INL/MIS-23-73826-Revision-0

Powerpoint Presentation for BEA-IEC Packaging Demonstration Meeting at Hanford (08/07 thru 08/11)

August 2023

Daniel Albert Thomas, Devin D Imholte

Changing the World's Energy Future

Idaho National Laboratory

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Daniel Thomas
Manager, Used Fuel Management Department

Review of DOE Standard Canister Remote Closure System

SNF Canister Closure Welding Technology Exchange and Demonstration

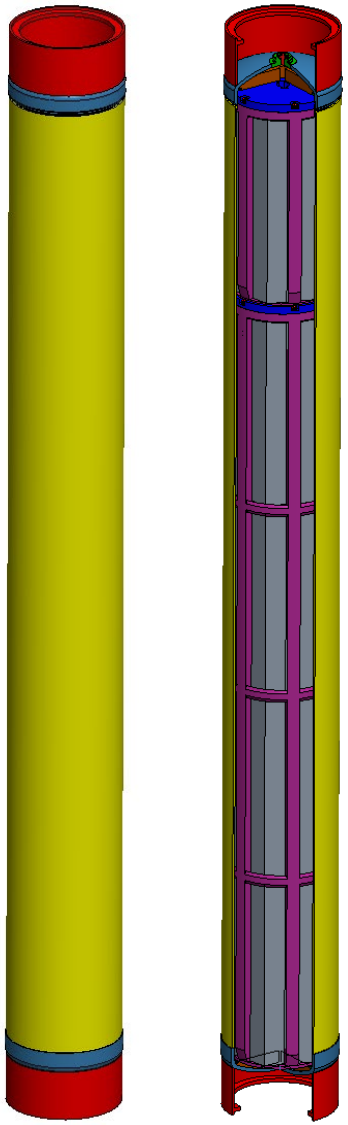
August 9th and 10th, Hanford Site

IDAHO ENVIRONMENTAL COALITION

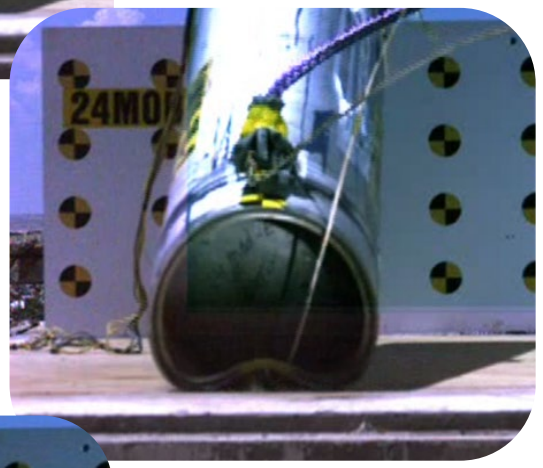
INL Idaho National Laboratory

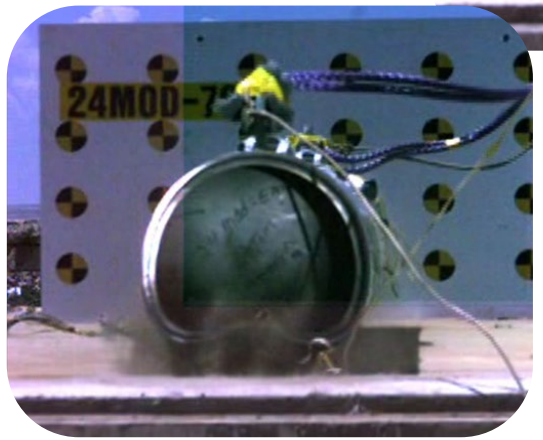
Outline

- DOE Standard Canisters (DOESCs)
- Remote Closure System
- Planned first use
  - DOE SNF Packaging Demonstration Project (Idaho Environmental Coalition (IEC) Led)
- Future uses



DOE Standard Canister





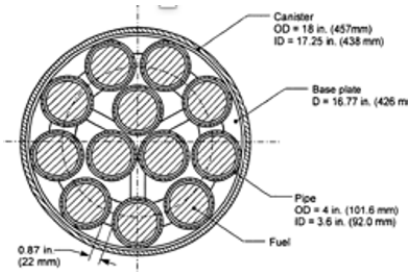
2004 Ø24" DOE Standard Canister Drop Test

DOESCs

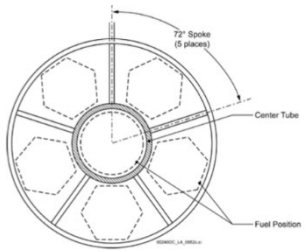
DOE Standard Canisters

- DOESCs for DOE-managed SNF were developed by the NSNFP in the 1990s.
  - Provide a robust barrier that prevents moderator intrusion and radionuclide release
  - Minimize reliance on the fuel form by transferring the safety function to the canister integrity
  - Provide standardized containers for the 200+ DOE SNF fuel types
- DOESCs were included in the Yucca Mountain license application (DOE/RW-0573) and the Idaho Spent Fuel Facility (NRC License SNM-2512).
  - Tested to meet 10 CFR 71 drop tests WITHOUT additional packaging*
  - The containment-confinement barrier also vastly simplifies future handlings away from hot cells.
- A range of internal basket designs exists to support the broad range of SNF.

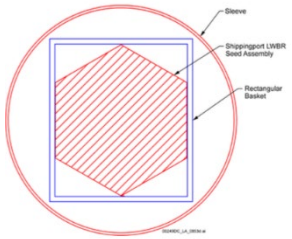
Drop Test of DOE Standard Canister at SNL - 1999



