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Design of a Universal Canister System for US High-Level Waste

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Abstract

A concept for a universal canister system for storage, transportation, and eventual disposition of certain high-level waste has been developed to support the safe clean-up mission of the US Department of Energy's Office of Environmental Management (DOE-EM). This concept supports the near-term storage and transportation of high-level radioactive waste (HLW) at several clean-up sites, including the cesium and strontium capsules at the Hanford Site, cesium that will be processed using non-elutable or elutable resins at the Hanford Site, and the calcine waste at Idaho National Laboratory. Specifically, the universal canister concept has been developed for near-term onsite dry storage of the cesium and strontium capsules at the Hanford Site. In addition, the universal canister system concept would be compatible with a deep borehole or a mined geologic repository concept.

This universal canister system was developed to provide a sealed canister that would never be opened and would be compatible with dry storage, transportation, and eventual disposition. This universal canister system is based on the concept of nested canisters (i.e., canisters inside of canisters), that can be moved to dry storage in near-term, with the flexibility to ensure that the universal canister would never have to be opened regardless of the disposal concept. Additionally, monitoring capabilities are being developed that will be integrated into the universal canister system to provide real-time waste configuration information.

This paper describes the universal canister concept and presents detailed shielding, thermal, and structural analyses results demonstrating how loaded universal canisters could satisfy current regulatory requirements for storage and transportation of HLW. Once a disposal pathway is selected and disposal regulations are developed, this concept is positioned to satisfy those requirements as well. One manner of achieving this goal would be to develop disposal overpacks that would be

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compatible with the universal canister system while ensuring that the disposal requirements were satisfied.

Introduction

According to Price et al. (2015) [1], the long-term objective is to develop a universal canister (UC) system concept for small waste forms. The canister system is designed to be used for multiple waste forms and to perform various waste management functions—storage, onsite transfers, transportation, and disposal—and it will also be compatible for use with multiple disposal concepts (e.g., deep borehole and mined repository). This report presents the preliminary work for developing a conceptual UC system suitable for small waste forms. In this initial conceptual design, the wastes to be considered as candidates for the UC include capsules containing strontium (Sr) and cesium (Cs) at the Waste Encapsulation and Storage Facility (WESF) at the Hanford Site. In addition to the UC, the UC system may also include a WESF transfer cask, UC sleeves, a sleeve transfer cask, and dual-purpose (storage and transportation) casks. The requirements for the design of the UC systems are specified in Refs. [1] and [2].

Cesium and Strontium Capsules

The nominal dimensions and the materials of construction [3] of the Cs capsules are shown in Table 1, and the same information is provided for the Sr capsules in Table 2.

Table 1 Materials and dimensions for the Cs capsules

Containment boundary	Material	Wall thickness (in)	OD (in)	Total length (in)	Cap thickness (in)	Average mass (empty capsule) (kg)
Inner	SS316L	0.095	2.250	19.725	0.4	2.047
		0.103	2.250			2.143
		0.136	2.255			2.687
Outer	SS316L	0.109	2.625	20.775	0.4	2.840
		0.119	2.645			3.100
		0.136	2.657			3.398

Table 2 Materials and dimensions for the Sr capsules

Containment boundary	Material	Wall thickness (in)	OD (in)	Total length (in)	Cap thickness (in)	Average mass (empty capsule) (kg)
Inner	Hastelloy C-276	0.120	2.250	19.05	0.4	2.701
		0.136				2.896
Outer	SS316L or	0.109	2.625	20.1	0.4	3.506

Hastelloy C-276	0.119	2.821
	0.120	3.008
	0.136	3.293

Universal Canister System Concept

The conceptual UC system is shown in Figure 1. The Cs/Sr capsules will be inserted into a basket inside a right circular cylinder, which is termed the universal canister. This basket may have a single cavity or three cavities. The single-cavity basket will hold Type W capsules or extremely hot capsules [1]. The three-cavity basket will hold regular Cs/Sr capsules. After loading, the UC will be welded and placed in a transfer cask that can hold up 12 UCs. The transfer cask and its associated transfer adapter will then be used to insert the UCs into another right circular cylinder (sleeve) capable of handling up to 8 stacked UCs at the same time. The sleeve may also be used as a disposal container, or it can be used in combination with a different disposal overpack. To support future handling operations, this design has spacers and/or impact limiters that would be inserted between the UCs. After the sleeve is loaded with UCs, spacers, and impact limiters, it would be welded[1] and stored in a basket inside a dual-purpose cask (DPC).

