INL/RPT-22-69150-Revision-0

DOESC Closure Leak Test Assembly

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Prepared for the
U.S. Department of Energy
Under DOE Idaho Operations Office
Contract DE-AC07-05ID14517

Document ID: FOR-760
Revision ID: 0
Effective Date: 09/14/2022

Functional and Operational Requirements

DOESC Closure Leak Test Assembly

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1. INTRODUCTION

1.1 Description of Engineering Task

The Department of Energy (DOE) Spent Nuclear Fuel Packaging Demonstration Project ("Packaging Demonstration") will demonstrate loading of spent nuclear fuel (SNF) into DOE Standard Canisters (DOESCs) for interim storage at the Idaho Nuclear Technology and Engineering Center (INTEC). The Packaging Demonstration will ultimately develop and demonstrate the designs, technology, processes, and regulatory framework for packaging DOE SNF for road-ready dry storage (RRDS); and establish the processes that will be used in a future storage facility.

The DOESC is a hermetically sealed canister intended for interim storage, transportation and disposal of DOE-managed SNF.[1,2,3] The DOESC has two possible diameters (Ø 18" [~460 mm] or Ø 24" [~600 mm]) and two possible lengths (10 ft [~3.0 m] or 15 ft [~4.6 m]). The Packaging Demonstration is using the Ø 18" and 15 ft. long version (Figure 1).[4]

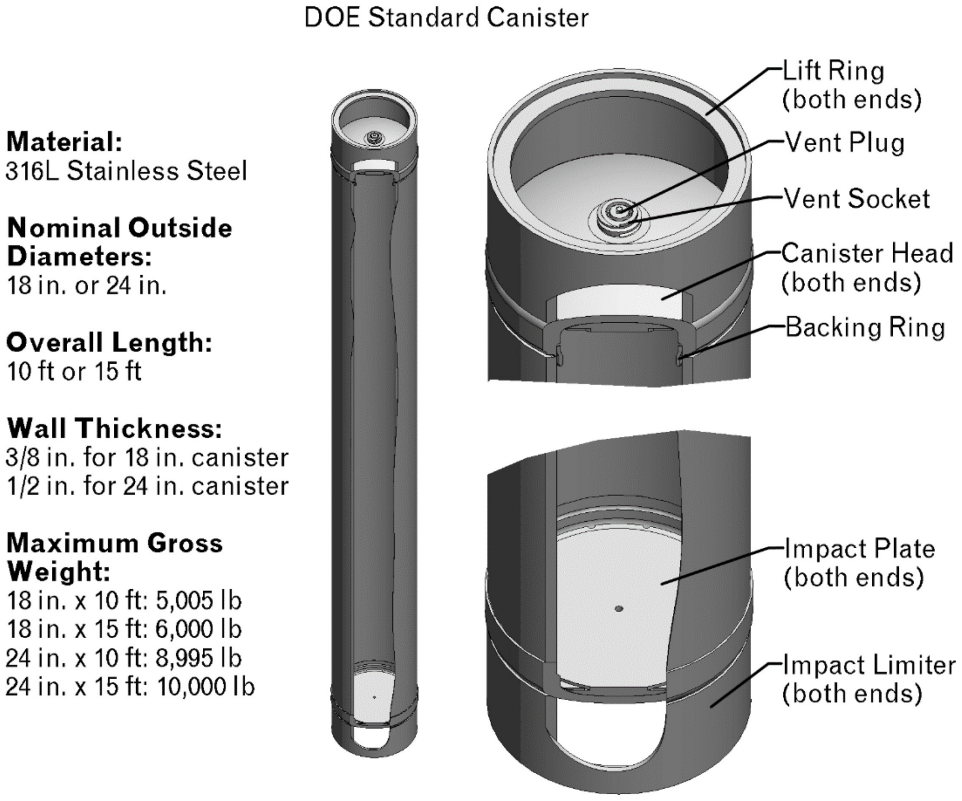

Figure 1: Department of Energy Standard Canister (DOESC)

There are two closure welds that are performed after SNF is loaded into each DOESC (Figure 2).