Type 4



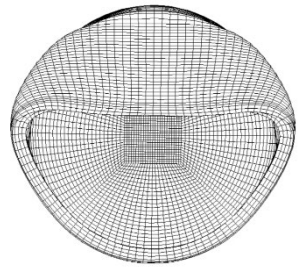
Type 3



Type 6c

Type 1a

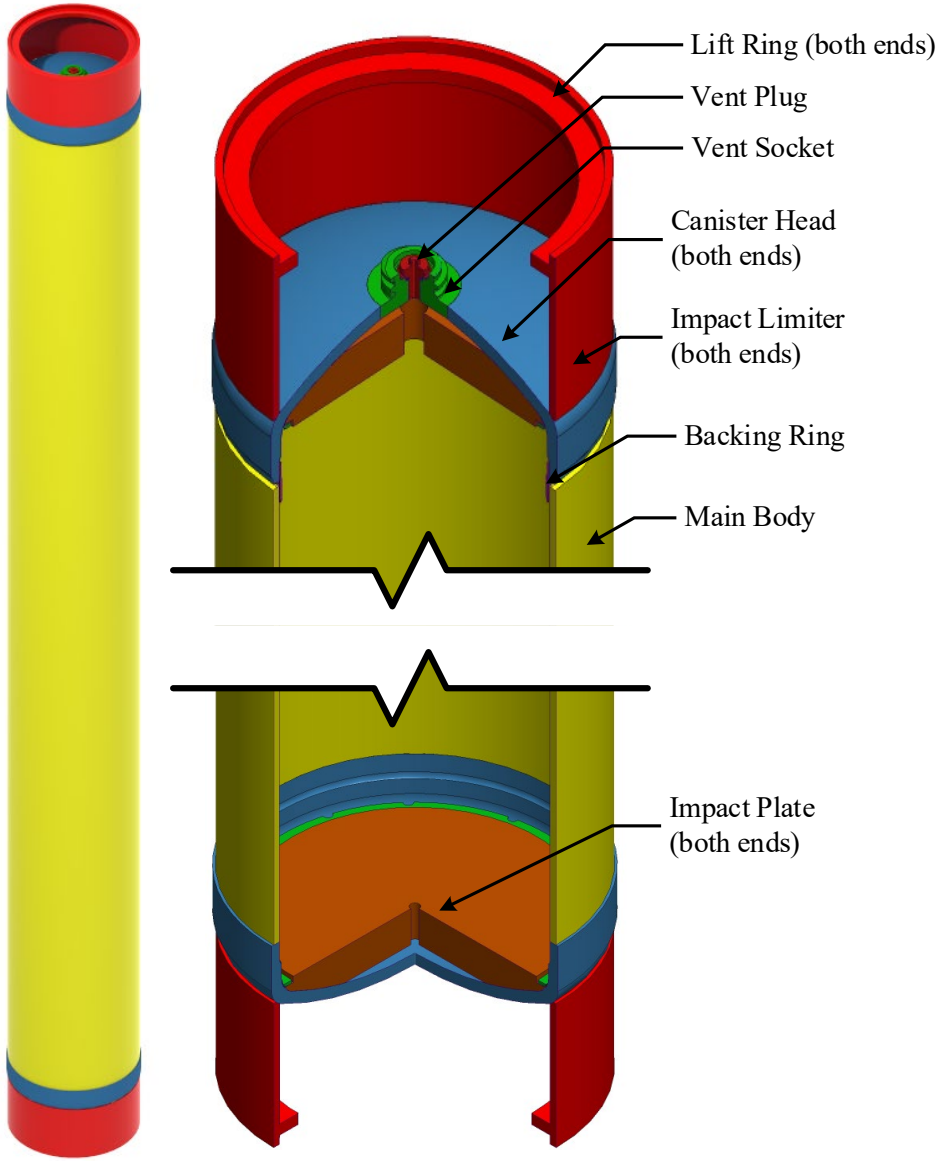
*Packaging refers to the storage overpacks, transfer casks, transportation casks (with impact limiters), and waste packages.



Comparison of Actual and Simulated Drop Tests

NSNFP – National Spent Nuclear Fuel Program; NRC – Nuclear Regulatory Commission; SNF – Spent Nuclear Fuel

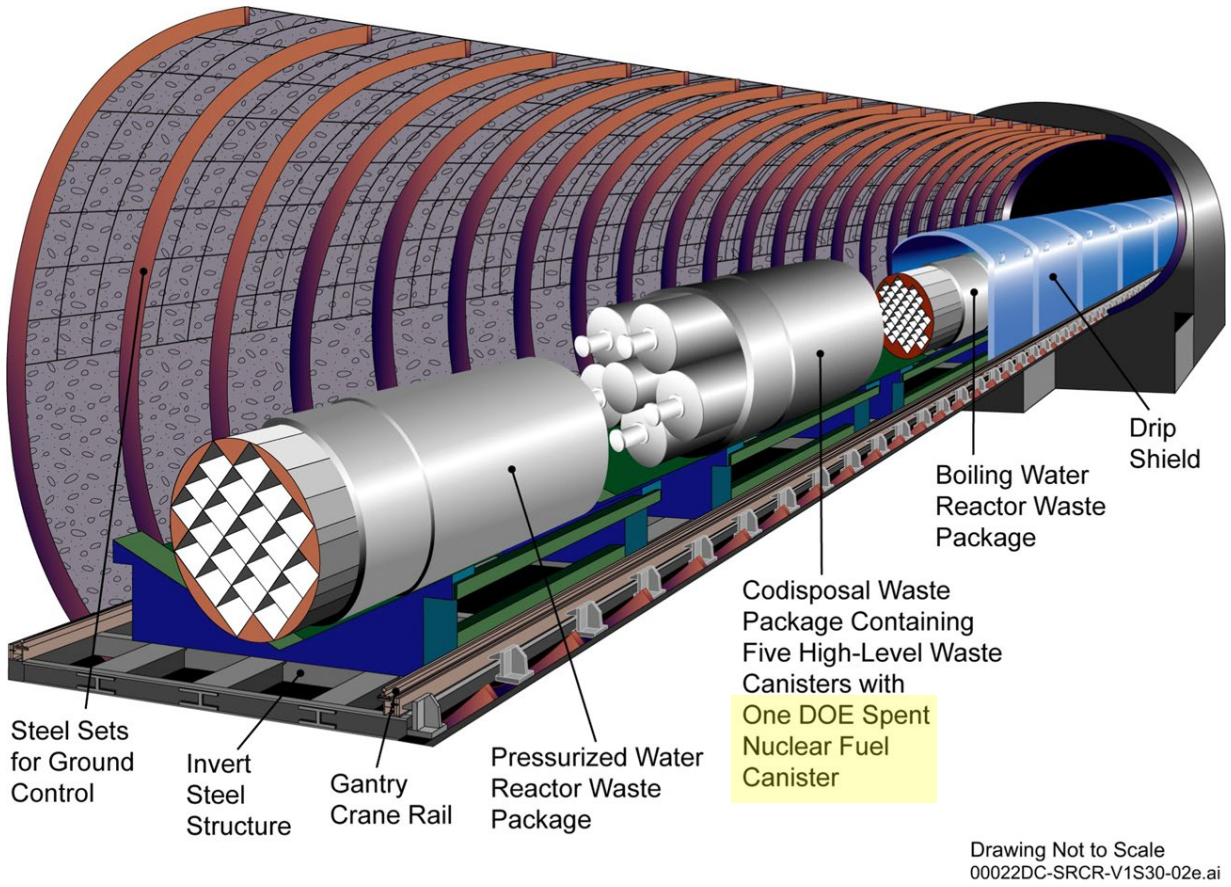
DOE Standard Canister Design



Size (OD × Length)	Material	Wall Thickness	Gross Weight Rating (DOE/SNF/REP-011)
Ø18” × 10 ft.	316L Stainless Steel	3/8”	5,005 lb
Ø18” × 15 ft.			6,000 lb
Ø24” × 10 ft.		1/2”	8,996 lb
Ø24” × 15 ft.			10,000 lb