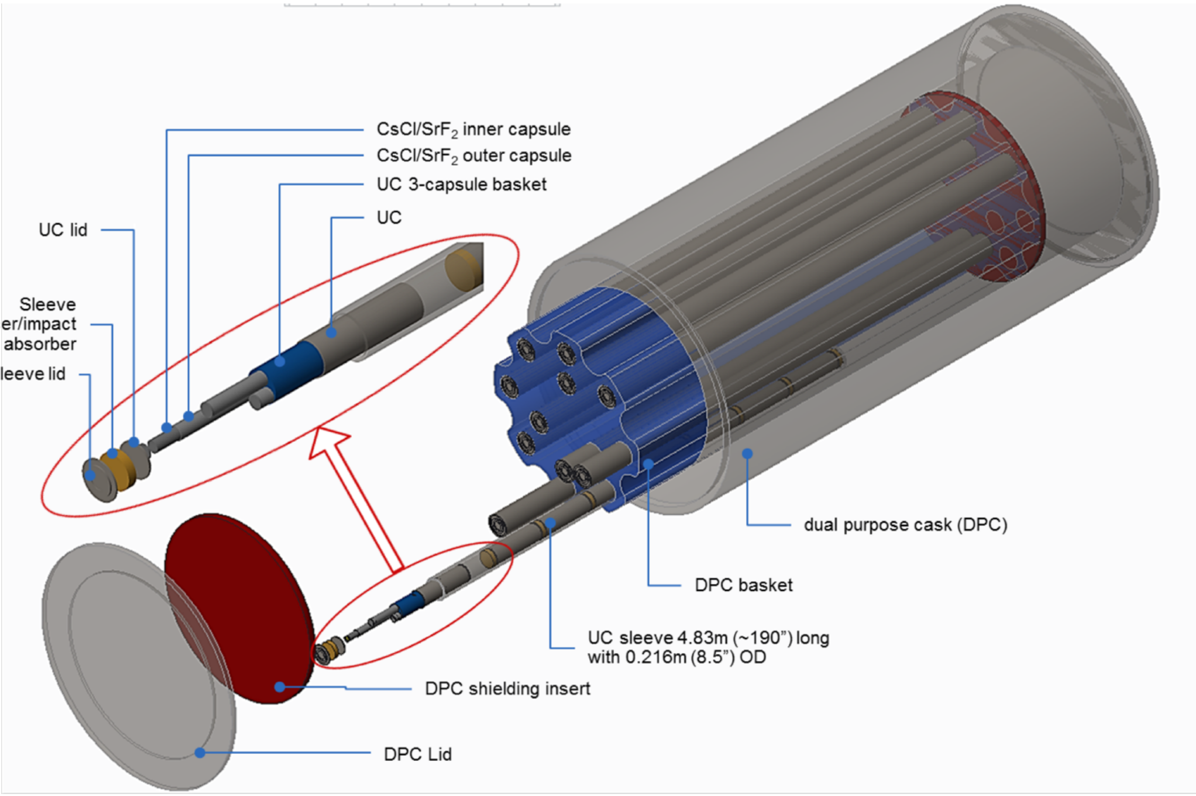

Figure 1 Initial conceptual design of UC system

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[1] Note that the current concept has the sleeve preloaded into the DPC, and the final weld of the sleeve would be performed in the DPC.

The total number of capsules in different components of the UC system is shown in Table 3.

Table 3 Number of capsules in components of UC system

Component in UC system	Size		Capacity	Notes
	OD (in)	Height (in)	(# of Capsules)	
Inner capsule	2.25	19.275	-	*WESF capsule data book*
Outer capsule	2.625	20.775	-	*WESF capsule data book*
UC basket	6	20.775	3	*1- or 3-capsule basket option*
UC	6.5	21.788	3	*1 or 3 capsules depending on basket*
WESF transfer cask	96	24	36	*12 or 36 capsules*
WESF transfer cask adapter	-	8	-	-
UC sleeve	8.5	190	24	*8 UCs per sleeve*
Sleeve transfer cask	TBD	207	24	*1 UC sleeve per cask*
DPC	96	207	288	*12 sleeves per DPC*

The information provided in Table 3 assumes that the three-capsule basket is used in all UCs, which implies that all 1,936 capsules at the Hanford Site [1] could be packaged into about 81 sleeves. In turn, this requires only 7 DPCs for storage and eventual transportation to a disposal site.

Universal Canister

The UC is a right cylinder with welded lids on the top and bottom. A basket supporting the Sr or Cs capsules is inside the UC. The nominal dimensions for the UC and the basket are shown in Figure 2. The UC cylinder and lids will be fabricated of 316L stainless steel, and the basket material will be aluminum.

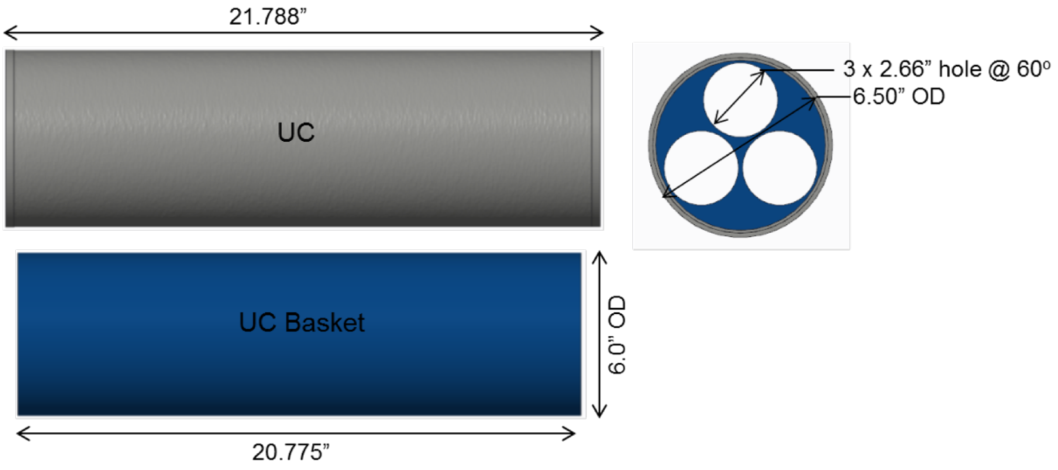

Figure 2 Basket and UC nominal dimensions

WESF UC Transfer Cask and Adapter

There are several potential options for handling the UCs. At the WESF facility, a 196 in. long sleeve cannot be loaded due to facility design limitations, especially in the G-cell [4]. A possible solution is to transfer some of the loaded UCs using a transfer cask. A conceptual UC transfer cask (Figure 3) was designed for this purpose. After it is loaded in the G-cell, this cask will mate with the DPC during the transfer stage. It is designed to have a maximum weight of 25 tons after loading in the G-cell. The maximum height of the UC transfer cask is 24 in.

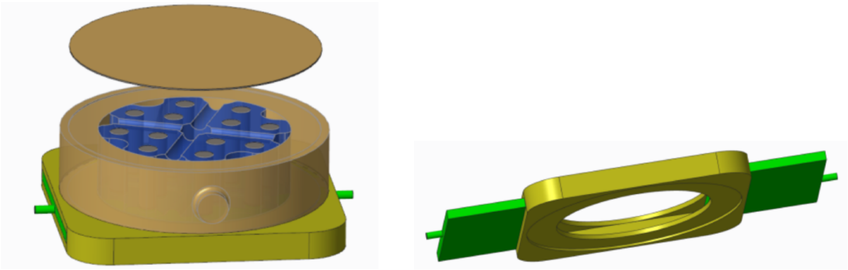

Figure 3 A 3D model of the transfer cask loaded with 12 UCs (left) and a 3D model of a WESF UC transfer cask adapter (right)

Once the WESF UC transfer cask is loaded in the G-cell of the WESF building, it would be lifted through the port above the G-cell and placed onto a site transport cart in the truck loading bay, where it would then be transported to the storage area (or transportation loading area if an offsite storage facility or repository is available). The UC transfer cask would be placed on top of the DPC[2] and connected to the DPC using a specially design UC transfer cask adapter as shown in Figure 3. The universal canisters could then be lowed individually into the package sleeve[3].

