NRIC National Reactor Innovation Center

NRIC-DOME Ecosystem

Overview and Status

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Ecosystem Overview

The National Reactor Innovation Center – Demonstration of Microreactor Experiments (NRIC-DOME) is more than just a test bed – a start to finish platform to bring the laboratory together with industry for advanced reactor development.

- **Construction of Physical Systems:**
  - NRIC-DOME Facility Construction
  - NRIC-DOME Equipment and Infrastructure (E&I)
- **Interface with DOME Users:**
  - Front-End Engineering and Experiment Design (FEEED)
  - Detailed Engineering and Experiment Planning (DEEP)
  - User guides
  - Technical interface
  - Schedule application process
- **Operations:**
  - Readiness, NRIC operating crews and staff
  - Reactor Installation - fuel storage, reactor assembly, and fueling
  - Testing
  - Decommissioning – reactor cooling & defueling

NRIC-DOME Ecosystem

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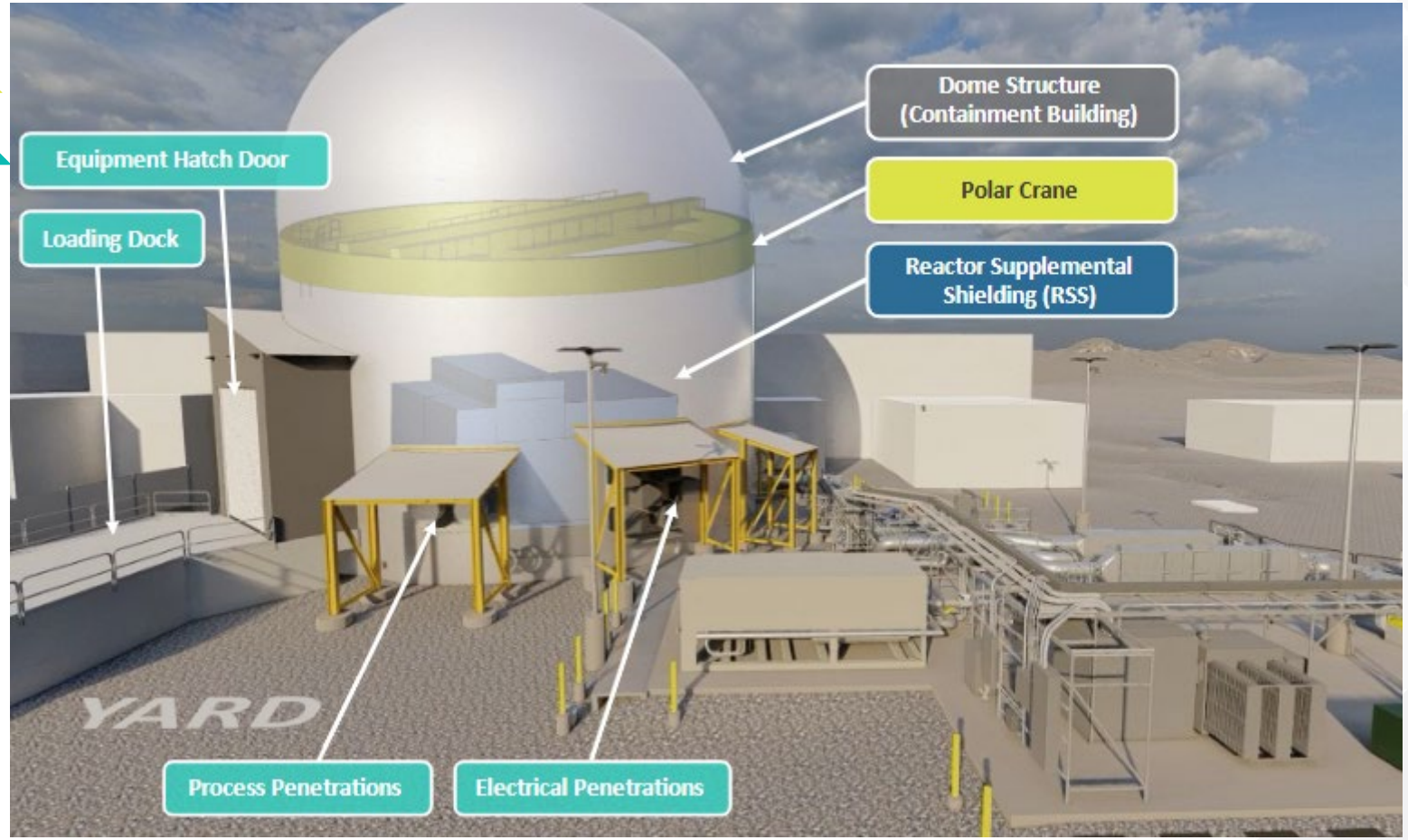
Physical Systems



- NRIC-DOME is the re-established EBR-II structure
- Designed for Advanced Microreactors up to 20MW_{th}
- Designed for High-Assay Low-Enriched Uranium ((HALEU) enrichment < 20%)
- Containment up to 10 psi
- Accommodates ISO 668 High-Cube Shipping Containers up to 40ft long
- 480V / 400Amp electrical service
- ≈ 78 ft diameter floor space with an 80ft ceiling
- 300kW of environmental cooling

Accomplishments

- Significant progress in construction, equipment and infrastructure activities, and safety basis development:
  - Penetrations being fabricated and installed
  - Factory acceptance testing completed for the equipment hatch
  - Substantial progress on all ancillary equipment and infrastructure
- Implemented robust FEEED and DEEP processes:
  - Completed FEEED process for two developers
  - Entered DEEP process for two developers
- Initiated staffing for operations phase:
  - Hired NRIC-DOME reactor manager
  - Posted for NRIC-DOME operations shift supervisor
  - Subcontracted commissioning agent
- Life cycle planning for new fuel storage, fueling, testing, cooling, and decommissioning and defueling:
  - Identifying locations for on-site reactor assembly and fueling
  - Identifying location for fresh fuel storage

Installation of Plant Air Insert

Risks and Challenges

Supply Chain Delays:

- Several Government Furnished Equipment (GFE) delivery dates have slipped.
- Polar crane delivery is longer than planned and being challenged to ensure readiness of NRIC-DOME to receive reactors.
- Shielding design and fabrication longer than originally planned - complex design for modularity, temperature limits, and materials.