Use of DOESCs

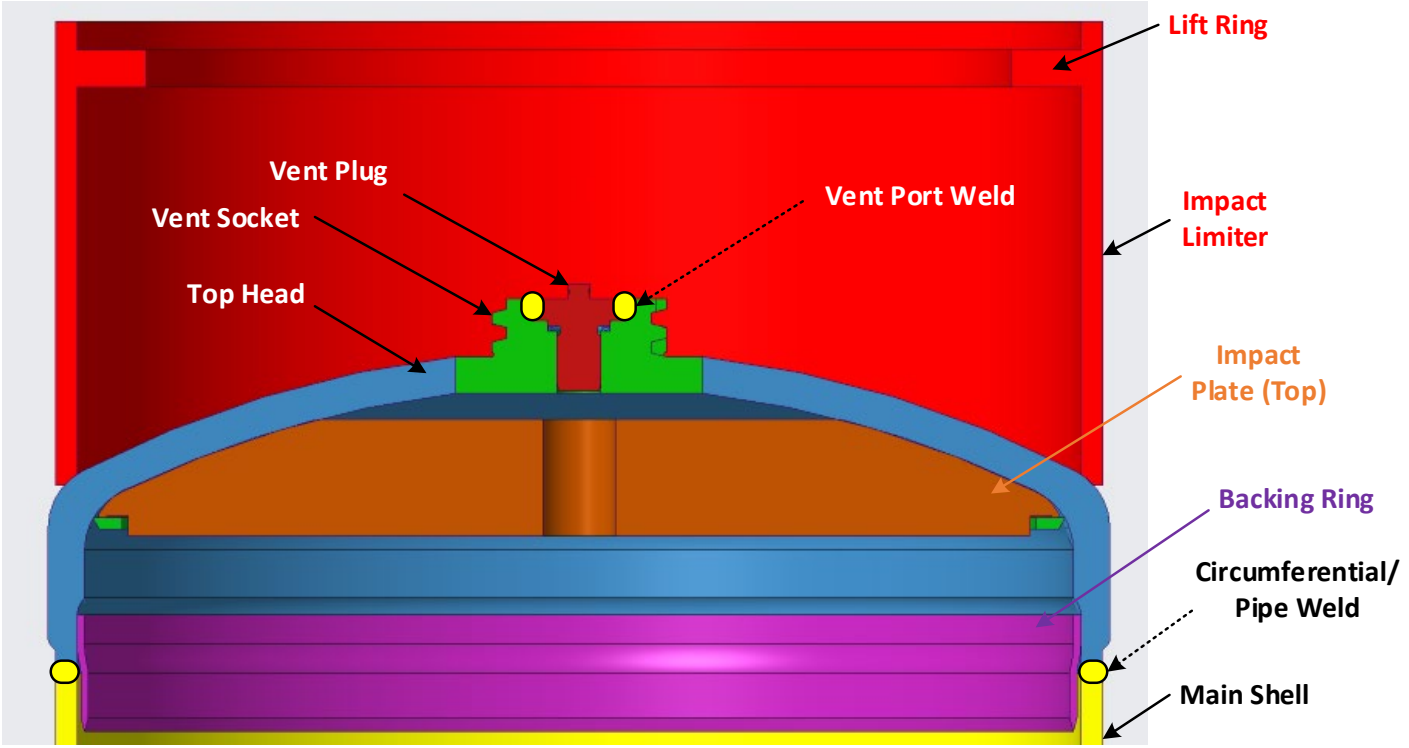
- DOESCs are to be loaded with DOE-managed SNF
- 5-12 DOESC may be loaded into larger over-canisters, or loaded directly into a storage or transportation overpack
- Once loaded and sealed, the DOESCs will never be opened.
- This combined storage, transportation, and disposal application is referred to as Road-Ready Dry Storage (RRDS)