Package Sleeve

The package sleeve is shown in Figure 4 and handles up to 8 UCs in a single package. It is designed to be used for storage, transportation, and disposal, with the proposed disposal requirements [1] being the most limiting. The sleeve has an axial length of 190 in. and an outer diameter (OD) of 8.5 in., with a 1.0 in. wall thickness. Structural analysis indicates that high strength stainless steel would be needed to withstand the borehole pressure if no additional disposal overpack were used. The current concept for handling includes providing a lifting ring on the top of the sleeve, though other options will be considered.

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[2] Note that in this concept the DPC would be preloaded with package sleeves.

[3] The operational method for lowering the UCs into the package sleeve have yet to be determined.

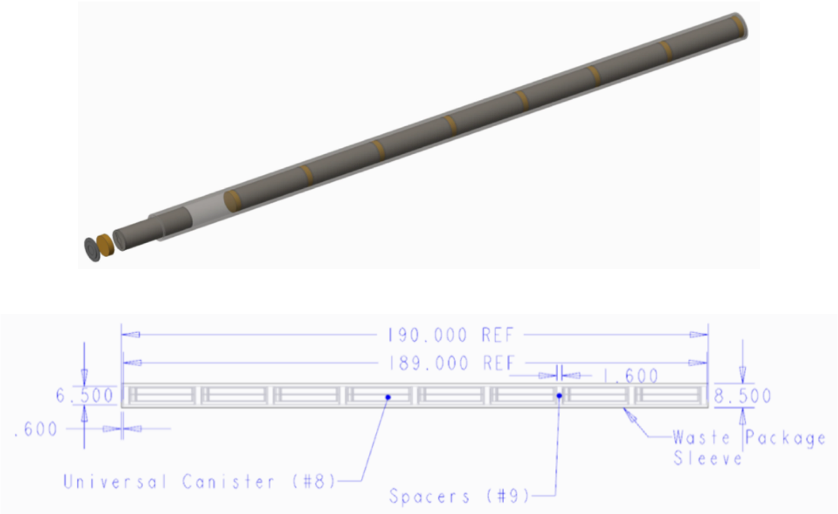

Figure 4 Sleeve loaded with 8 UCs

Dual-Purpose Cask (DPC)

The conceptual DPC will serve the dual purposes of storing and transporting the sleeves to the disposal site. This conceptual DPC design will be required to meet the 10 Code of Federal Regulations (CFR) 71 and 10 CFR 72 regulations [5, 6]. The DPC is a hollow right cylinder with proposed dimensions as shown in Figure 5. The internal diameter of the bore is 34.4 in. to accommodate a DPC basket with 12 internal bores to accommodate 12 sleeves. The bottom and the top of the DPC will be covered with shielding plugs and lids as shown in Figure 5. The initial thickness of the DPC at the region around the sleeves is 13 in., though shielding results suggest wall thicknesses less that the assumed 13 in. will be sufficient. This thickness of the stainless steel ensures structural integrity and is adequate to provide gamma shielding [5] of the capsules' source as required by regulations.

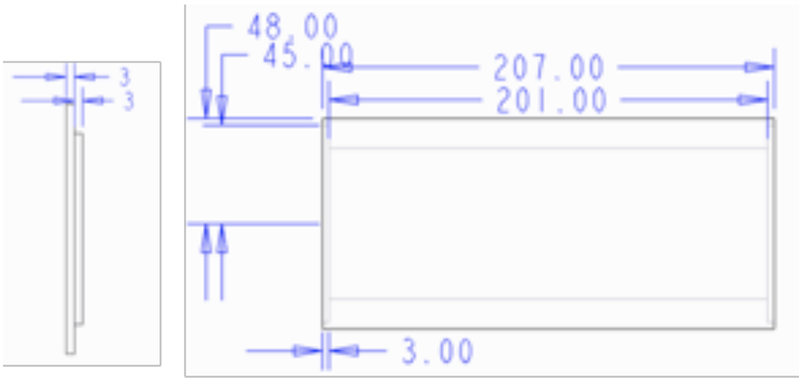

Figure 5 Dimensions of the conceptual DPC in inches

The cross section of the DPC basket is shown in Figure 6 (dimensions in inches). Flow channels are provided around the basket and on the top and bottom of the basket to allow the flow of backfill gas (e.g., helium). The purpose of the backfilled gas is to ensure an inert environment; there are essentially no heat transfer impacts of using air instead of helium.

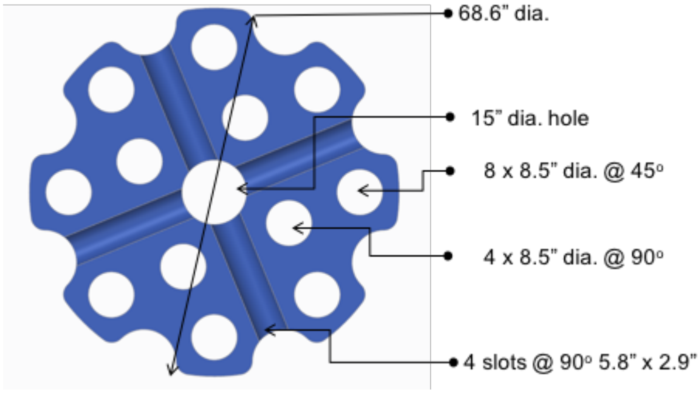

Figure 6 DPC basket dimensions in inches

The exploded view of the assembled DPC, basket, shielding plugs (red component) materials and lids is shown in Figure 7.