Mitigations for procurements and supply chain:

- NRIC is working with vendors to improve delivery dates.
  - Site visits – staff and management
  - Active engagement with vendors
- Innovative contract mechanisms implemented to improve performance.
  - Schedule performance incentives incorporated in selected contracts.
  - Phasing and early engagement of fabrication subcontractors in design contracts.

DOME Hatch: Prep for Factory Acceptance Testing

Opportunities for Efficiency

- Provide the capability to receive and store unirradiated fuel (potential location - CPP-651)
- Provide the capability to fuel reactors at Idaho National Laboratory (INL) but outside of NRIC-DOME - potential locations:
  - Sodium Component Maintenance Shop (SCMS) at the Materials and Fuels Complex (MFC)
  - Remote Handled Low-Level Waste (RHLLW) Facility
- Provide the capability to cool and defuel irradiated reactors (potential location – Radioactive Scrap and Waste Facility [RSWF]).
- Potential use of a gantry crane to provide alternate means of lifting and assembling first reactor.

Providing additional front-end and back-end capabilities can accelerate developer schedules and reduce the time developers need inside the NRIC-DOME – Maximize NRIC-DOME availability.

Ecosystem Path Forward

- Complete construction and E&I activities through commissioning.
- Finish staffing for NRIC operations and finalize operational readiness plans.
- Work with Department of Energy (DOE) to finalize planning for fuel storage, fueling, testing and defueling/decommissioning.
- Release Notice of Opportunity for scheduling developers into NRIC-DOME.
- NRIC will be ready to receive advanced reactors for fueling in 2026.

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NRIC-DOME Construction

Chance Price

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NRIC-DOME Construction Flythrough

The video includes a 3D model projection of the National Reactor Innovation Center-Demonstration of Microreactor Experiments (NRIC-DOME) facility final design.

NRIC- DOME Facility

Accomplishments:

- Water jetting concrete for the penetrations and hatch
- Removed steel plate and concrete blocks from NRIC-DOME interior east wall.
- 3 steel cuts for the penetrations
- Removed old loading dock vestibule

Next Steps:

- Cut NRIC-DOME steel for remaining penetrations and hatch.
- Complete penetration and hatch installation

2024

2025

NRIC-DOME Equipment Pad

Accomplishments:

- Concrete pad form and pour.
- Received/installed the following:
  - Ventilation exhaust stack
  - Exhaust stack monitor enclosure
  - Ventilation HEPA filter bank
  - Makeup air unit
  - Conduit bridge and HVAC ductwork installation
  - Electrical power switchboard assembly
  - Handrail

Next Steps:

- Complete equipment installation.

2024

2025

NRIC-DOME Control Room Accomplishments

Accomplishments:

- Post rough-in
- Texturing in prep for paint
- Paint the control room
- Installed electrical instrumentation and controls cabinet and conduit
- Installed inline heater and fan
- Installed raised floor
- Installed drop ceiling
- Installed furniture and handrails.
- Completed Estech's control room scope

Next Steps:

- Final electrical connections

2024

2025

NRIC-DOME Hatch/Penetrations

Accomplishments:

- Fabrication of Hatch assembly
- Fabrication Utility Penetrations:
  - Ventilation
  - Utility service
  - Developer process lines
  - Developer electrical
- Completed the Hatch Facility Acceptance Testing
- Received 2 penetrations at Idaho National Laboratory (INL)

Next Steps:

- Receive remaining penetrations and hatch at INL and install

NRIC-DOME Polar Crane

Trade study compared the following: lift capacity, lift height, lift coverage, lift velocity, footprint, single failure proof and efficiency.

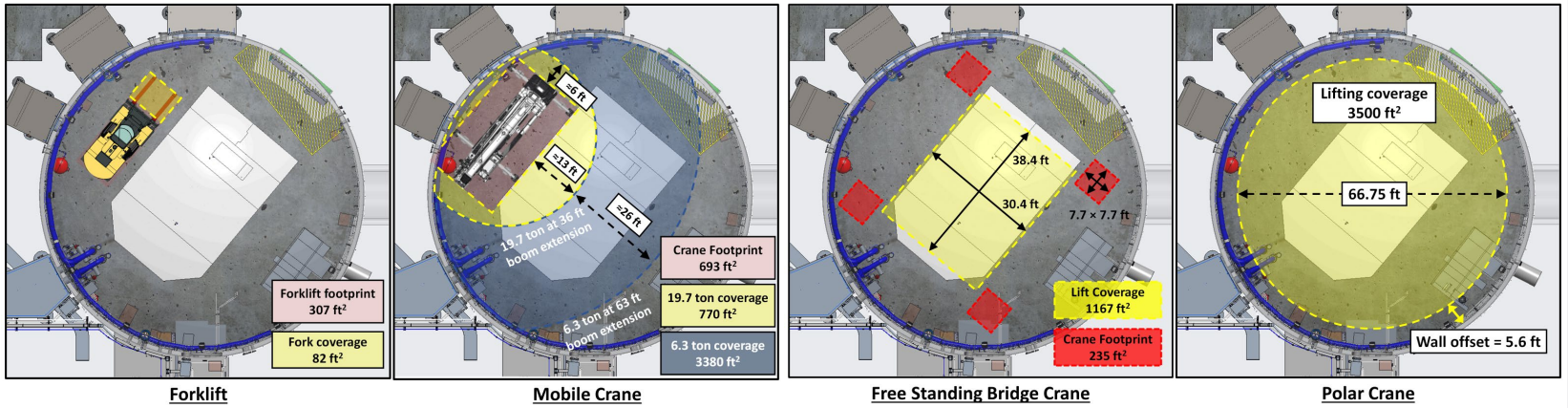
- The polar crane offers significantly more operational flexibility at a comparable price to the gantry crane.

Accomplishments:

- Released the Polar Crane Repair Specification
- Awarded the Polar Crane Repair subcontract

Next Steps:

- Work with subcontractor to identify opportunities to improve schedule.