Yucca Mountain Repository Concept

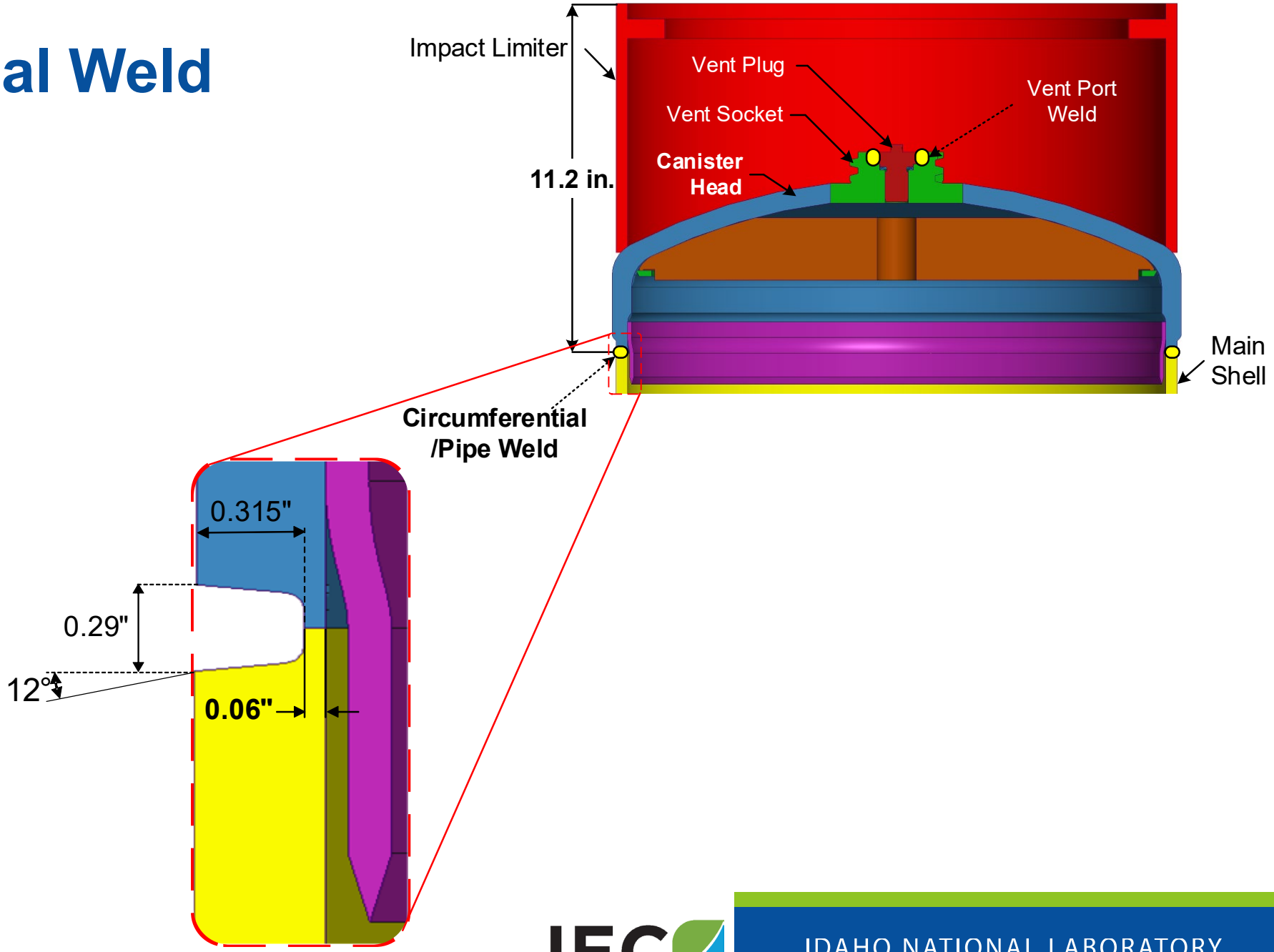
Long-term Closure Issues

- 2000+ DOESCs of SNF to be loaded and sealed at INL.
- DOESCs require two closure welds:
  - circumferential weld
  - vent port weld
- Each weld needs to be inspected and repaired, if required.
- DOESC closure must be functional in a high radiation, contaminated, and moderator control area.
- Remote operation is desirable for efficient loading

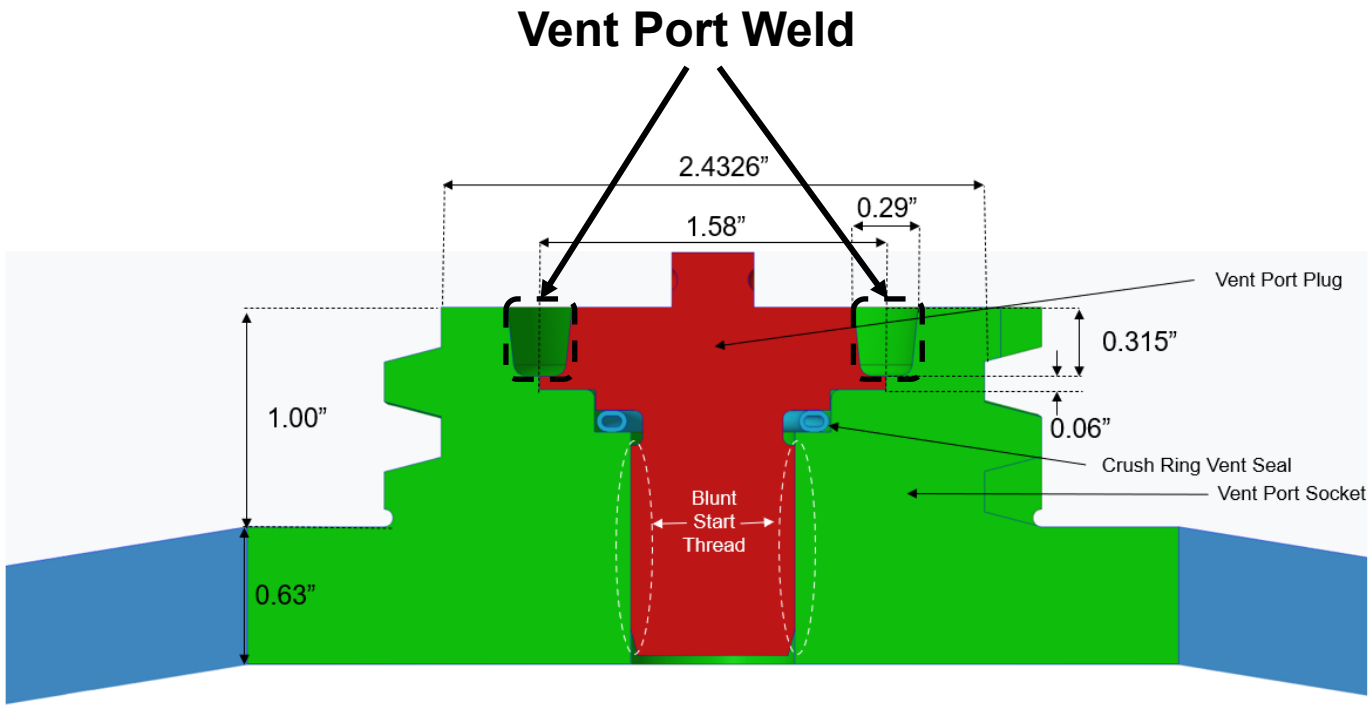


Circumferential Weld

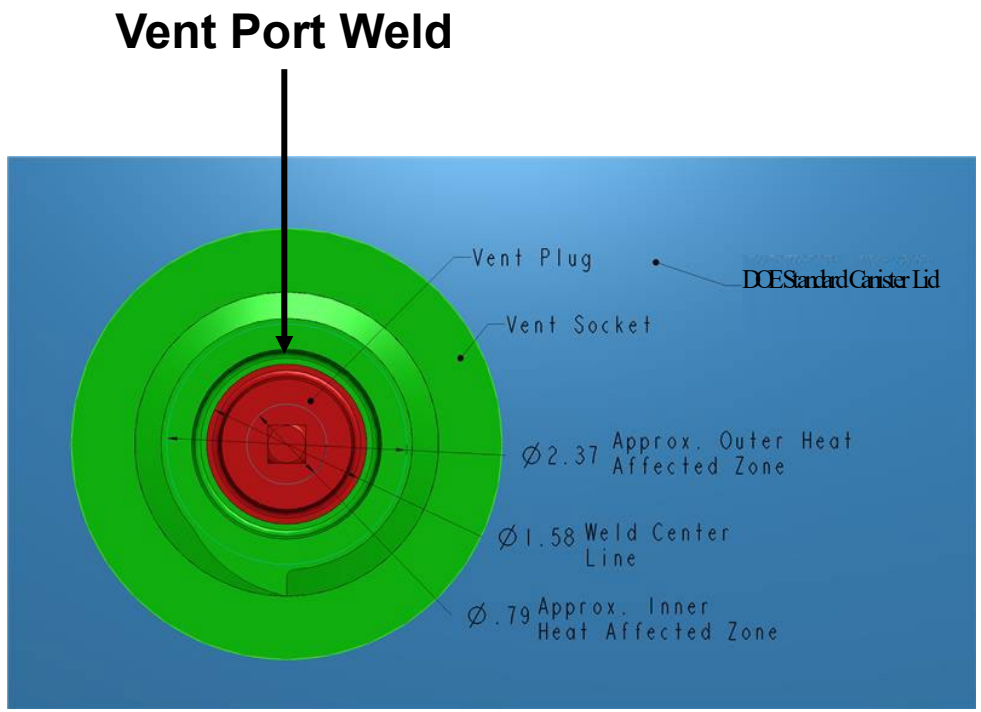
- Circumferential Weld is 11.2 in. from the top of the Impact Limiter.
  - May be modified for other fuel types and canister configurations.