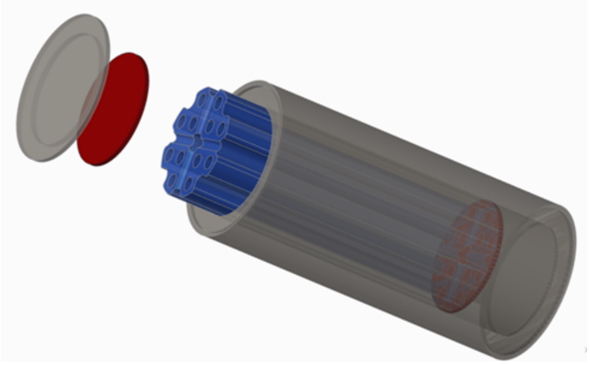

Figure 7 Exploded view of assembled DPC and internal components

Concept of Operation

The general concept of operation to move the capsules from WESF to eventual disposal in a deep borehole or repository is illustrated in Figure 8. The high-level steps are:

1. Move capsules from WESF pool to WESF hot cell
2. Load capsules into WESF UC transfer cask in hot cell
3. Weld UCs in hot cell
4. Move UC transfer cask to DPC transfer area outside of hot cell
5. Preload DPC with UC sleeves and hold at the cask-to-DPC transfer area
6. Transfer individual UCs into UC sleeves inside the DPC
7. Repeat steps 1–6 until the UC sleeve is full
8. Weld the UC sleeves
9. Move the DPC to the storage area (optional)
10. Prepare the DPC for transportation
11. Transport the DPC to the appropriate disposal site
12. Dispose of the UC sleeve

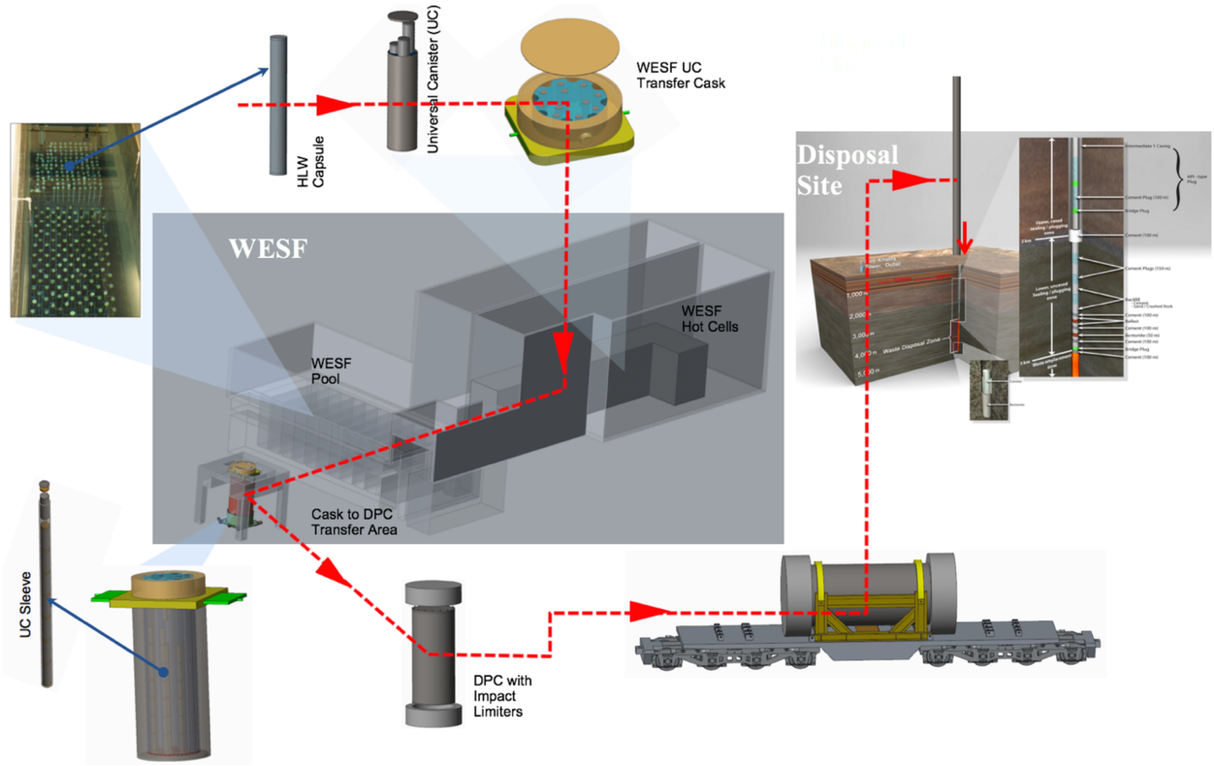

Figure 8 Example concept of operation (pathway) to move the HLW capsules from the WESF pool to eventual disposal

Shielding Analyses

Shielding analyses were performed to calculate the dose rates of the UC system at different locations in the air outside the system, including: an unshielded UC sleeve, a UC sleeve in a transfer cask, and a DPC in transportation cask.

Shielding Model Setup

This section presents dose rate calculations performed for the UC containing the CsCl or SrF_2 source capsules, including calculations for dose rate associated with unshielded sleeves and dose rate calculations to establish minimum shielding requirements for a transfer cask and a transportation package. The maximum source activity as of 01/01/2025 were used in the dose rate calculations (i.e., 2.78×10^4 Ci of Cs per CsCl source capsule and 4.94×10^4 Ci of ^{90}Sr per SrF_2 source capsule [1]). A CsCl capsule was assumed to contain 2.7 kg of CsCl with a mass density of either 2.65 g/cm^3 (i.e., mass density of the melt waste form) or 3.8 g/cm^3 (i.e., mass density at room temperature) [7]. A SrF_2 capsule was assumed to contain 2.8 kg of SrF_2 with a mass density of 2.88 g/cm^3 [8]

The dose rate calculations were performed with MAVRIC [9], the SCALE [10] Monte Carlo transport shielding sequence with automated variance reduction capabilities to significantly increase the efficiency of Monte Carlo radiation transport calculations. A variance reduction method [11, 12] was used in the MAVRIC calculations to obtain dose rate estimates with good statistical accuracy outside the package. This method requires both forward and adjoint discrete ordinates calculations with Denovo [13]. The SCALE continuous-energy cross section data library, ce_v7.0_endf.xml, and the ANSI/ANS 6.1.1-1977 photon flux-to-dose-rate conversion factors [14], were used in the dose rate calculations.

Shielding Results

The dose rate values for the unshielded sleeve as of 01/01/2025 are presented in Table 4.