Forklift | Mobile Crane | Free Standing Bridge Crane | Polar Crane

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NRIC-DOME Support Equipment & Infrastructure (E&I)

Chance Price

4/1/2025

NRIC-DOME Reactor Supplemental Shielding (RSS) and Reactor Anchoring Platform (RAP)

A radiation shielding system is needed to protect personnel and equipment from harsh neutron and photon fluxes during:

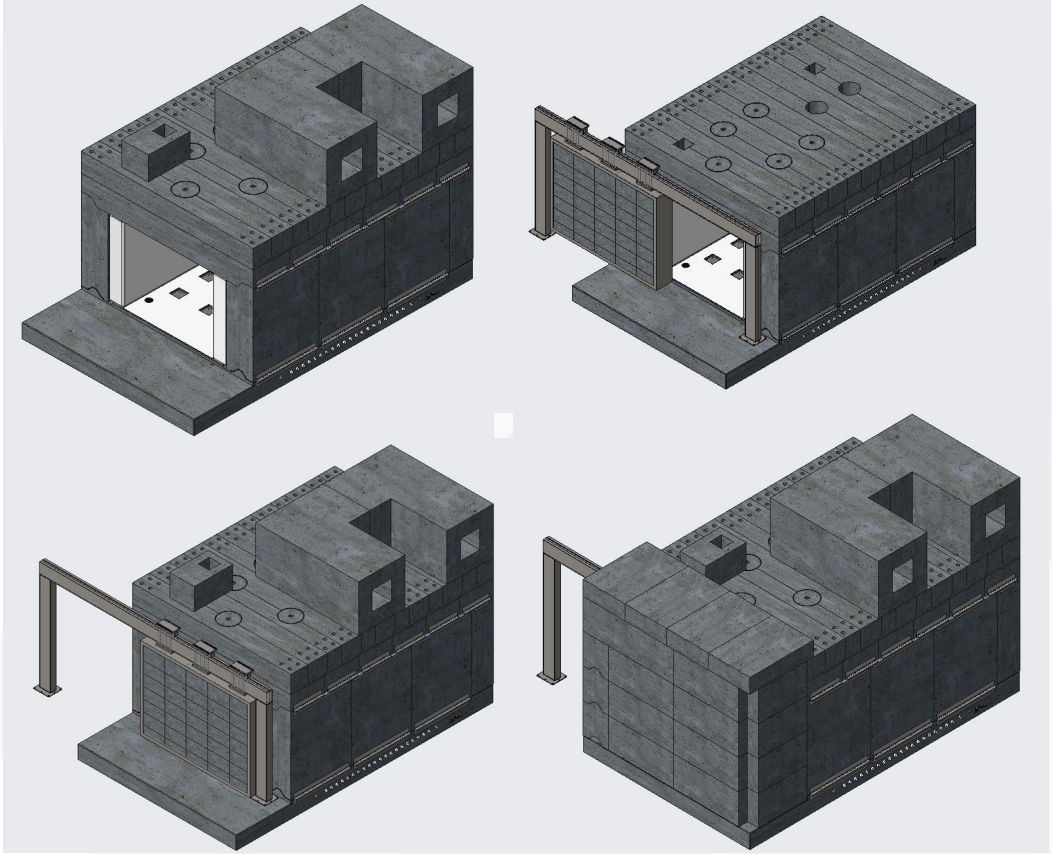
- Reactor operations
- Post shut down operations
- Disassembly
- Decommissioning

Accomplishments:

- Completed RSS/RAP preliminary design.
- Awarded final design subcontract.

Next Steps:

- Complete Final Design.
- Initiate Procurement for RSS fabrication and RAP construction.



NRIC-DOME Remote Teleoperated (RTO) Equipment

The RTO will be used in conjunction with one of the two NRIC-DOME Polar Crane's trolleys to perform a variety of tasks during reactor operations and post shutdown operations.

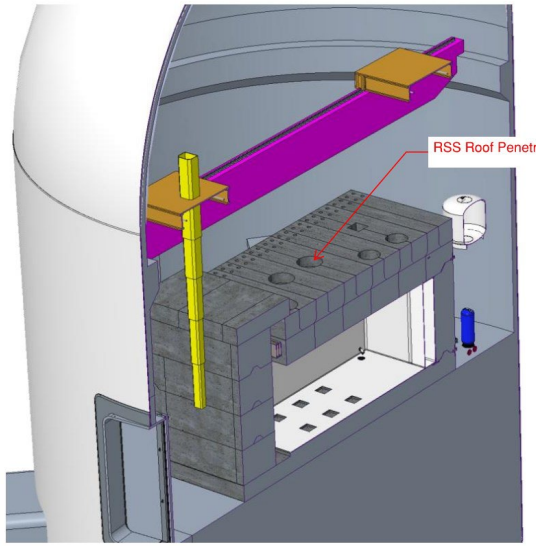
- The RTO equipment is necessary to protect personnel from hazardous conditions created during the reactor experiments.

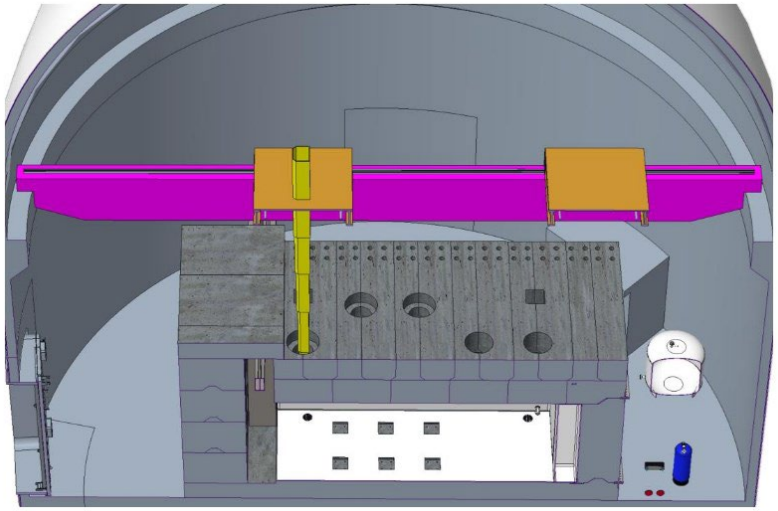
Accomplishments:

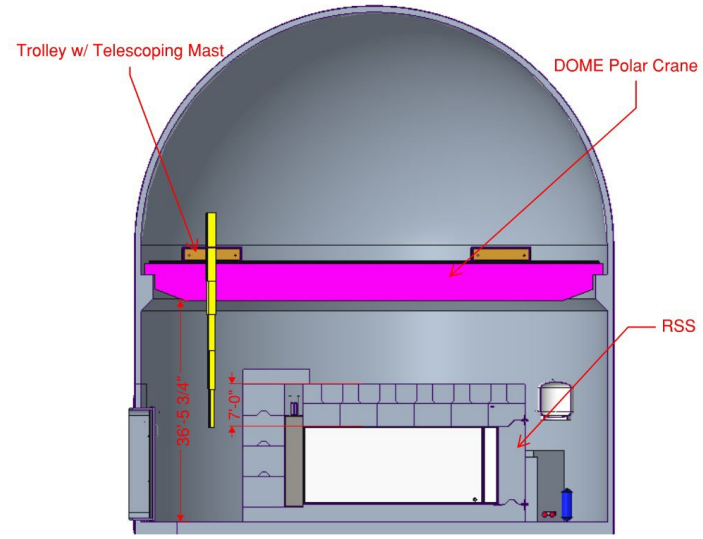
- Released the RTO specification

Next Steps:

- Issue RFP to solicit proposals for design and fabrication of the RTO system







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NRIC-DOME Reactor Handling System (RHS)

Many large components including shield panels, reactor support equipment, microreactors, and transport shielding will need to be moved inside of NRIC-DOME.

- The RHS will lift these components onto the loading dock, rotated to align with the equipment hatch, and brought through the equipment hatch to be picked up by the Polar Crane.

Next Steps:

- Issue RFP to solicit solutions
- Issue contract for RHS support

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NRIC-DOME Test Reactor Fuel Cycle

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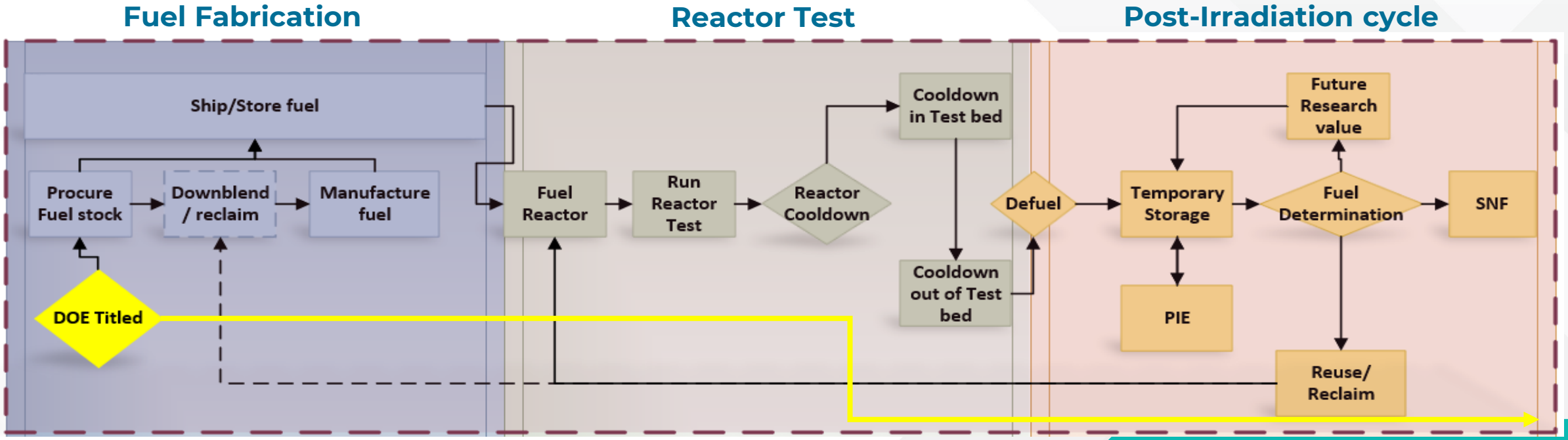
NRIC-DOME Fuel: Cradle to Grave

- Process needs to be informed by key Department of Energy (DOE) policies.
- All current National Reactor Innovation Center – Demonstration of Microreactor Experiments (NRIC-DOME) developers are planning to a Tristructural Isotropic (TRISO) based reactor with DOE titled fuel.
- Framework for the NRIC-DOME fuel cycle:



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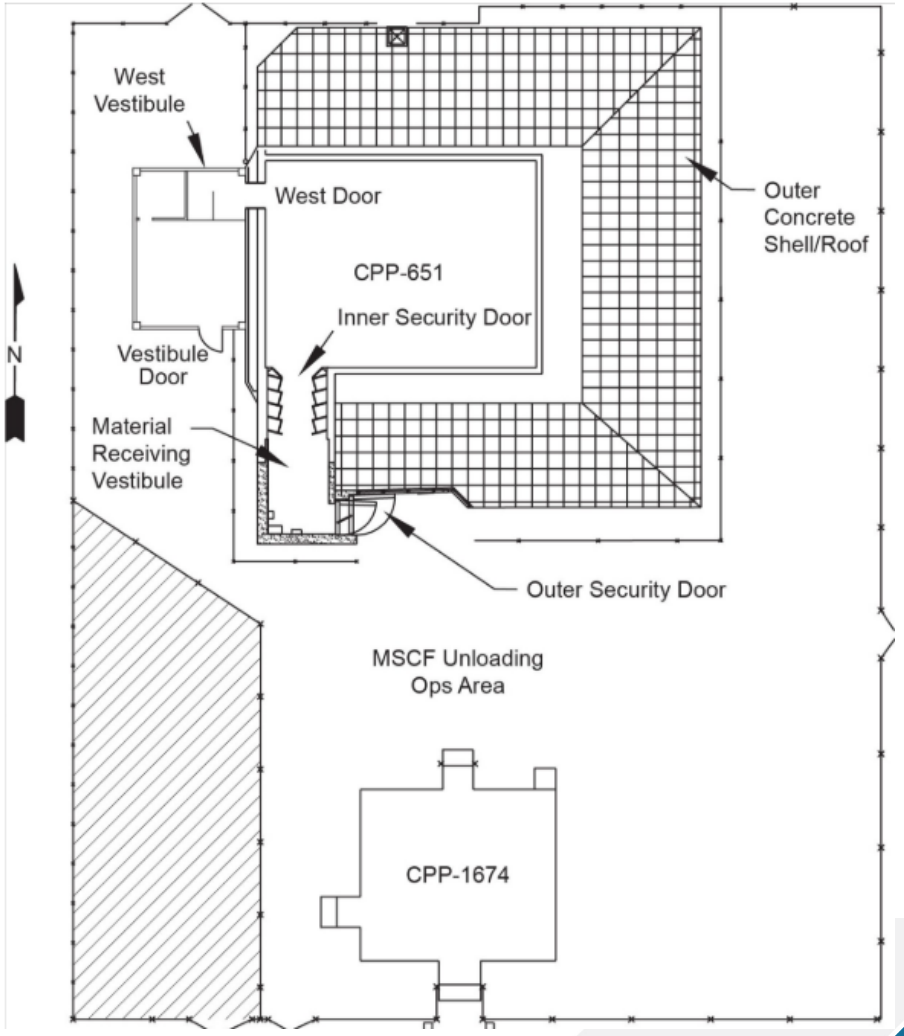
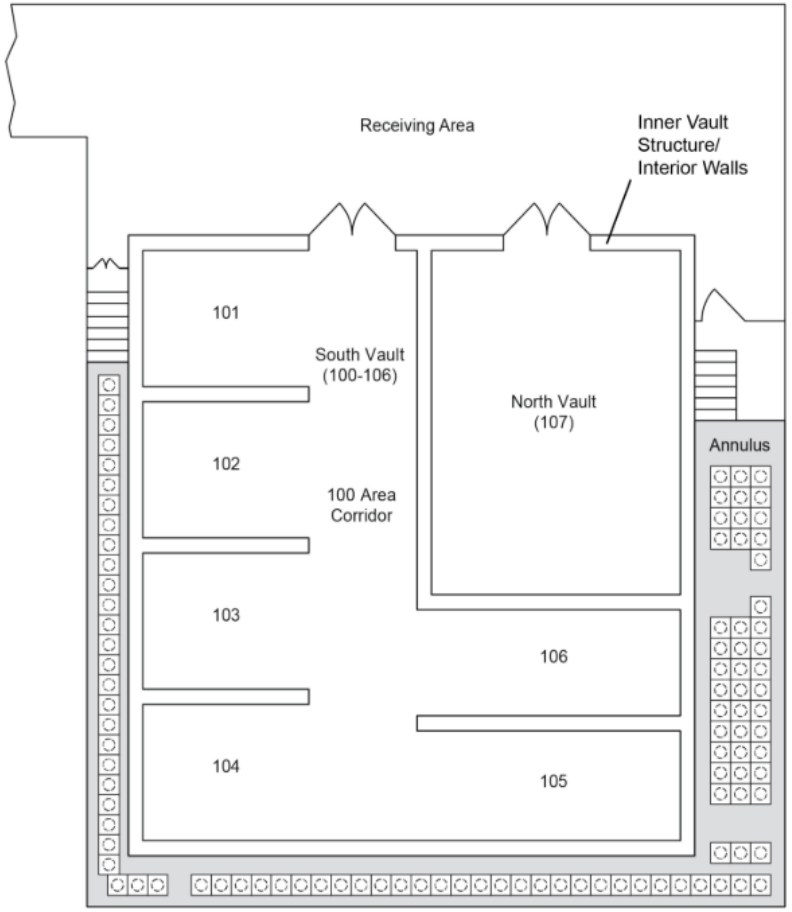
NRIC-DOME Fresh Fuel storage

- CPP-651 is the planned location for Fresh fuel storage if the fuel can not be shipped to NRIC-DOME.
- Space is available in rooms 101, 102, 103 and the annulus.





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Fueling NRIC-DOME reactors

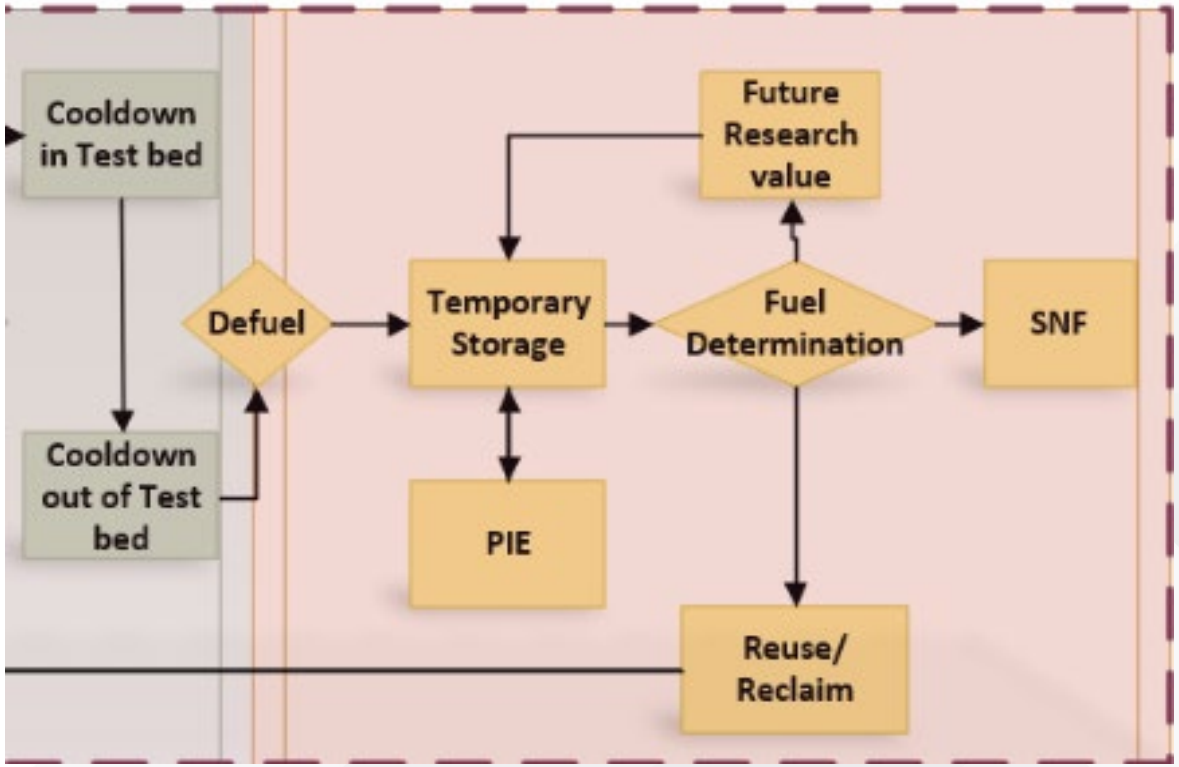
- Original plan to fuel reactors in NRIC-DOME.
- A potential opportunity to identify an alternate reactor assembly or fueling location is underway.
  - Optimizes availability of NRIC-DOME.
  - Mitigate possible schedule delays and provide opportunities for early reactor deliveries.
- Fueling reactors is a collaborative effort with reactor developers.
- Startup physics is an important data point for all reactors to be in NRIC-DOME.

