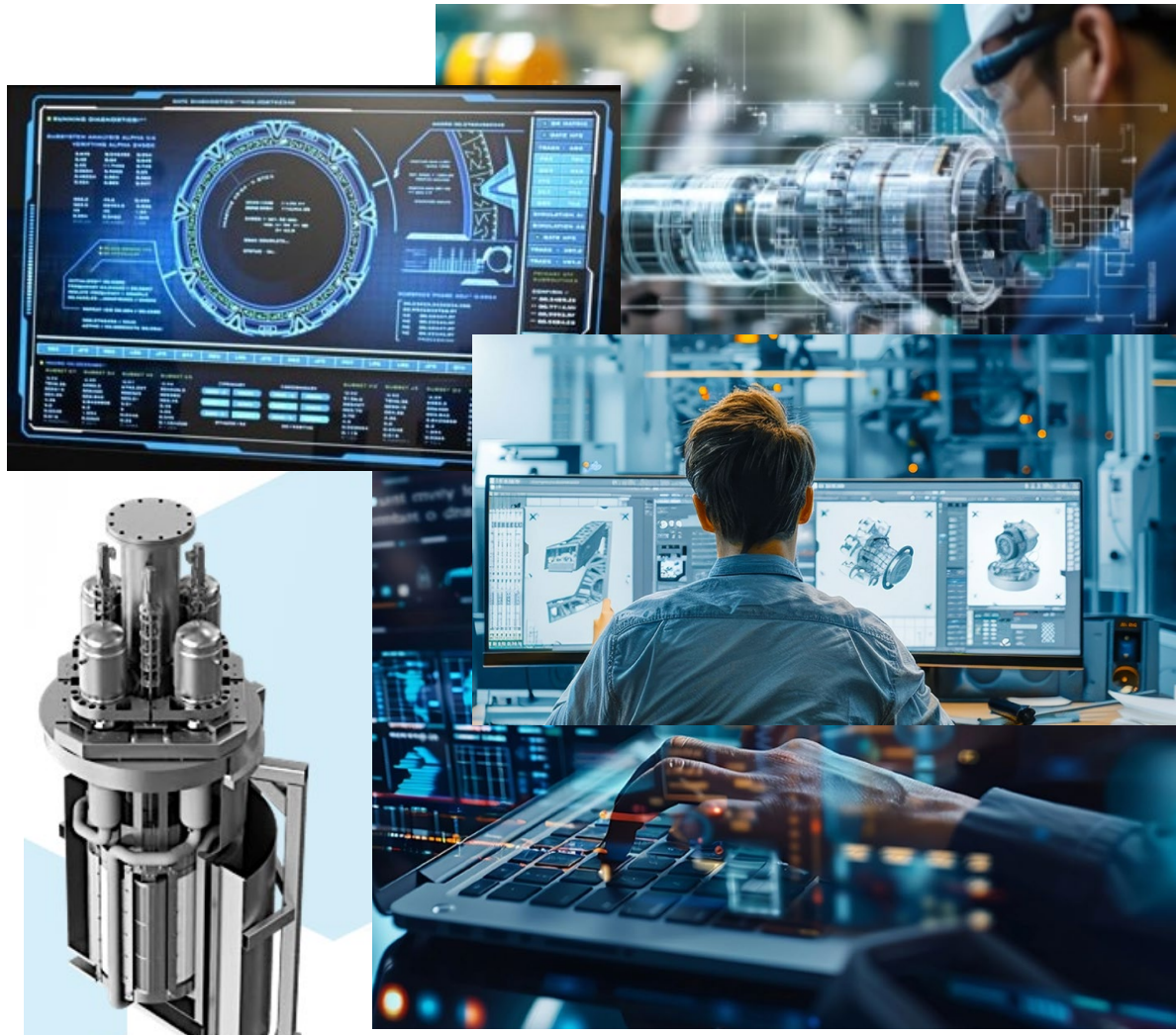


INL Waste Management Program (WMP)

