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# United States Department of Energy

## National Spent Nuclear Fuel Program

# Preliminary Design Specification for Department of Energy Standardized Spent Nuclear Fuel Canisters

## Volume I – Design Specification

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U.S. Department of Energy
Assistant Secretary for Environmental Management
Office of Spent Fuel Management and Special Projects

DOE/SNF/REP-0011
REVISION 0

# Preliminary Design Specification for Department of Energy Standardized Spent Nuclear Fuel Canisters

## Volume I – Design Specification

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# ABSTRACT

This document (Volume I) is the preliminary design specification for the canisters to be used during the handling, storage, transportation, and repository disposal of Department of Energy (DOE) spent nuclear fuel (SNF). This document contains no procurement information, such as the number of canisters to be fabricated, explicit timeframes for deliverables, etc. A companion document (Volume II) provides background information and design philosophy in order to help engineers better understand the established design requirements for these DOE SNF canisters.

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# ACRONYMS, ABBREVIATIONS, AND DEFINITIONS

| | |
|---|---|
| ANS | American Nuclear Society |
| ANSI | American National Standards Institute |
| ASME | American Society of Mechanical Engineers |
| B&PV | Boiler and Pressure Vessel |
| can | a smaller structure surrounding SNF or other highly radioactive components that can be placed into a canister |
| canister | a large structure (approximately 18 to 24-inch diameter) surrounding SNF or other highly radioactive components (bare or in cans) that facilitates handling, storage, transportation, and/or disposal and can be placed into a disposal container or cask |
| cask | a structure used for the transportation or storage of SNF and/or HLW comprised of components intended to provide radiation shielding and retention of spent nuclear fuel and radioactive material contents during storage or transportation that meets all applicable regulatory requirements |
| CFR | Code of Federal Regulations |
| confinement | retention of a material within an area from which releases or leakage are permitted but controlled, and leakage of other substances into the area may also occur |
| containment | the complete and absolute retention of any substance within a closed area and no other substance may gain access inside the closed area |
| damaged SNF | SNF with cladding defects greater than hairline cracks or pinhole leaks (per Draft NUREG-1617) |
| disposal | the container in which the DOE SNF canisters are to be placed at the geologic repository container for disposal, prior to acceptance of the final barrier weld, at which time the disposal container becomes a waste package |
| DOE | Department of Energy |
| failed SNF | SNF with hairline cracks or pinhole leaks in the cladding (as defined for this document only) |
| HEPA | high efficiency particulate air |
| HLW | high-level radioactive waste means (1) the highly radioactive material resulting from the reprocessing of spent nuclear fuel and (2) other highly radioactive material that the NRC determines by rule requires permanent isolation |
| intact SNF | SNF with no hairline cracks or pinhole leaks in the cladding (as defined for this document only) |
| INEEL | Idaho National Engineering and Environmental Laboratory |

| | |
|---|---|
| internals | items (baskets, spacers, sleeves, dividers, cans, etc.) placed inside the DOE SNF canister along with the SNF for supporting and positioning the SNF and to also prevent criticality |
| ISFSI | independent spent fuel storage installation |
| LMITCO | Lockheed Martin Idaho Technologies Company |
| MNIP | Maximum Normal In-Plant Handling Pressure (Section III, Division 3 definition) |
| MNOP | Maximum Normal Operating Pressure (Section III, Division 3 definition) |
| NRC | Nuclear Regulatory Commission |
| NSNFP | National Spent Nuclear Fuel Program |
| OCRWM | Office of Civilian Radioactive Waste Management (DOE) |
| OD | outer diameter |
| package | the packaging together with its radioactive contents as presented for transport |
| packaging | assembly of components necessary to ensure compliance with the requirements of 10 CFR Part 71 |
| psig | pounds per square inch gage pressure |
| QA | quality assurance |
| QAPM | quality assurance program manager |
| repository | synonymous with geologic repository, a system that is intended to be used for the disposal of radioactive wastes in excavated geologic media |
| RT | radiographic test |
| SNF | spent nuclear fuel is fuel that has been withdrawn from a nuclear reactor following irradiation, the constituent elements of which have not been separated by reprocessing |
| SRS | Savannah River Site |
| SST | stainless steel |
| storage | large outer container (approximately 5 or 6 feet in diameter) used in storage of SNF industry canister |
| U.S. | United States |
| USNRC | United States Nuclear Regulatory Commission |
| UT | ultrasonic testing |
| waste package | the name of the disposal container after the final barrier weld is accepted (formal definition in 10 CFR Part 60.2) |

# Preliminary
# Design Specification
# for Department of Energy
# Standardized Spent Nuclear Fuel Canisters

# Volume I - Design Specification

## 1. INTRODUCTION

The Department of Energy's National Spent Nuclear Fuel Program (NSNFP) is working with the Department's Office of Civilian Radioactive Waste Management (OCRWM), the Idaho National Engineering and Environmental Laboratory (INEEL), Hanford, Oak Ridge National Laboratory, Argonne National Laboratory, and the Savannah River Site (SRS) to develop a set of standard canisters for handling, interim storage, transportation, and disposal in the national repository of Department of Energy (DOE) spent nuclear fuel (SNF). This resulting preliminary specification is written in two volumes. Volume I contains design parameters for the standardized SNF canisters. Volume II provides background information and associated reasons for specifying certain design parameters for these standard canisters.