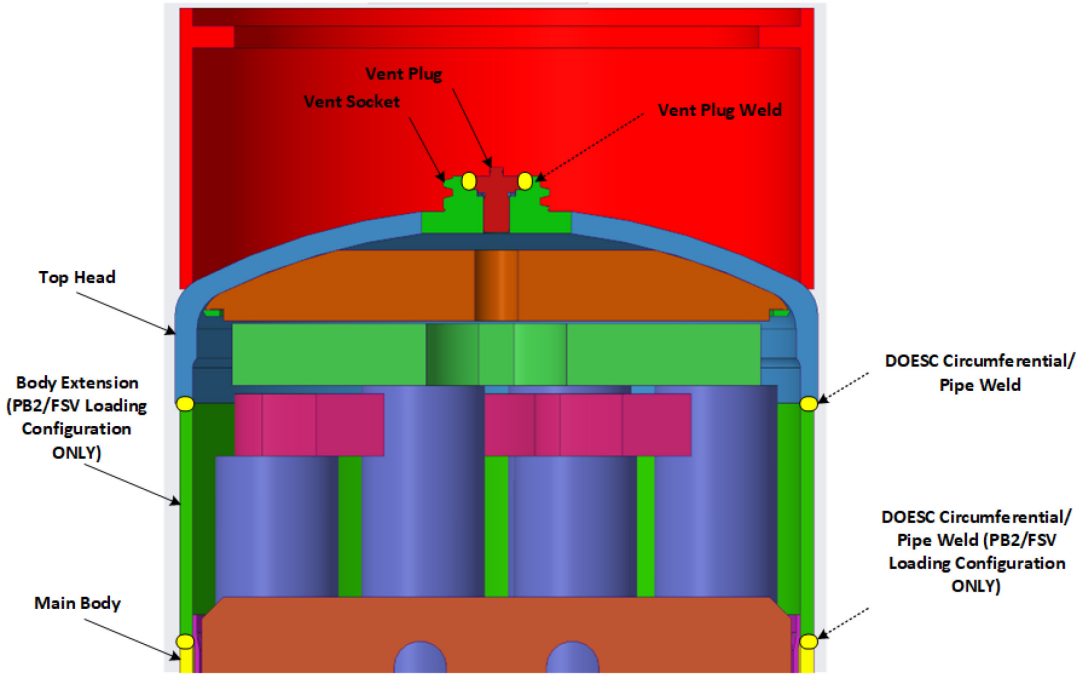

Figure 2: DOESC Closure Welds and Components (diameter mismatch between Top Head and Body Extension is prior to machining)

All DOESC welds provide containment for the SNF stored within. This containment is critical for DOE-managed SNF that is failed and/or damaged, which requires an additional level of containment for interim storage. In accordance with the Code of Record for the DOESC, these closure welds will be leak tested to verify containment after SNF loading.[5] This FOR is limited to the DOESC Closure Leak Test Assembly that will support the leak test of the closure welds.

1.2 Description of the End-Use for the Engineered Item or Activity

As part of the Packaging Demonstration, Idaho National Laboratory (INL, Battelle Energy Alliance, LLC) will perform design, testing and fabrication of the DOESC Closure Leak Test Assembly.[4] The Closure Leak Test Assembly will be delivered to and operated at the CPP-603, "Irradiated Fuel Storage Facility", a Hazard Category 2 nuclear facility at INTEC for performance of the closure leak test. These INTEC activities will be performed by Idaho Cleanup Project (ICP, Idaho Environmental Coalition) personnel.

2. OVERVIEW

2.1 Ownership of the F&OR

The owner of this F&OR is the Packaging Demonstration Project Lead. Acceptance of this F&OR document signifies that all programmatic requirements for the customer are included and accurate.