Vent Port Weld



Side Cut-Away View

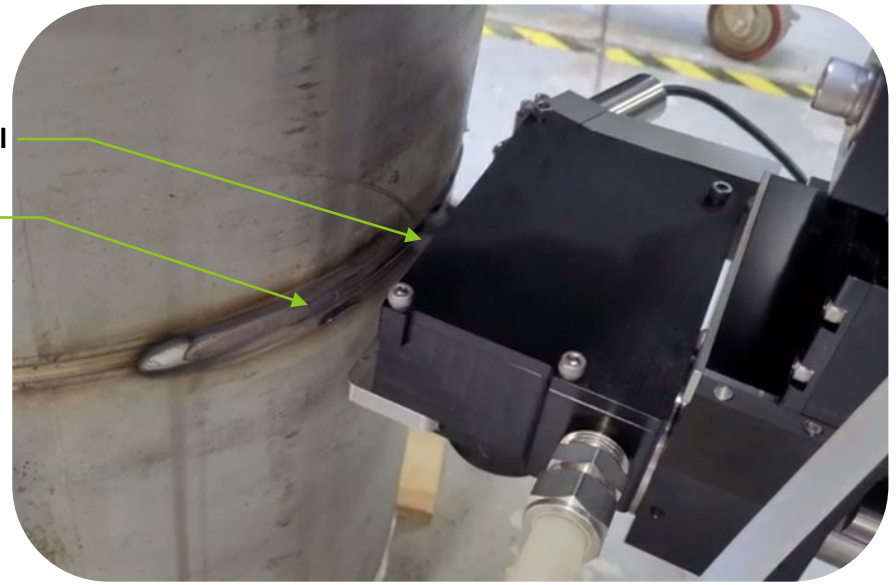


Top-Down View

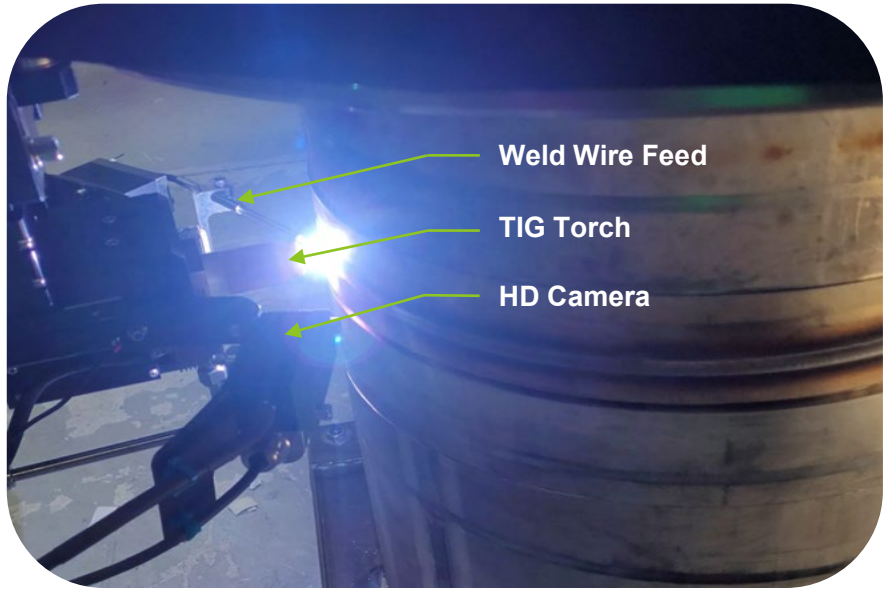
Remote Closure System

Remote Closure System

- We researched companies involved in both completely remote welding systems and systems for nuclear applications.
- We selected Liburdi Dimetrics Corporation (Liburdi).
- After reviewing the available technologies, we selected orbital platforms (tools rotate around the canisters on platforms).
- We have worked with Liburdi through:
  - Conceptual Designs,
  - Final Designs,
  - Fabrication, and
  - Testing.

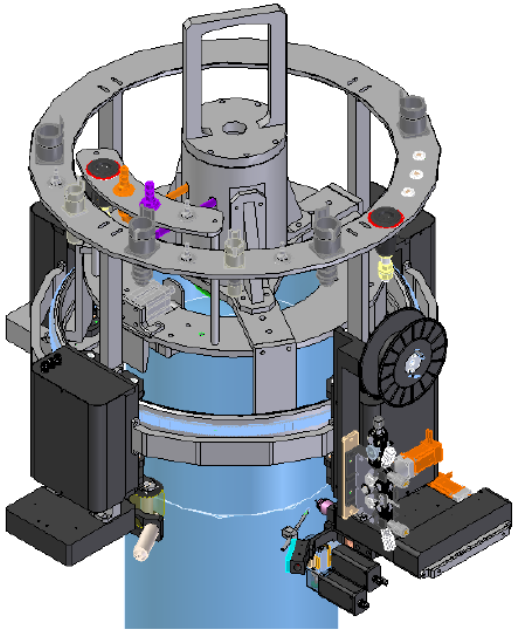


Circumferential Weld Repair – Cutting Wheel (Liburdi Diametrics Corporation)

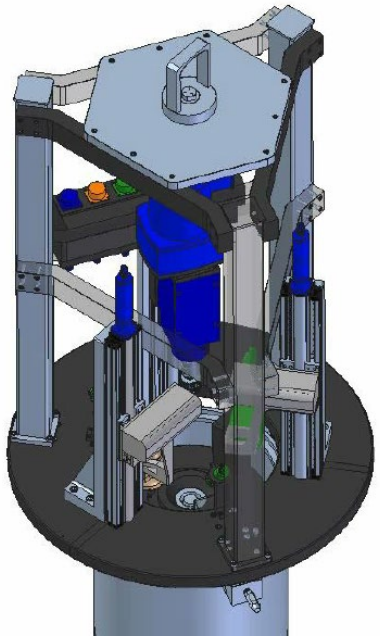


Circumferential Welder – Tungsten Inert Gas Welder (Liburdi Diametrics Corporation)

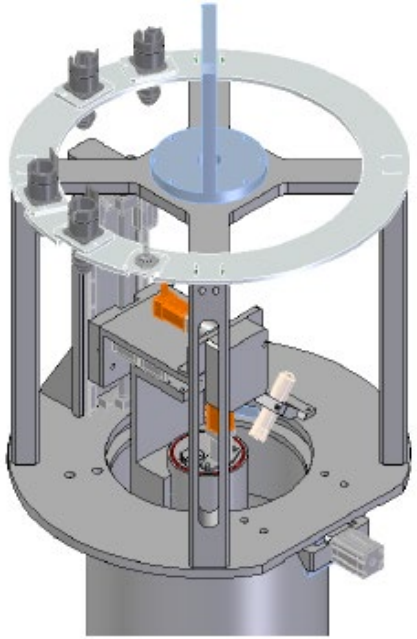
Remote Closure Platforms



Platform #1



Platform #3



Platform #4

(Images courtesy of Liburdi Dimetrics Corporation)