### 1.1 Objective

The objective of this specification is to provide the requirements and necessary information to design the standardized canisters to be used for handling, interim storage, transportation, and disposal in the national repository of DOE SNF. This design specification addresses two different outer diameter (OD) sizes of DOE SNF standardized canisters, including two different lengths for each canister OD, resulting in a total of four unique canister geometries. This design specification does not consider using these DOE SNF canisters for either U.S. Navy or commercial SNF or HLW (either commercial or defense) materials. This design specification does not provide any procurement-specific information.

Although using the same terminology, the standardized DOE SNF canister must not be confused with the containers used in current interim SNF storage systems for commercial spent nuclear fuels. Many independent spent fuel storage installation (ISFSI) or dry storage system vendors also call their SNF container a canister. However, the commercial nuclear industry storage canister (hereafter referred to as the storage industry canister) is typically 5 to 6 feet in diameter. The DOE SNF canisters are approximately 1.5 to 2 feet in diameter.

### 1.2 Standardized Canister Design Approach

According to the Foreword in ANSI/ANS-57.9-1992, "...the safe storage of spent fuel assemblies is achieved by maintaining a minimum of two independent barriers between the fuel and the environs. The fuel cladding is considered the primary barrier for undamaged fuel. ...In addition, the complete confinement system for the stored fuel is conservatively designed to withstand damaging events... so that there is an effective secondary barrier(s) to the release of radioactive materials under all credible conditions." The storage industry canister is intended to provide the secondary barrier for the commercial SNF. The DOE SNF canisters are intended to provide the primary barrier (cladding replacement) for damaged DOE SNF during interim storage and transportation to the repository. Intact, failed, and damaged DOE SNF can be placed directly into the standardized DOE SNF canisters.

Although details regarding SNF loading, interim storage, and transportation are not yet finalized, the NSNFP is establishing a design for the DOE SNF canisters. The approach taken by the NSNFP is to specify a design[a] for the DOE SNF canister. This design must be robust. Robust is defined herein to mean a design that has significant safety margins for the known loads and safety margins for the loads that have been estimated.

a. The mention of any specific products and/or manufacturers in this document implies neither endorsement or preference, nor disapproval by the U. S. Government, any of its agencies, or LMITCO, of the use of a specific product for any purpose.

# 2. REFERENCES

### Federal Regulations:

| | | |
|---|---|---|
| A. | 10 CFR Part 60<br>January 1, 1998 Edition | Disposal of High-Level Radioactive Waste in Geologic Repositories |
| B. | 10 CFR Part 71<br>January 1, 1998 Edition | Packaging and Transportation of Radioactive Material |
| C. | 10 CFR Part 72<br>January 1, 1998 Edition | Licensing Requirements for the Independent Storage of Spent Nuclear Fuel and High-Level Radioactive Waste |

### DOE RW Documents:

| | | |
|---|---|---|
| A. | DOE/RW-0333P<br>Rev 8, June 5, 1998 | OCRWM Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program |

### National Standards:

| | | |
|---|---|---|
| A. | ANSI/ANS-57.9<br>1992 | Design Criteria for an Independent Spent Fuel Storage Installation (Dry Type) |
| B. | ANSI N14.5<br>1987 | American National Standard for Radioactive Materials - Leakage Tests on Packages for Shipment |
| C. | ANSI N14.6<br>1993 | American National Standard for Special Lifting Devices for Shipping Containers Weighing 10,000 Pounds (4500 kg) or More for Nuclear Materials |
| D. | ASME B&PV Code, Section II, 1995 Edition, 1997 Addenda | Materials |
| E. | ASME B&PV Code, Section III, Division 1, Subsection NB, 1989 Edition | Rules for Construction of Nuclear Power Plant Components Class 1 Components |
| F. | ASME B&PV Code, Section III, Division 3, 1997 Edition | Containment Systems and Transport Packagings for Spent Nuclear Fuel and High Level Radioactive Waste |
| G. | ASME B&PV Code, Section IX, 1995 Edition, 1997 Addenda | Welding and Brazing Qualifications |

# 3. DESIGN REQUIREMENTS FOR THE DOE SNF CANISTERS

This preliminary design specification establishes a common basis for all standardized DOE SNF canisters so that they can be accepted for disposal at the repository. It is recognized that the DOE SNF canister final design must be integrated with the total system design, including storage and transportation requirements. Different groups of DOE SNF canisters may be stored in a variety of facilities and these same groups of DOE SNF canisters may even be transported in a variety of transportation casks.