Table 4 Maximum external dose rates for unshielded sleeves

Location	CsCl sources[a] ($2.65\ g/cm^3$) Dose rate (rem/h)	RE[b]	CsCl sources[a] ($3.8\ g/cm^3$) Dose rate (rem/h)	RE	SrF_2 sources Dose rate (rem/h)	RE
Outer sleeve radial surface	1.51E+05	0.0075	1.81E+05	0.007	5.96E+03	0.010
sleeve top surface	3.71E+03	0.0498	6.49E+02	0.0755	1.20E+02	0.052
sleeve bottom surface	8.38E+03	0.0409	9.13E+03	0.0383	3.39E+02	0.085
1 m from sleeve radial surface	8.98E+03	0.0081	7.73E+03	0.0081	3.44E+02	0.009
1 m from sleeve top surface	6.90E+02	0.0395	5.35E+02	0.0429	1.20E+02	0.052
1 m from sleeve bottom surface	7.10E+02	0.0418	6.69E+02	0.0369	2.79E+01	0.041

[a] The CsCl mass assumed per capsule is 2.7 kg.

[b] Relative statistical error.

No specific regulatory dose rate limit is provided for transfer casks, and the as low as reasonably achievable (ALARA) principle is used in transfer operations. Target dose rate values of 2.5, 10, and 100 mrem/h were used to determine the required thicknesses for the transfer cask carbon steel walls to achieve those dose rate values at the external surface of the transfer cask as shown in Table 5.

Table 5 Sleeve transfer cask dose rates (as of 01/01/2025) as a function of gamma shield thickness

	Radial direction					Axial direction				
Target dose rate (mrem/h)	Shield thickness (in./cm)	Surface dose rate (mrem/h)	RE[a]	Dose rate at 1 from surface (mrem/h)	RE	Shield thickness (in./cm)	Surface dose rate (mrem/h)	RE	Dose rate at 1 from surface (mrem/h)	RE
2.5	12.5/31.75	2.13	0.01	0.46	0.01	10.875/27.6225	1.49	0.02	0.08	0.07
10	11.5/29.21	8.39	0.01	1.73	0.01	9.75/24.765	7.16	0.02	0.36	0.10
100	9.8125/ 24.92375	86.94	0.01	16.5	0.01	7.9375/ 20.16125	89.22	0.01	4.79	0.10

[a] Relative statistical error.

The shielding design for the DPC was determined based on the shielding regulatory requirements for exclusive use shipments provided in Code of Federal Regulations (CFR) Part 71, Title 10, "Packaging and Transportation of Radioactive Material" [5]. The overpack shielding requirements were determined for the DPC containing 12 sleeves with a total of 288 (i.e., 8 × 3 × 12) source capsules as of 01/01/2025. If stainless steel were used as the gamma shielding material of the transportation overpack, the minimum required thickness of the radial shell would be 8.875 in. (22.5425 cm), and the minimum required thickness for the bottom plate/top lid would be 8.0 in. (20.32 cm). If carbon steel were used as the gamma shielding material of the transportation overpack, the minimum required thickness of the radial shell would be 9 in. (22.86 cm), and the minimum required thickness for the bottom plate/top lid would be 8.125 in. (20.6375 cm). The maximum dose rate values at external dose rate locations of interest based on these shielding requirements are presented in Table 6.

Table 6 Maximum dose rate values as of 01/01/2025 corresponding to minimum required shielding

	CsCl source capsules											
	CsCl mass density = 2.65 g/cm^3				CsCl mass density = 3.8 g/cm^3				SrF_2 source capsules			
	Overpack surface[a]		2 m from overpack surface[b]		Overpack surface[a]		2 m from overpack surface[b]		Overpack surface[a]		2 m from overpack surface[b]	
Surface	Dose rate (mrem/h)	RE[c]	Dose rate (mrem/h)	RE[c]	Dose rate (mrem/h)	RE[c]	Dose rate (mrem/h)	RE[c]	Dose rate (mrem/h)	RE[c]	Dose rate (mrem/h)	RE[c]
Stainless steel overpack walls												
Radial	53.742	0.014	8.694	0.034	57.898	0.014	6.882	0.010	16.404	0.013	2.758	0.008
Top	68.294	0.078	9.652	0.085	16.824	0.029	2.254	0.028	14.198	0.019	2.200	0.022
Bottom	70.889	0.077	8.324	0.087	69.498	0.023	8.640	0.026	16.337	0.018	2.273	0.022
Carbon steel overpack walls												
Radial	59.529	0.008	9.144	0.005	64.045	0.007	7.743	0.005	17.418	0.007	2.966	0.004
Top	64.744	0.012	9.306	0.012	16.664	0.015	2.317	0.015	14.510	0.010	2.290	0.012
Bottom	64.298	0.012	8.268	0.014	61.866	0.012	7.689	0.013	16.460	0.010	2.382	0.012

[a] Maximum regulatory dose rate for this surface is 200 mrem/h.

[b] Maximum regulatory dose rate for this surface is 10 mrem/h.

[c] Relative statistical error (RE) of the Monte Carlo dose rate estimate.

Thermal Analyses

Thermal analyses of both the storage and the potential borehole disposal configurations were performed. The disposal configurations assumed that the sleeve had no additional overpacking.

Thermal Model Setup

The objective of the DPC thermal evaluation is to ensure that the DPC is capable of removing decay heat during dry storage so that the salt-metal-interface (SMI) temperatures of the cesium (strontium) capsules remain within the allowable limits under normal [4], off-normal, and accident conditions. For capsules in storage configuration, the limiting temperatures under normal, off-normal, and accident conditions as specified in the *Thermal Analysis of a Dry Storage Concept for Capsule Dry Storage Project* [15] are shown in Table 7. The 2D cross sectional model of the loaded storage overpack was built using Creo Parametric 3.0 [16], and the model was imported into ANSYS 16.0 design modeler. The model was then meshed, and the materials were assigned to the components of the UC system as shown Figure 9. It was assumed that no gap exists between the UC system components except for the UCs which are already sealed with helium backfill.