Post Irradiation Fuel Management Plan (PLN-7043)

This is initial high-level process overview framework for managing the post irradiated fuel from the reactors in NRIC-DOME.

- Outlines the steps for managing NRIC-DOME reactor fuel post-irradiation. Need to evaluate all possibilities.
- This plan is being developed in parallel with both the developers' removal and disposal plans and the NRIC-DOME construction.
- Key steps include cooldown, defueling, temporary storage, post-irradiation examination, fuel determination, future research value, spent nuclear fuel handling, and fuel reuse or reclamation.
- It is assumed that DOE has title of Fuel. This is a DOE collaboration.

All current NRIC-DOME developers are planning to a TRISO based reactor with assumed DOE titled fuel.



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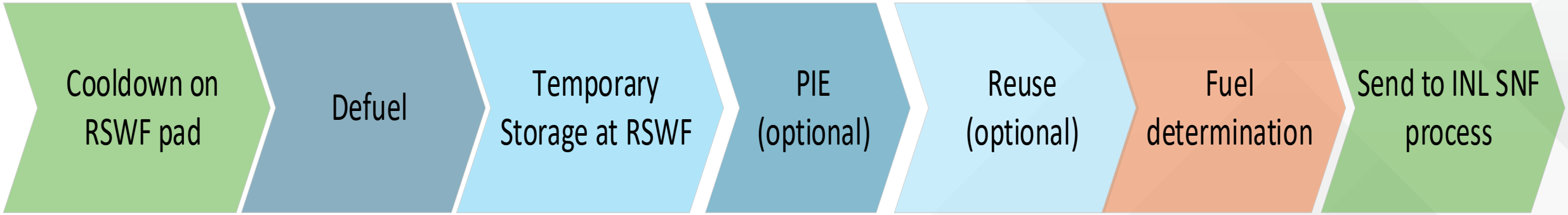
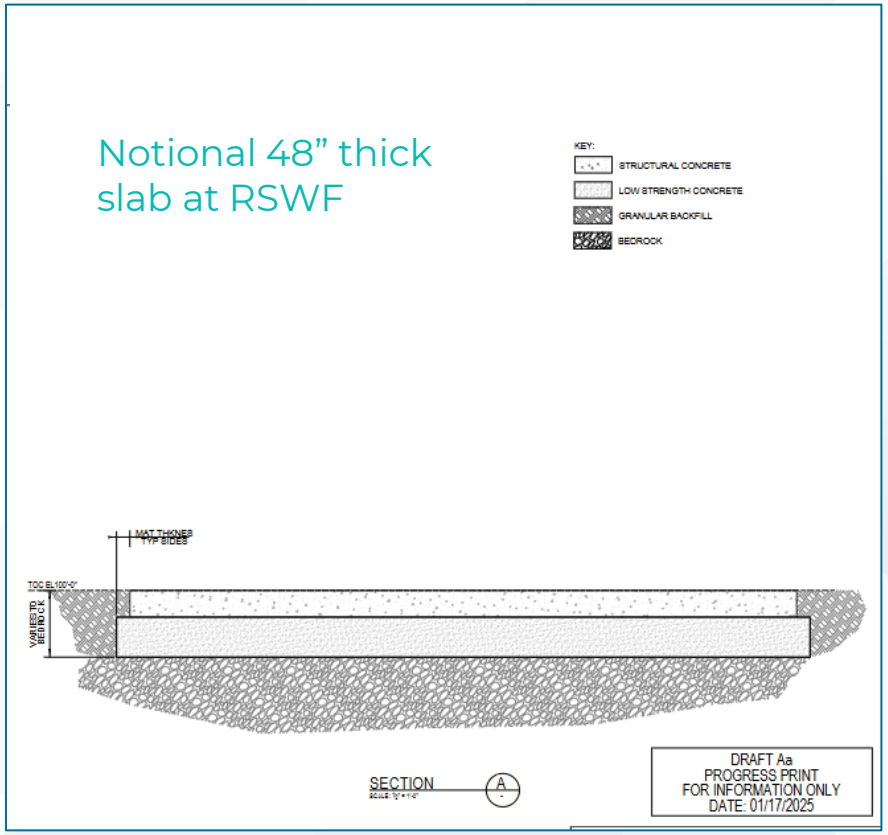
NRIC-DOME Fuel: Proposed Scope



Cooldown at Radioactive Scrap and Waste Facility (RSWF)

- Initial cooldown time in NRIC-DOME after reactor shutdown is experiment-dependent.
- Idaho National Laboratory (INL) plans to provide certain generic remote-operated equipment for Defueling and Decommissioning (D&D) activities.
- Current plan is for developers are responsible for providing transport shielding and specialized equipment needed to remove the reactor from the Reactor Supplemental Shielding (RSS).
- Transport shielding and removal operations will meet dose limits specified by INL.
- Heavy hauler equipment will be used to transport the reactor to RSWF for further cooldown.
- Extended cooldown is planned to be at a modified location at RSWF planned to be developed and funded by NRIC.