Platform No.	DOESC Weld	Weld Equipment	Inspection Equipment	Repair Equipment
1	Circumferential	Air-Cooled GTAW Torch	ET, PAUT, HD Camera	-
2	Circumferential	-	ET, HD Camera	Side Milling Cutter
3	Vent Port	Air-Cooled GTAW Torch	ET, HD Camera	-
4	Vent Port	-	PAUT, HD Camera	-
5	Vent Port	-	HD Camera	Annular Cutting Wheel

GTAW – Gas Tungsten Arc Weld; ET – Eddy Current Testing; PAUT – Phased Array Ultrasonic Testing; HD – High Definition

Remote Closure System Final Design (Continued)

- All platforms feature:
  - High-definition video cameras (for visual inspections of welds)
  - Connectors for power, gas, and data cables/lines—easily worked via remote manipulators
  - Powered positioning clamps
  - Scanners to read scribe/positioning marks on canisters.
- One set of control systems for all the platforms that will be located outside the hot cell/FHC.
  - All video and sensors feeds (voltage, temperature, gas flow, etc.) from processes performed using the platforms will be recorded.
  - Video and sensor feed data will serve as quality assurance records.

Control Systems

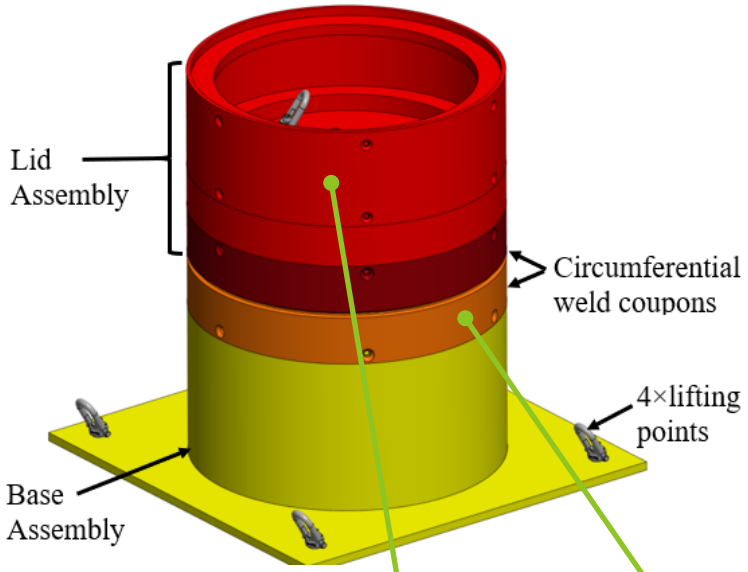
(Images courtesy of Liburdi Dimetrics Corporation.)

FHC – Fuel Handling Cave

Status and Plans

- Liburdi is fabricating the circumferential platforms and control system.
- Completed factory acceptance tests last week.
- Expected delivery of the circumferential platforms and control to INL the end of August 2023.
- Equipment testing work planned for several months in Idaho Engineering Demonstration Facility (IEDF).
- Fabrication of the Vent Port platforms to start next year.

Circumferential Equipment Test Array (CETA)

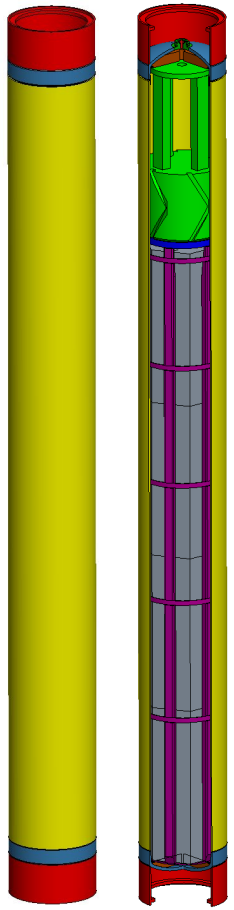


IEDF W-1 High Bay, Facing South

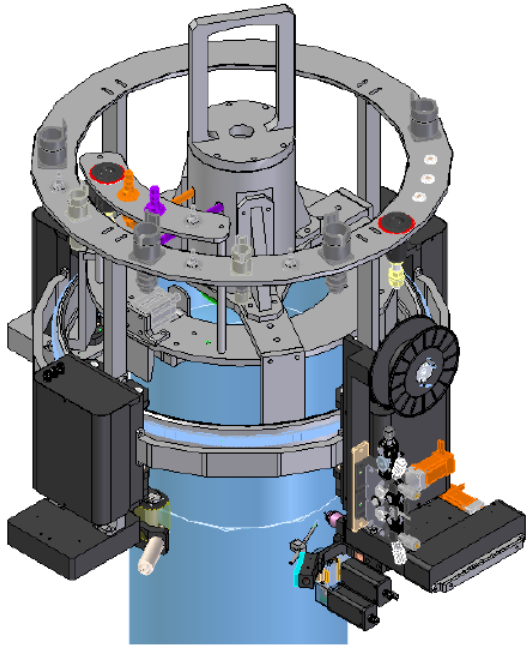
First Use –
DOE SNF Packaging Demonstration Project

Purpose: DOE SNF Packaging Demonstration Project

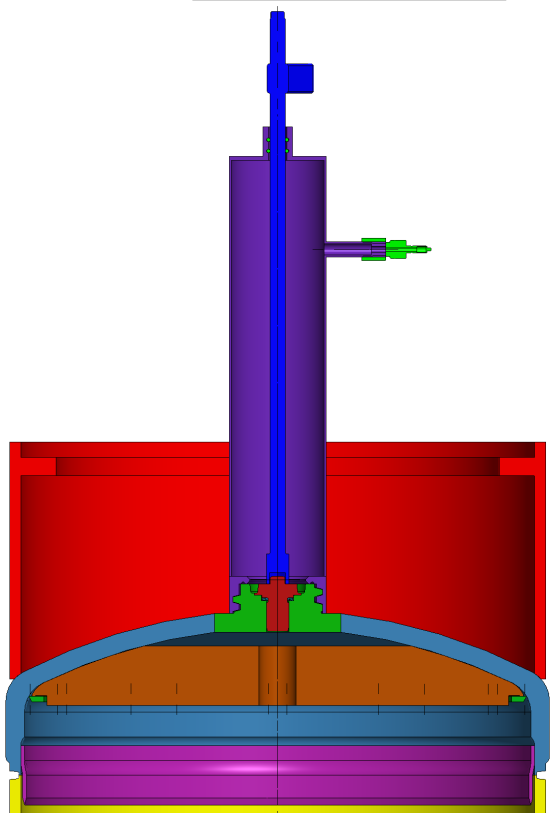
- The purpose of the DOE SNF Packaging Demonstration Project is to develop and demonstrate the designs, technologies, processes, and regulatory framework for packaging DOE SNF for RRDS and to **establish the processes that will be used in a production facility**.