Table 7 Performance specifications for salt-metal interface temperature

	Strontium capsules	**Cesium capsules**
Accident conditions	800 °C	600 °C
Processing, including process upsets	540 °C	450 °C
Interim storage configuration under summer storage conditions	540 °C	317 °C

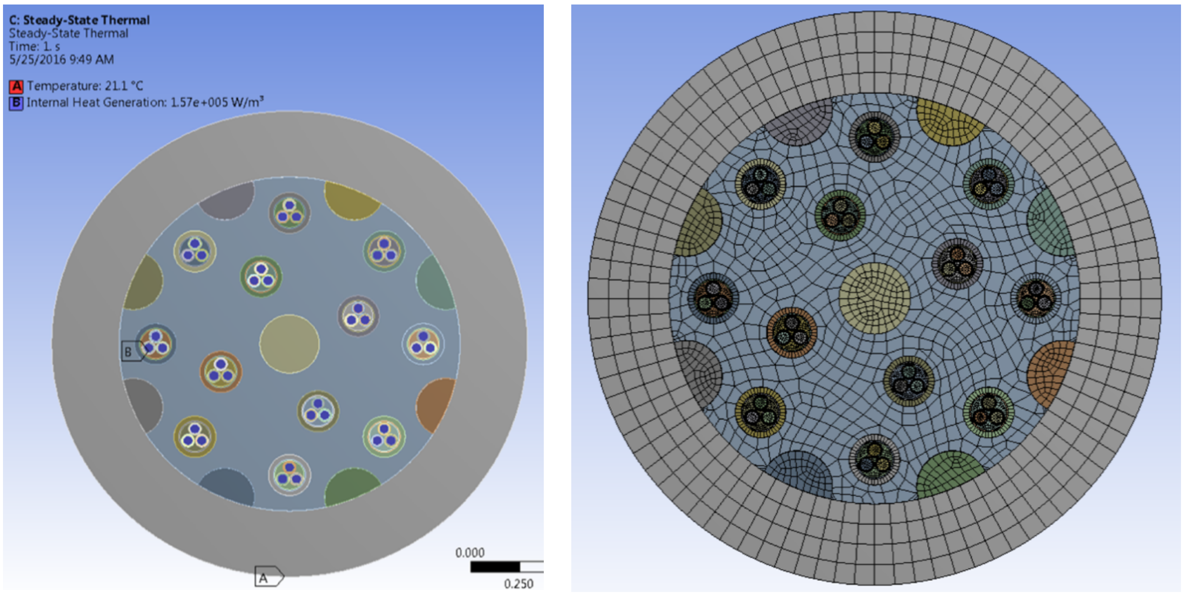

Figure 9 2D Cross section of the UC system storage configuration and model mesh

Figure 10 shows the finite element mesh used to generate results in the emplaced configuration assuming a 100 in. rock diameter; this case has 56,118 elements with 281,895 nodes.

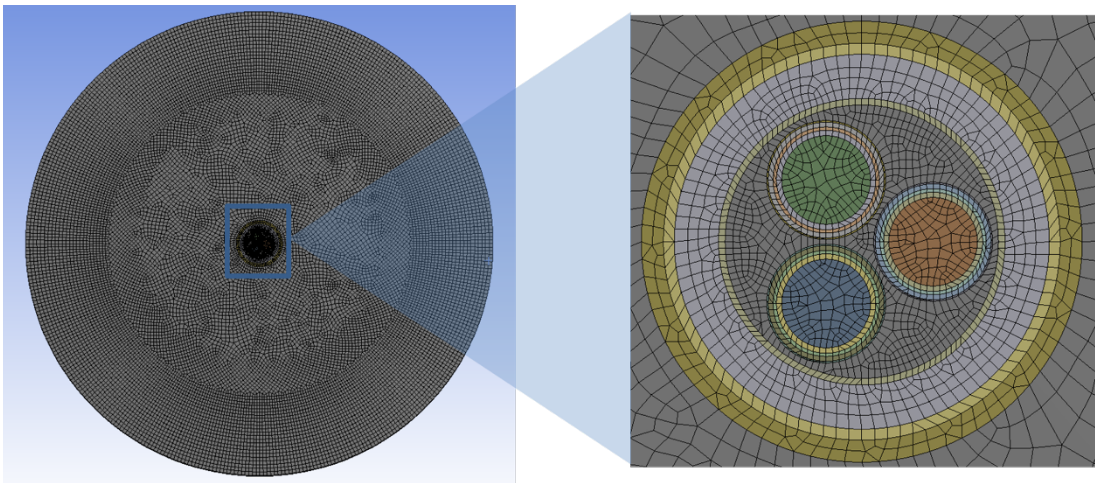

Figure 10 Finite element mesh of the emplaced waste package in granite rock

Thermal Results

A summary of the results obtained from the thermal analysis of the storage configuration is shown in Table 8. During the simulated fire accident conditions, the predicted temperature for the SMI is slightly higher than the suggested 430 °C and well above the 317 °C specified in Table 7 for cesium capsules. The reason for the observed result is that the stainless steel material of the overpack conducted heat into the overpack contents. It is expected that a more detailed transient analysis will predict a more accurate (i.e., lower) SMI temperature for the accident condition.

Table 8 Temperature at locations of interest in the storage configuration

	Overpack surface °C (°F)	**Salt-metal interface °C (°F)**	**Salt centerline °C (°F)**
Normal storage condition	21.1 (70.0)	45.5 (113.9)	68.9 (156.1)
Off-normal condition	39.4 (103.0)	63.6 (146.4)	87.0 (188.7)
Accident condition (fire)	426.7 (800.0)	449.2 (840.6)	472.8 (883.1)

The temperature profile of the emplaced configuration in steady state is shown in Figure 11.