Notional 48” thick slab at RSWF



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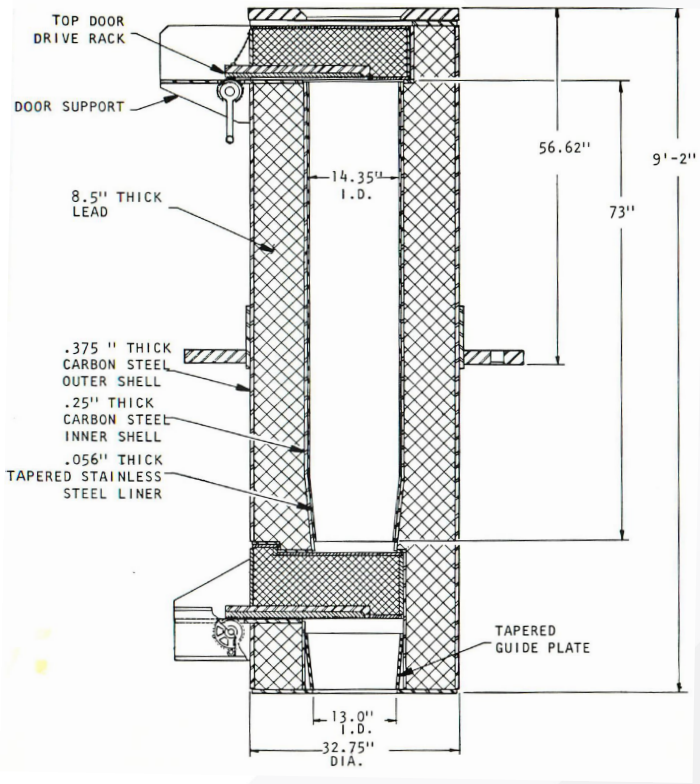
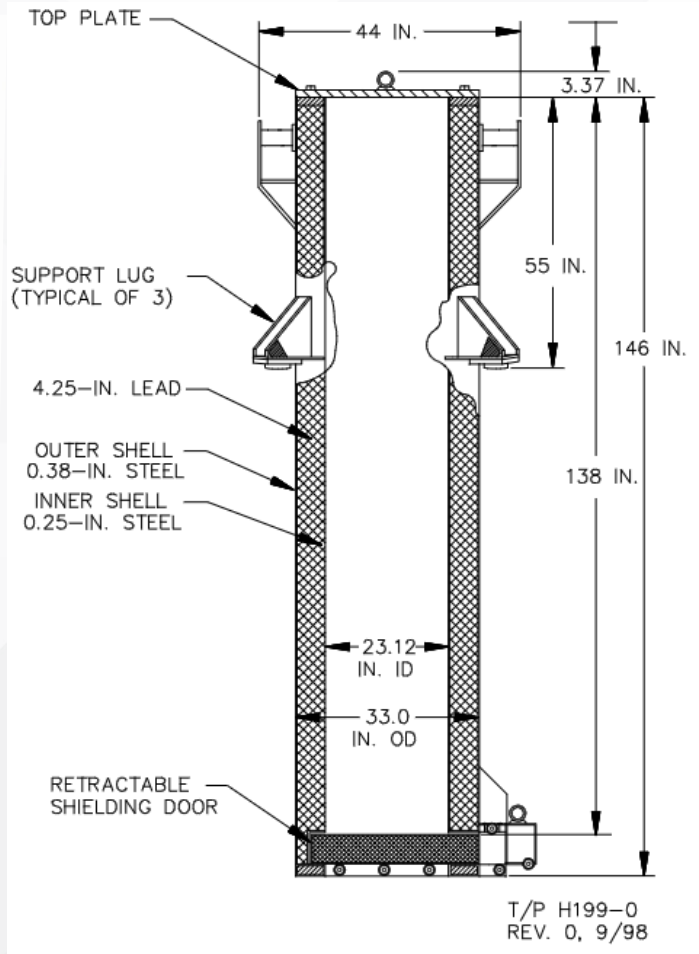
Defueling

- Defueling will occur after the RWSF cooldown.
- Each developer is responsible for developing the defueling plan for its respective reactor experiment.
- The current plans assume defueling will occur in NRIC-DOME.
- Fuel will be loaded into a container that is compatible with either, HFEF 14 of HFEF 5 cask.

HFEF-5

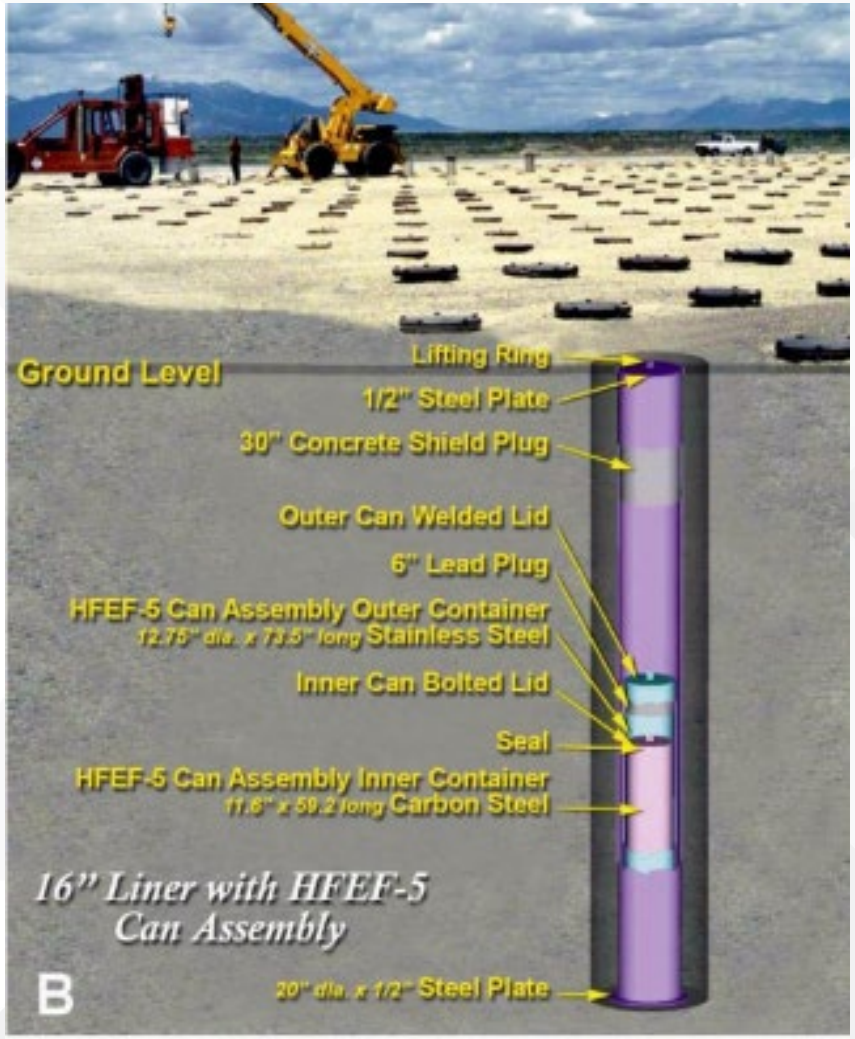


HFEF-14



Temporary storage and PIE

- Irradiated fuel are assumed be placed in existing canisters and casks and sent to RSWF for temporary storage prior to PIE or decommissioning/disposal.
- Any PIE activities are assumed to be done using existing facilities and processes for transportation to and from RSWF.
- Working assumption that DOE has title of fuel.