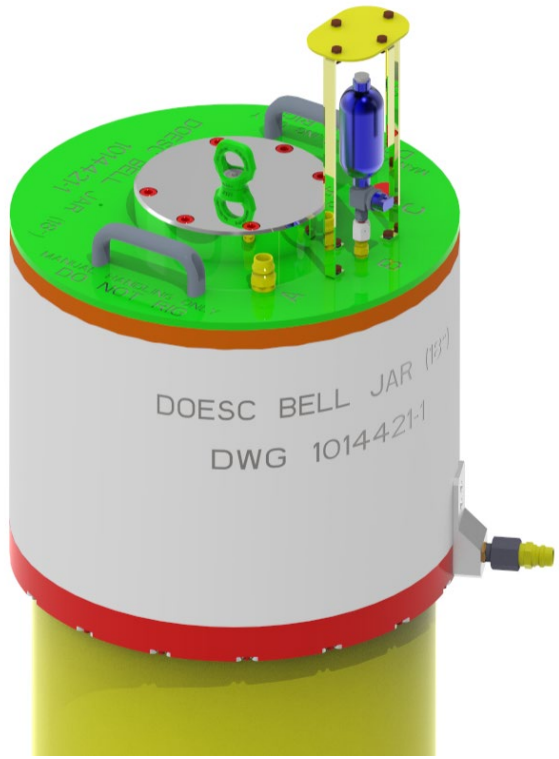
DOE Standard Canister
(with shield plug)



Remote Closure Platforms



Remote Conditioning Assembly
(Drying/Inerting/Backfilling)

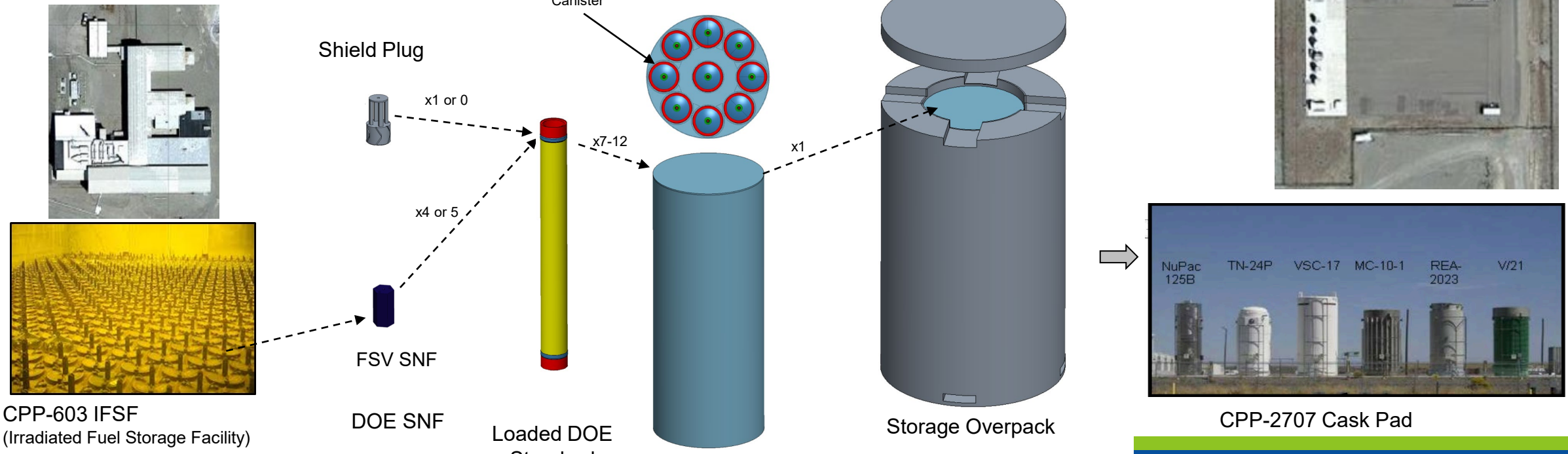


Closure Leak Test Assembly

Overview: DOE SNF Packaging Demonstration Project

Demonstrate the capability to put DOE-managed SNF into RRDS.

1. Load and seal DOE-managed SNF from CPP-603 facility into 7-12 DOESCs.
2. Place the sealed DOESCs into a commercial vendor supplied over-canister (equivalent to commercial MPCs).
3. Seal the over-canister and place it into a commercial vendor supplied storage overpack which is placed on the CPP-2707 cask pad.



MPC – Multi-purpose Canister

DOE SNF Packaging Demonstration Project

- Major Project Parts:
  - Designs (canisters, baskets, equipment, handling tools, etc.)
  - Procurement/Fabrications
  - Facility Modifications
  - Testing
  - Operational Readiness
  - Operations
    - DOESC Loading
    - Storage System Loading
  - Project Closeout and Lessons Learned

IEC	BEA	DOE-EM/NE

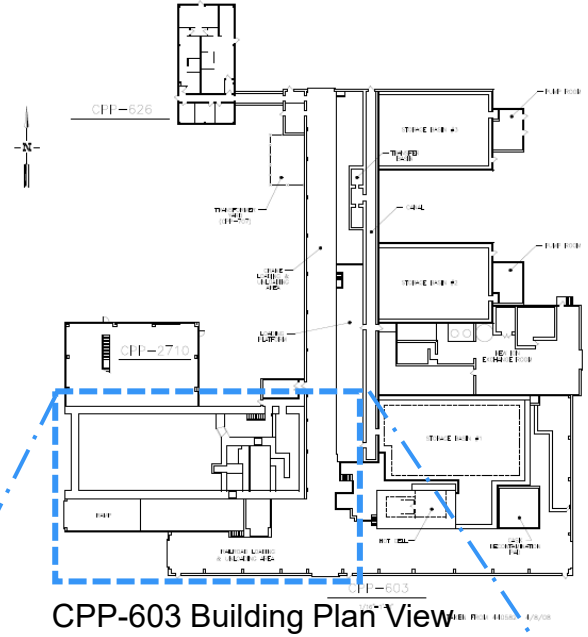
• Project Lead
  • Scope & Schedule
  • Technical & Functional Requirements
  • Fuel Packaging Strategy
• CPP-603 Facility Modifications
• Design/fabricate equipment for DOESC handling, fuel handling, transfer car, cask handling etc.
• Subcontract with commercial vendor for OC and Cask *design*
• Subcontract with heavy-haul vendor to make transfer to CPP-2707
	• Design and Procure DOESC
	  • Subcontract with welding and/or inspection vendor for DOESC closure operations
	  • Fuel element basket
	  • Weld backing ring
	  • Shield plug
	• Develop and test DOESC machine weld, inspection, and repair platforms and supporting closure equipment.
	  • Back purge system, funnel, collet, CLS, etc.
	• Leak Test and Conditioning of DOESC
	• Analysis of DOESC storage and transportation of package to repository requirements
		• Lead interactions with NRC for storage and transportation system licensing.
		• Project Oversight
		• Project Funding