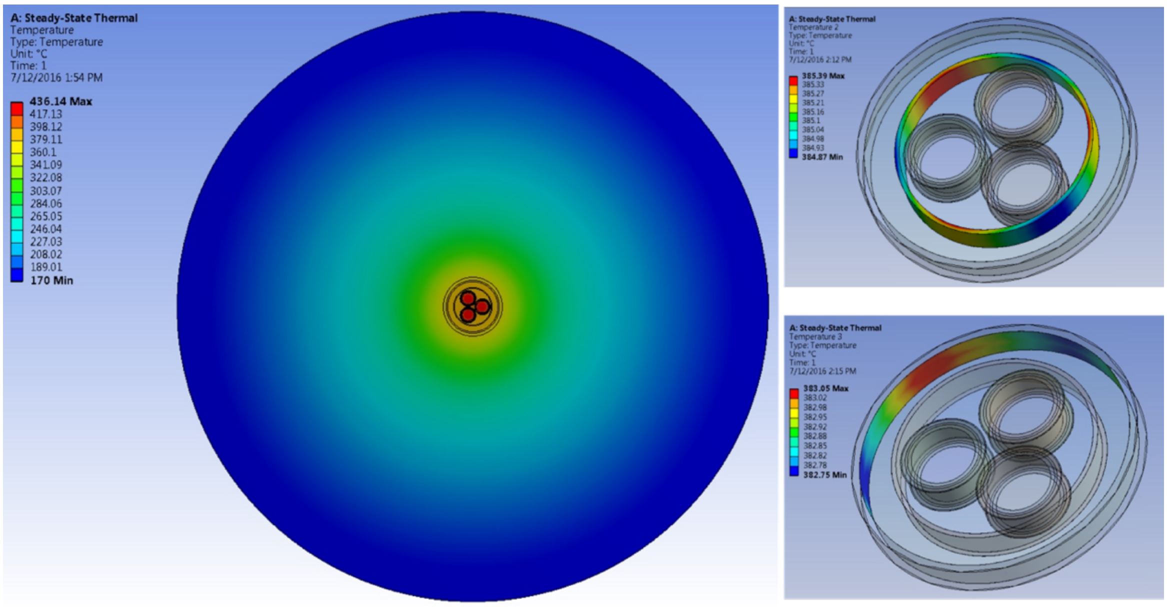

Figure 11 Temperature profile of emplaced waste package in steady state

Under the steady state conditions, with the rock outside diameter fixed at 100 in., the three canisters were loaded to give a total decay heat per waste package of 150 W, 300 W, and 471 W. The results of the salt centerline (salt), universal canister (UC) shell (canister) and waste package outside surface (WP surface) interface maximum temperatures are shown in Figure 12.

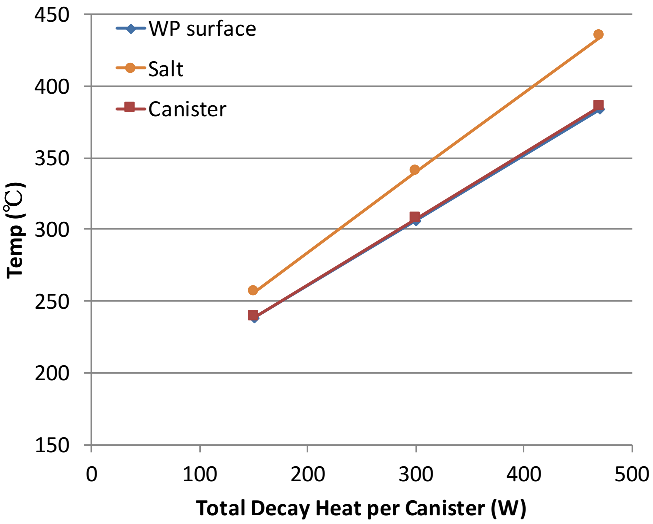

Figure 12 Temperature at different locations in the emplaced configuration

It can be concluded from the thermal analysis results that the conceptual DPC dimensions and design were adequate to meet the thermal functions and performance specifications for storage.

Structural Analyses

Structural analysis of five different load cases on the sleeve were analyzed and are identified in Table 9.

Table 9 Load cases

Load case description
Deadweight
Design pressure
Thermal storage conditions
Compressive buckling analysis
Compressive load analysis

Structural Model Setup

The sleeve design was modeled in ANSYS workbench [17] as illustrated in Figure 13. The sleeve and UC were modeled with 4-node linear shell elements with three integration points through the thickness of the shell element. The spacer and the basket were modeled with an 8-node solid brick element. The sleeve shell elements were 1 in. thick, and the UC shell elements were 0.25 in thick. The sleeve finite element analysis (FEA) model consisted of 72,717 elements and 367,213 nodes. Surface-to-surface contact interactions were set between the sleeve spacer, the sleeve's UC, the UC basket, and between the UCs themselves. All components in the sleeve assembly were modeled with 316L stainless steel in accordance with ASME SA-213 [18]. The material model includes a density of 0.290 lbm/in^3, a Young's Modulus of 2.8 × 107 psi, and a Poisson's ratio of 0.29.

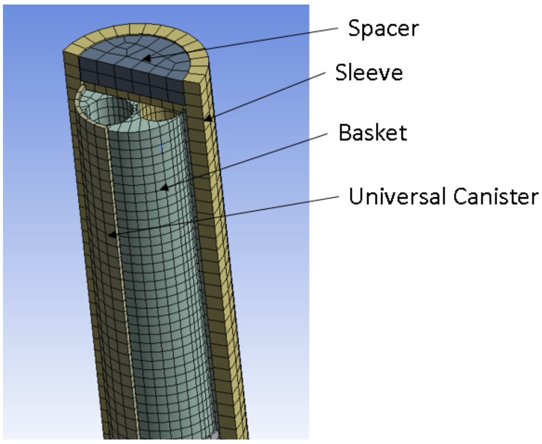

Figure 13 Deep borehole sleeve FEM

Structural Results

The nominal design for the sleeve was analyzed, and the results show that the nominal dimensions of the sleeve with the 316L stainless steel material do not meet the ASME design requirements. A parametric study was then performed to determine the OD needed to meet the ASME design requirement.

Another possible approach to meet the ASME design requirement is to use a material with a high design stress intensity value (Sm) (i.e., high-strength steel). From Figure 14, at the nominal OD value of 8.5 in., the resulting stress intensity for stainless steel from an external pressure load is 23.5 ksi. A material with a design strength intensity greater than 23.5 ksi is required to keep the OD of the sleeve at the nominal value of 8.5 in. while meeting the ASME design requirement. Table 10 shows a list of possible high-strength material choices for the sleeve.