2.2 End-User of Engineered Item or Activity

Upon completion of INL design, testing and fabrication activities, the DOESC Closure Leak Test Assembly will be delivered for operation to the SNF Operations Manager of INTEC.

3. ENGINEERING INPUTS

This DOESC Closure Leak Test Assembly ("Assembly") will comply with the following requirements, which were defined by the task description, Code of Record[5], a review of relevant state and federal regulations, INL procedures, initial scoping activities with operations and support personnel, and engineering owner and performer experience and process knowledge. Deviation and justification for deviation from these requirements will be documented as a revision to this FOR in accordance with LWP-10000, "Engineering Initiation".[6]

3.1 Assumptions

3.1.1 The location of the closure leak test will occur at the same location where the closure welds and subsequent conditioning and back-filling operations are performed on the DOESC.

3.1.2 The closure leak test may occur within CPP-603 at either the (1) FHC or (2) PCS. Manual or remote operation may occur at both locations, depending on Packaging Demonstration preference.

3.1.3 During performance of the closure weld helium leak test, there will be:

3.1.3.1 ≥ 6" of vertical clearance below the DOESC's top circumferential closure weld (INL Dwg. 1004060),

3.1.3.2 ≥ 12" of radial clearance beyond the outside diameter of the DOESC (i.e., Ø 42" clearance circle per INL Dwg. 1004060), and

3.1.3.3 ≥ 36" above the DOESC's Impact Limiter (INL Dwg. 1004061, Item 5) for the Assembly.

3.2 Functional and Operational Requirements

No.	Requirement Description	Basis	Verification Method
3.2.1	The Assembly shall be capable of remote operation within the CPP-603 Fuel Handling Cave (FHC) within range of the tele-manipulators and PaR Systems © arm (MAN-GSF-401)	DOESC closure may be completed in the FHC. The Assembly will require actuation of some components to perform the leak test, which should be done remotely since the FHC is a radiation and contamination area.	Design Drawings
3.2.2	For CPP-603 FHC operation, the Assembly shall be compatible with hoisting and rigging using the CRN-GSF-101 (15 ton) and/or CRN-GSF-401 (2 ton) cranes.	These are the only two cranes available inside the FHC.	Design Drawings
3.2.3	For CPP-603 Permanent Containment Structure (PCS) operation, the Assembly shall be capable of remote operation within range of tele-manipulators or expedient manual operation.	DOESC closure may be completed either manually or remotely in the PCS. The Assembly will require actuation of some components to perform the leak test. The PCS is a radiation/contamination area. Operation of the Assembly should therefore be done either manually and quickly, or remotely if available.	Design Drawings
3.2.4	For CPP-603 PCS operation, the Assembly shall be compatible with hoisting and rigging using the CRN-SF-003 and CRN-SF-004 tandem cranes.	These are the only cranes available for operation in the PCS.	Design Drawings
3.2.5	The Assembly should be designed for remote operation and inspection to the maximum practical extent.	ALARA	Design Drawings and System Design Description