NRIC

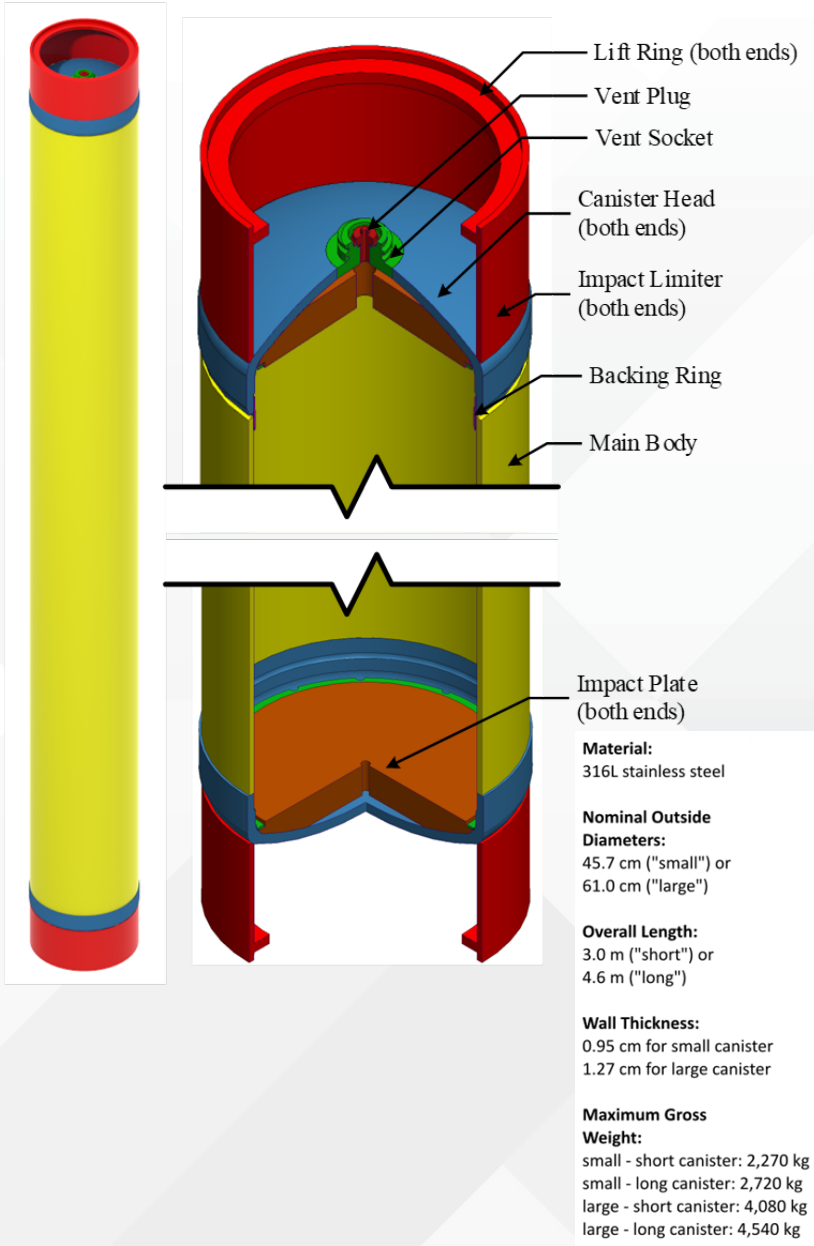
PIE Research SNF

Standard DOE SNF

- Once the fuel is determined as Spent Nuclear Fuel (SNF)
  - Managed in the same way as other DOE owned SNF at INL
  - Either NRIC or developer will pay costs for the existing SNF process
- Fuel disposition will be determined by a process that requires DOE approval.
- For removal from the INL site the DOE standard canister is an option being explored for storing, shipping, and disposal.

Bounding SNF

- 0.52 metric tons / experiment
- 10.4 metric tons over the 20-year lifetime (20 reactors).
- Entire amount of SNF, would be about 3.2% of the total current SNF inventory.



Material:
316L stainless steel

Nominal Outside Diameters:
45.7 cm ("small") or
61.0 cm ("large")

Overall Length:
3.0 m ("short") or
4.6 m ("long")

Wall Thickness:
0.95 cm for small canister
1.27 cm for large canister

Maximum Gross Weight:
small - short canister: 2,270 kg
small - long canister: 2,720 kg
large - short canister: 4,080 kg
large - long canister: 4,540 kg

Key Assumptions

1. NRIC is planning to modify the RSWF facility for the reactor cooldown period outside of the DOME cooldown period.
2. NRIC is planning to provide some generic equipment and infrastructure for defueling of the reactors.
3. RSWF is the planned storage location once it is defueled and waiting PIE, reuse, or determination as SNF. Collaborate with DOE on the facility use and costs.
4. DOE approval for use of these facilities, processes, and containers will need to be obtained collaboratively with the developers and DOE.
5. DOE has title of the fuel through the entire process. Continue collaboration with DOE.
6. After the reactor is defueled, all shipping and packaging of fuel is planned to use an existing processes for transport or dry storage/SNF.
7. The developer is responsible for costs for developing the defueling process and associated specific equipment, PIE, and reuse.
8. The Reactor developers are responsible for providing the defueling/disposal plan (DEEP), procedures, and specific equipment for defueling.
9. The developers are responsible for costs for Defueling, decommissioning, and RSWF storage/Cooldown.

Next Steps

NRIC is planning to provide a drafted update to the NRIC-DOME post irradiation fuel management plan by 7/31/2025 for further review and engagement with DOE.

Finalize a Pre-conceptual design for the RSWF cooldown pad by 7/31/2025.

Continue to work with Developers to define the processes needed to support the back end of NRIC-DOME.

Work with DOE to finalize plans and funding requests

Continue to develop plan for Fueling reactors in alternate to NRIC-DOME locations.