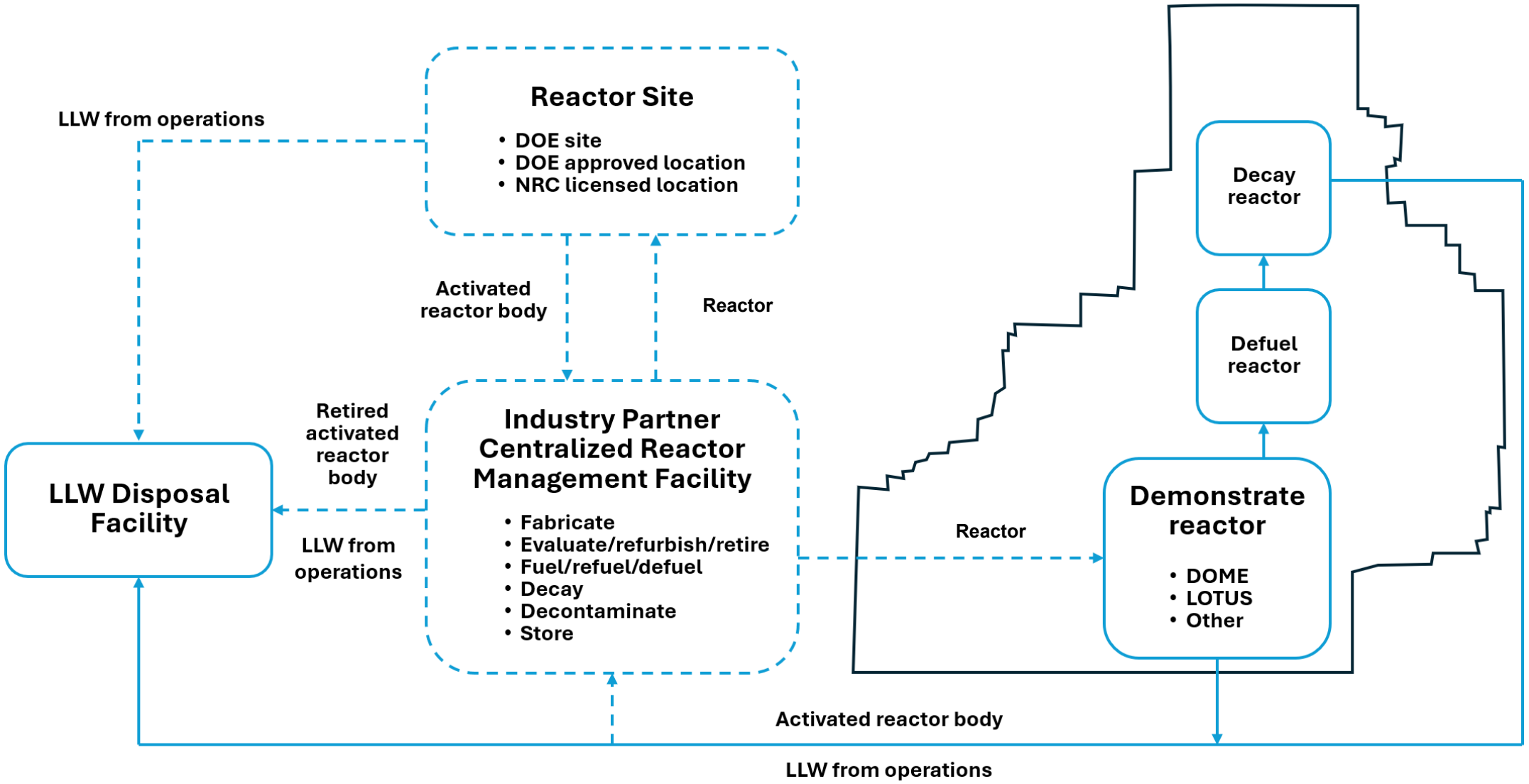
- Opens and maintains disposition paths for hazardous waste, radioactive, and mixed waste
- Conducts or brokers disposition of more than 1400 containers per year
- Operates a full cost recovery and chargeback system that began in 2009
  - Maintains 17 years of detailed container-level cost information including labor, ODCs, and vendor charges
  - Updates container-level cost bases every year for service rate build-up and environmental liability estimates

NRIC and WMP Interface

- NRIC D&D Capability Stage Gate Review
  - December 2020
- NRIC Developers Best Practices Workshop
  - May 2023
  - Update project disposition strategy as designs mature
    - Baseline disposition strategies
    - Updates based on changes in materials, coolant, operational approaches, etc.
    - Activation analysis on reactor components and materials
  - Clarify waste disposition fiscal responsibility with agreement parties
    - INL generators pay for waste disposition
  - Leverage waste strategy into a strength
    - Inform stakeholders you know how much waste you are going to generate, where it's going, and how much it's going to cost