No.	Requirement Description	Basis	Verification Method
3.2.6	The Assembly shall be capable of measuring a leakage rate of 1E-07 std-cc/sec, of air, from the closure welds specified in Requirement 3.2.7 with the upstream and downstream pressure requirements specified in ANSI N14.5[7].	ANSI N14.5[7] defines this leakage rate as "leaktight", meaning no leakage rate need be determined for each radioactive payload if welds pass this acceptance criteria.	Design Drawings Engineering Test(s) Leak Test Procedure(s)
3.2.7	The Assembly shall measure the helium leakage rate from the DOESC Closure Welds (Ø 18" variation): • INL Dwg. 1004060, Note 5, "Vent Plug Seal Weld.", AND • INL Dwg. 1004060, Note 4, "Canister Lid to Canister Body Weld", OR • INL Dwg. 1004062, Circumferential Single-U Butt Joint Weld.	DOESC Preliminary Design Specification[1,2] and Packaging Demonstration Scope[4].	Design Drawings
3.2.8	The Assembly design shall minimize features that trap contamination.	The closure leak test will be performed in either the FHC or PCS, both of which are Contamination Areas with fixed and/or airborne contamination.	Design Drawings and System Design Description
3.2.9	The Assembly shall be constructed and operated per PDD-13000, "INL Quality Assurance Program"[8] and PRD-5071, "[IEC] Quality Assurance Program."[9]	INL Requirement - this engineering work effort is an "activity affecting quality."	Design Drawings and Procurement Documents
3.2.10	A quality level shall be assigned for the Assembly, and subcomponents as necessary, per LWP-13014, "Determining Quality Levels"[10] and MCP-540, "Assigning Quality Levels."[11]	INL Requirement – a quality level must be assigned to determine the level of rigor associated with Assembly construction.	Quality Level Determination and Procurement Documents

No.	Requirement Description	Basis	Verification Method
3.2.11	The Assembly shall be constructed of materials rated for a cumulative gamma radiation dose of at least 1E+06 rad (gamma).	The Assembly will be directly exposed to gamma radiation from the SNF within the loaded DOESC and potentially other sources. The amount of dose will depend on the source(s) and shielding. The 1E+06 rad (gamma) dose rating is based on typical hot cell radiation environments.	Design Drawings
3.2.12	The Assembly shall be removable via remote and manual methods from the DOESC following the leak test without any damage or permanent alteration to the DOESC.	The Assembly will not be part of the DOESC (i.e., waste package), transportation package or storage package, and must be removed following the test.	Design Drawings
3.2.13	The Assembly design shall permit nominal installation and removal within a single working shift.	CPP-603 has additional activities to be performed in the FHC and PCS (e.g., fuel condition station of Advanced Test Reactor fuel). The Assembly shall enable installation or removal to prevent delay of facility operations.	Design Drawings Mock-up Testing
3.2.14	The Assembly shall be operated utilizing personnel, hardware, and processes qualified to the "Examination, Inspection and Testing" consensus standard identified in INL TPR-13438[12] and the DOESC Code of Record.[5]	Reliable leak test results are ensured through use of qualified and trained inspection personnel.	INL TPR-13438[12], or approved equivalent
3.2.15	All engineering activities associated with the Assembly shall comply with Environmental Checklist – ICP-20-018, "INL-DOE SNF Packaging Demonstration Project"	LWP-8000, "Environmental Instructions for Facilities, Processes, Materials and Equipment"[13] or IEC Equivalent.	Work Control Documents

3.3 Owner Specified Technical Requirements

#	Requirement Description	Basis	Verification Method
3.3.1	The Assembly geometry shall minimize the potential for binding, hang up, interference and piston effects during material handling (i.e., crane operations).	Operational Requirement	Design Drawings and System Design Description
3.3.2	The Assembly shall be operated in CPP-603 per SAR-100, Chapter 11, "Operational Safety."[14]	SAR-114, Chapter 11 Requirement	Design Drawings Structural ECAR
3.3.3	The Assembly should, as much as practically achievable, use existing plumbing feedthroughs and connections in CPP-603.	Minimizes modifications to facility and maximizes changes of success using existing operational practices.	Design Drawings
3.3.4	The Assembly shall be rated for the mechanical and thermal loads associated with normal and off-normal service, including: • Vacuum service • Hoisting and Rigging	The Assembly must withstand normal and off-normal loading conditions to adequately perform its function.	Structural and/or Thermal ECAR(s)