Table 10 Alternate high strength steel material selection for sleeve

		Sy (ksi)	Su (ksi)	Sm (ksi)	Pm(Sm)	Pm+Pb (1.5Sm)
ASME SA-186	Type F316L	25	65	16.7	16.7	25
ASME SA-564	Type 630 H1075	125	145	48	48	72
ASME SA-564	Type 630 H1100	115	140	47	47	70

From ASME BPVC Sect II, Part D, Subpart 1, Table Y-1, Table U, Table 2A

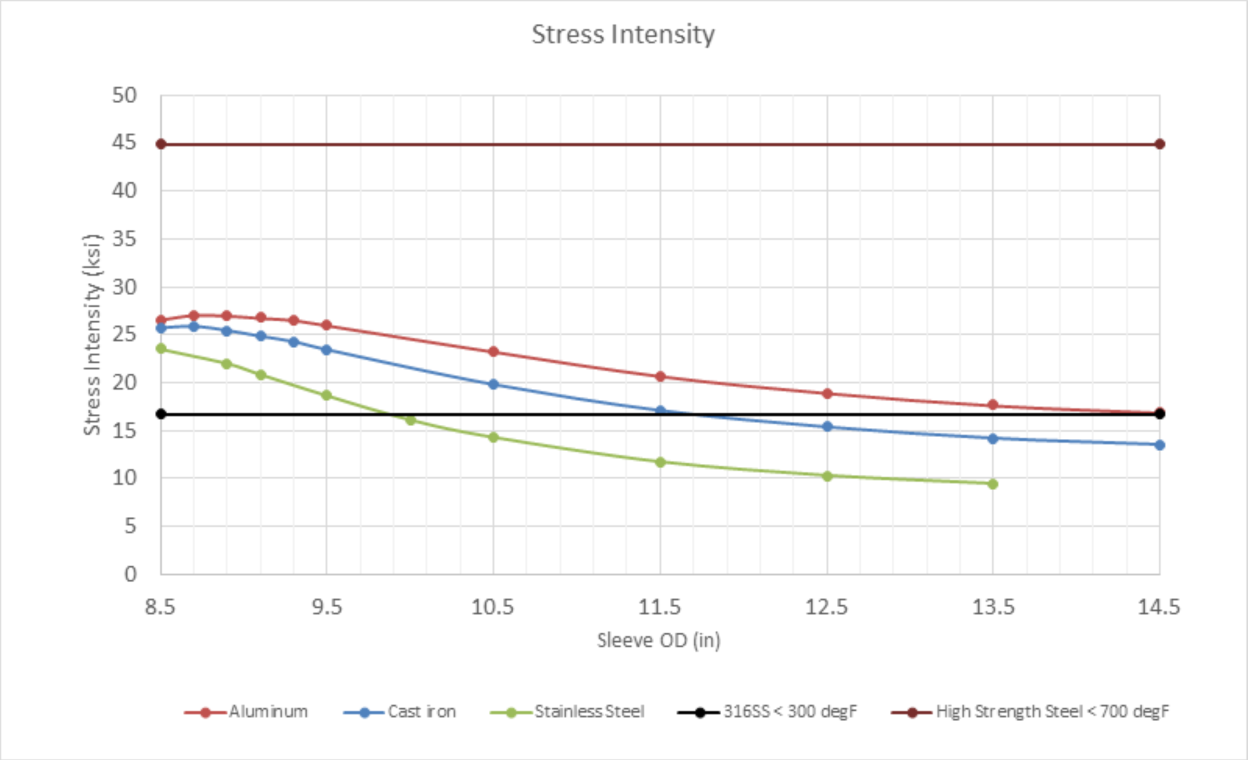

Figure 14 Sleeve parametric study comparing stress intensity to sleeve OD

Structural Conclusions

The initial design of the sleeve assembly did not meet the ASME design criteria [19] when subjected to an external pressure of 9.6 ksi. High-strength steel, which has a greater design stress intensity limit, could be used for the sleeve. The greater design stress intensity limit allows for an 8.5 in. OD of the sleeve to be used while still meeting the ASME design stress limit. In addition, a parametric study was performed to determine the minimum sleeve OD needed to meet the ASME design criteria using

316L stainless steel. The parametric study revealed that an OD of 10.0 in. is needed for the sleeve to be below the acceptable ASME design stress criteria.

Conclusions

To support the safe clean-up mission of the US Department of Energy's Office of Environmental Management (DOE-EM), a concept for a universal canister system for storage, transportation, and eventual disposition of certain high-level waste has been developed. Specifically, the universal canister concept has been developed for near-term, onsite dry storage of the cesium and strontium capsules at the Hanford Site. In addition, the universal canister system concept would be compatible with a deep borehole or a mined geologic repository concept.

This universal canister system was developed to provide a sealed canister that would never be opened and would be compatible with dry storage, transportation, and eventual disposition. This universal canister system is based on the concept of nested canisters (i.e., canisters inside of canisters) that can be moved to dry storage in near-term, with the flexibility to ensure that the universal canister would never have to be opened regardless of the disposal concept. The analyses presented in this paper show that this concept for a universal canister system should be viable for storage, transportation, and eventual disposition of HLW while avoiding the need to repackage the HLW. However, in order to move this idea from a concept to a licensable design, a number of additional analyses must be performed, and operational constraints must be confirmed. Some future activities are identified below.

- Detailed transportation package design, including impact limiter design to support 10 CFR Part 71 regulations related to:
    - Accessible surface temperatures of the package
    - Drop, puncture, fire, and submersion testing including structural confirmation that the DPC lid will stay in place.
    - Confirmation of not exceeding dose limits
    - Leak rates
- Storage configuration designs that support 10 CFR Part 72 (or applicable DOE Orders) site boundary dose, as well as normal and off-normal events
- Detailed acceptable content determinations for the universal canister, the universal canister sleeve, and the dual-purpose cask
- Detailed transfer casks calculations to ensure proper heat transfer
- Operational confirmations regarding
    - Waste Encapsulation and Storage Facility (WESF) hot cell design, and impacts to WESF transfer cask design

  - Canister and capsule drying
  - WESF hot cell radioactivity and material limits
  - Welding of universal canisters inside of WESF hot cells
  - Welding of universal canister sleeves while in the dual-purpose cask
- Confirmation of practicality of fabrication for UC system components, including:
  - WESF UC transfer cask
  - UC Sleeve transfer cask
  - Shielding material in the DPC

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