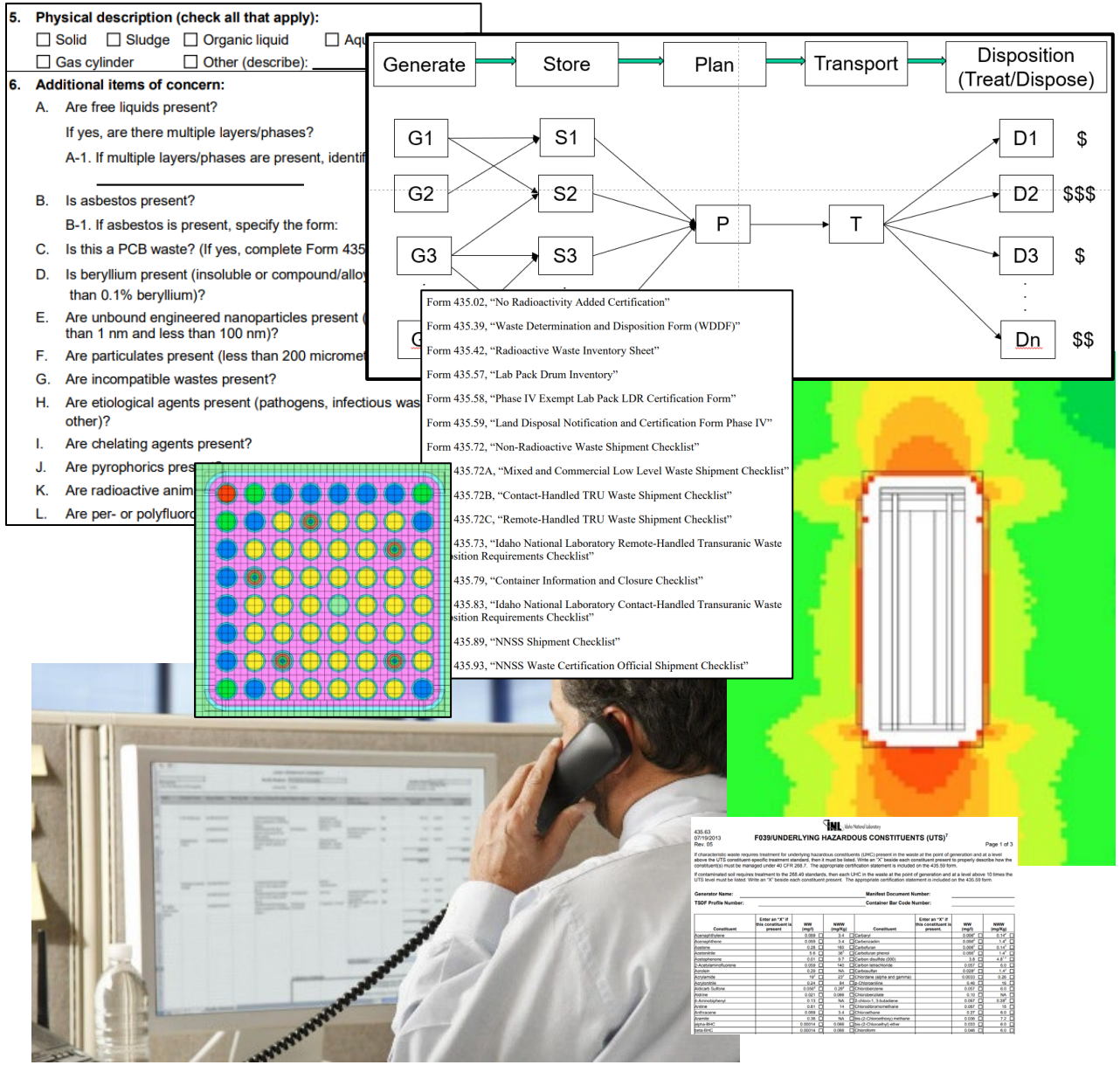


Generic SMR/Microreactor Roadmap



Design Integration Process

- NRIC Project Manager connects Industry Partner with WMP
- Industry Partner provides component level activation analysis to WMP
- WMP conducts iterative component-by-component analysis
  - TSDF WAC evaluation
  - Treatment strategy
  - Container selection and loading strategy
  - DOT shipping strategy
- Develop project specific waste management plan and cost estimate
- Feedback results to Industry Partner
  - Opportunity to make design changes
  - Repeat process until achieve desired result
  - Benefits INL demonstration and long-term commercialization goals



Project Examples

- Beryllium reflector
  - Final design approval delayed over concern that scab uranium would transmute into plutonium
  - Design team a bit surprised
    - Advantages of beryllium reflectors well known for reactor performance
    - Contacted WMP
    - Modeled for less than one year run time at several hundred watts => Class A LLW
  - Commercialization impacts
- Heat pipes containing sodium
  - Engaged WMP during conceptual design phase
  - Provided component activation analysis to WMP/WGS for analysis
  - Modified design
    - Heat tubes detachable from core and be treated separately
    - Avoided generation of some GTCC components

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.