3.4 Supporting Information

3.4.1 Need for Configuration Management (CM)

The Assembly is being used to qualify a waste form (i.e., DOESC) for acceptance for interim storage at a DOE nuclear facility under the Packaging Demonstration. This qualification will also be relevant for future transportation and disposal of the SNF within the DOESC. Failure of the Assembly to perform its principal function (i.e., closure weld leak detection), whether it is functionally inoperable or provides erroneous readings, could impact the ultimate objectives of the Packaging Demonstration. In addition, the Assembly's hoisting and rigging and operating environment call for CM. Therefore, the Assembly in its entirety (i.e., "All" per LWP-10500) shall be under the control of CM per LWP-10500.[15] The Assembly shall use the CM documentation

guidance provided for "Hot Cell Remote SSCs" per LWP-10500[15], Appendix B, with the exception that Vendor Data is not required if associated requirements are adequately addressed in Specifications written per LWP-10101.[16]

3.4.2 Sensitive Information

The Packaging Demonstration will not generate or involve the use of classified information as defined in LWP-11202.[17]

3.4.3 Export Control

Technical information and engineering deliverables generated during Assembly construction will receive export control reviews per Management System Transformation Initiative (MSTI) KB0015182, "Obtain Export Review".

3.4.4 Need for Engineering Change Control

Per LWP-10000[6], Table 1, the Assembly requires Engineering Change Control in accordance with LWP-10501.[18]

3.4.5 Level of Verification Needed

Given the collaboration and coordination across different contractors (i.e., BEA and IEC) and facilities (e.g., CPP-603, "Irradiated Fuel Storage Facility" and IF-657, "INL Engineering Demonstration Facility"), a Formal Design Review per LWP-10106 will be performed, in addition to checking, approval and acceptance per LWP-10106.[19]

3.4.6 Technical Integrator

The technical integrator for this task will be the Project Lead for the Packaging Demonstration as assigned by the Used Fuel Management (C430) Department Manager.

4. REFERENCES

[1] DOE/SNF/REP-011-Vol. 1, "Preliminary Design Specification for Department of Energy Standardized Spent Nuclear Fuel Canisters: Volume I – Design Specifications", 1998

[2] DOE/SNF/REP-011-Vol. 2, "Preliminary Design Specification for Department of Energy Standardized Spent Nuclear Fuel Canisters: Volume II – Rationale Document", 1998

[3] SDD-563, "DOE Standard Canister", Rev. 0, INL, 2021

[4] Thomas, D., "DOE SNF Packaging Demonstration Project Overview and 2021 Activities – 22083", WM2022, March 2022.

[5] COR-0009, "DOE Standard Canister (DOESC)", Rev. 0, INL, 2022

[6] LWP-10000, "Engineering Initiation", Rev. 13, INL, 2021

[7] ANSI N14.5, "Radioactive Materials – Leakage Tests on Packages for Shipment – INMM", ANSI, 2014

[8] PDD-13000, "Quality Assurance Program Description", Rev. 9, INL, 2022

[9] PRD-5071, "Quality Assurance Program", Rev. 27, ICP, 2020

[10] LWP-13014, "Determining Quality Levels", Rev. 10, INL, 2022

[11] MCP-540, "Assigning Quality Levels", Rev. 27, ICP, 2021

[12] TPR-13438, "Leak Test Procedure", Rev. 4, INL, 2018

[13] LWP-8000, "Environmental Instructions for Facilities, Process, Materials, and Equipment", Rev. 23, INL, 2022

[14] SAR-100, "ICP Standardized Safety Analysis Report (SAR) Chapters", Rev. 18, ICP, 2018

[15] LWP-10500, "Managing the Configuration of Structures, Systems and Components", Rev. 9, INL, 2020

[16] LWP-10101, "General Specification Template", Rev. 2, INL, 2022

[17] LWP-11202, "Controlled Unclassified Information Program", Rev. 19, INL, 2022

[18] LWP-10501, "Engineering Change Control", Rev. 7, INL, 2022

[19] LWP-10106, "Engineering Verification", Rev. 11, INL, 2021