Major Division of Responsibilities

CLD – Canister Loading Sleeve; OC – Over-canister

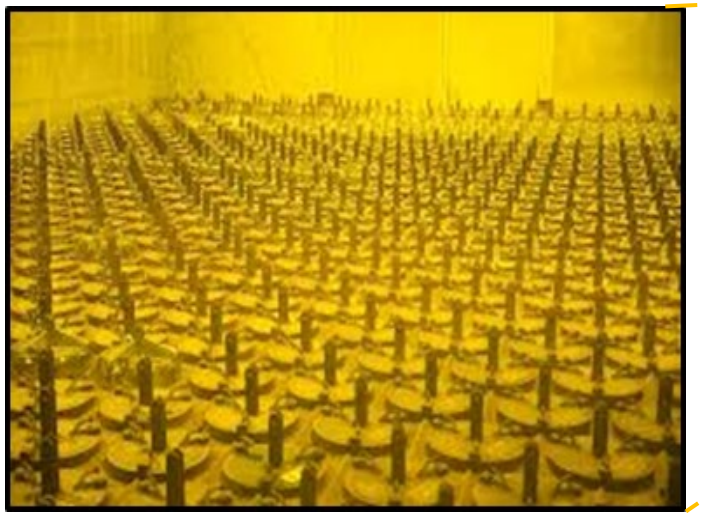
CPP-603 Facility

CPP-603 Building
(Looking South)

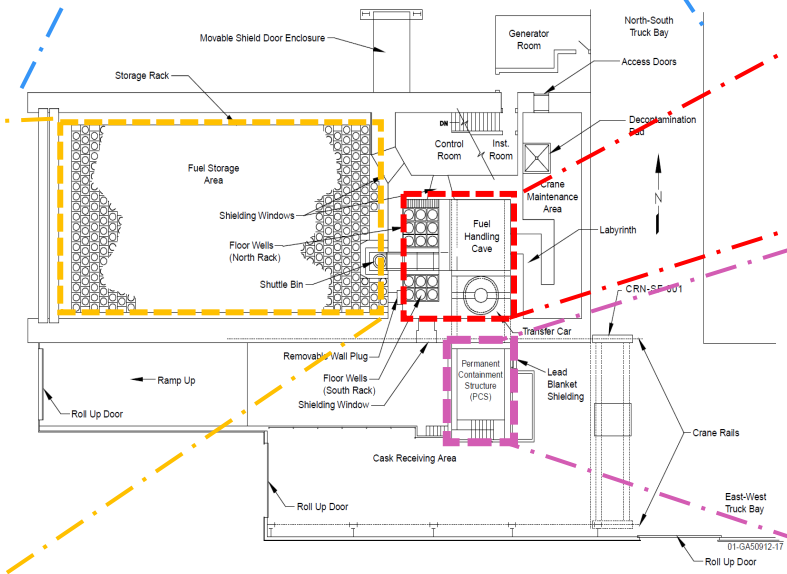


CPP-603 Building Plan View

CPP-603 Fuel Handling Cave



CPP-603 Fuel Storage Area



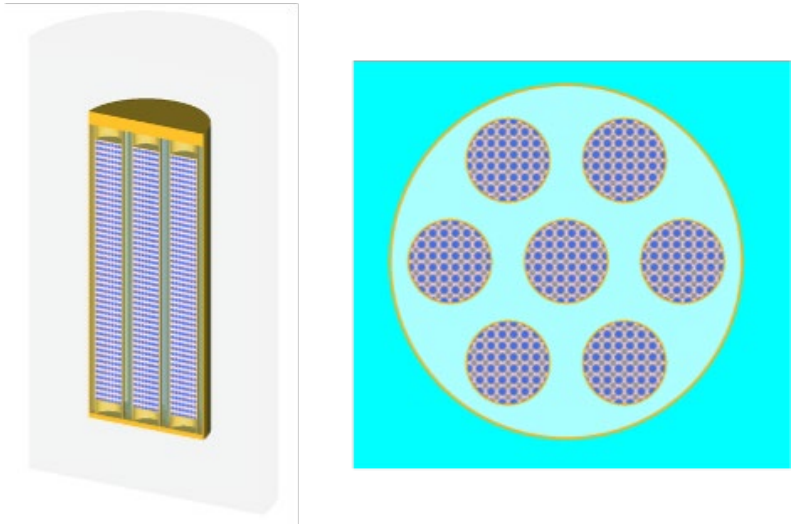
CPP-603 Building Southwest
Corner Plan View

Permanent Containment Structure

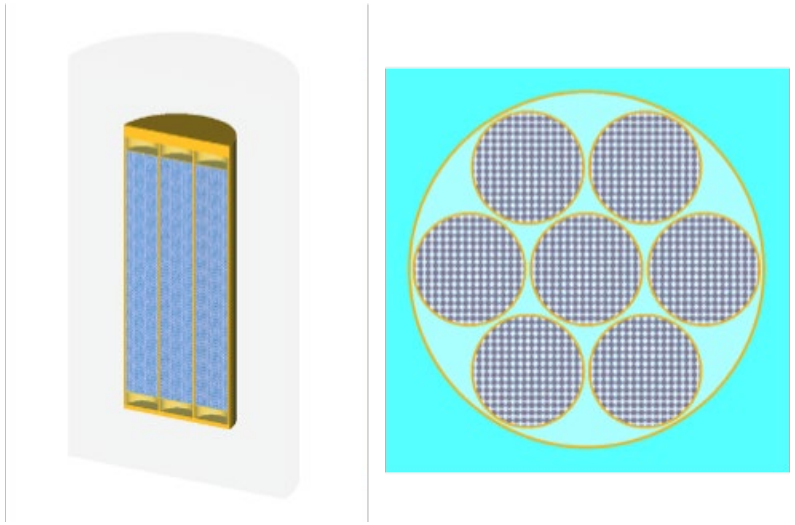
Future Uses

Future Uses of the DOESC Remote Closure System

- Closure of DOESCs loaded with DOE-managed SNF for production operations at INTEC facilities.
- Closure of DOESCs loaded with DOE-managed SNF at other facilities.
- Closure of DOESCs loaded with Advanced Reactor SNF from experiments and test reactors.



Axial (left) and radial (right) view of the General-37 (generic DPC) with seven Ø18” × 15’ L DOE Standard Canisters loaded with Xe-100 SNF pebbles



Axial (left) and radial (right) view of the General-37 (generic DPC) with seven Ø24” × 15’ L DOE Standard Canisters loaded with KP-FHR SNF pebbles

INTEC – Idaho Nuclear Technology and Engineering Center; DPC – Dual Purpose Canister

Questions?