Each unique group of DOE SNF canisters will require Design Specifications and Design Reports [per the ASME Boiler & Pressure Vessel (B&PV) Code]. The Design Report must establish the design bases and establish the specified uses of the DOE SNF canister. The Design Reports may also have to be updated as necessary when design information changes.

## 3.1 NSNFP Specified Canister Design

The specified standardized DOE SNF canister designs for the four unique geometries are shown on the engineering drawings (see Appendix A). The storage system vendor and the transportation cask designer must incorporate the specified DOE SNF canister design into their respective system designs. For clarification, the design loads defined in 10 CFR Part 71.71 and 71.73 shall be applied to the DOE SNF canister and the outer transportation cask as a combined system (canister and cask), not individually. The same combined system design philosophy applies to the DOE SNF canister and the applicable storage system.

This preliminary design specification (Volume I) identifies the requirements necessary to construct (design, fabricate, examine) the DOE SNF canisters. Additional background information, functionality requirements, intended canister use details, or an explanation of imposed requirements can be found in Volume II of this document.

## 3.2 Design Requirements

### 3.2.1 Acceptance Criteria

The DOE SNF canisters shall be designed, fabricated, and examined per the requirements of the ASME B&PV Code, Section III, Division 3, 1997 Edition (or most current edition approved by the NRC) for the loads and environments identified in this design specification. However, due to the presence of the SNF after loading, the DOE SNF canisters shall not be required to satisfy pressure test requirements of Section III, Division 3, after loading and final seal welding. The DOE SNF canisters shall not contain any pressure relief devices. The DOE SNF canisters shall be stamped following the philosophy of a proposed Code Case for spent fuel storage canisters currently being considered by the ASME B&PV Code, Section III, Subgroup on Containment Systems for Spent Fuel and High Level Waste Transport Packagings.

Depending on how the DOE SNF canister is used for interim storage, there could exist the possible requirement to demonstrate DOE SNF canister structural adequacy. If this occurs, it may be necessary to demonstrate compliance with the requirements of the ASME B&PV Code, Section III, Division 1, Subsection NB. However, this is achievable because the DOE SNF canisters are already Section III vessels.

### 3.2.2 Geometry

All of the DOE SNF canisters shall be right circular cylinders that are able to stand vertically when placed on a flat surface after being loaded with SNF. The large canister shall have a nominal OD of 610 mm (24.00 inches) and a nominal wall thickness of 12.7 mm (0.500 inches). The small canister shall

have a nominal OD of 457 mm (18.00 inches) and a nominal wall thickness of 9.53 mm (0.375 inches). Both of these canisters shall be designed for a maximum overall length of either 3,000 mm (118.11 inches) or 4,570 mm (179.92 inches). Appendix A of this design specification contains the engineering drawings showing the specified NSNFP canister design. Dimensional tolerances and fabrication processes (including weld grinding where necessary) shall be controlled so that the maximum dimensions are not exceeded.

Typical fabrication tolerances are indicated on the engineering drawings. Since the material specification is SA-312 (for seamless and welded austenitic stainless steel pipes), certain dimensional tolerances (from material specification SA-530 in Section II of the ASME B&PV Code) associated with the exterior canister shell are already specified. Outer diameter variations shall not be over by more than 3.2 mm (0.125 inches) for the 610 mm (24.00 inches) canister and 2.4 mm (0.093 inches) for the 457 mm (18.00 inches) canister. For ovality, the difference in extreme outside diameter readings in any one cross-section shall not exceed 1.5% of the specified nominal outside diameter. Straightness tolerances for each canister shall not exceed 3.2 mm (0.125 inches) maximum deviation for every 3.0 m (10 feet) of pipe length (both ends of a 3.0-m (10-foot) straightedge used for the measurement are in contact with the surface). In addition to the above mentioned mill tolerances, provisions must be made for the as-welded condition of the final canister weld (attaching the top head to the canister shell). Therefore, an additional diameter increase of 4.76 mm (0.1875 inches) shall be considered acceptable for the crown of the final canister weld.

In order to ensure that certain contents can be placed inside these canisters and that the canister can be placed in the repository waste package, the following dimensions shall be incorporated into the canister design:

**Table 3.1.** DOE SNF canister dimensions.

| Canister Size | Nominal Outer Diameter | Long Canister Max. External Length | Short Canister Max. External Length | Min. Internal Diameter | Long Canister Min. Internal Length | Short Canister Min. Internal Length |
|---|---|---|---|---|---|---|
| Large | 610 mm (24.00 in.) | 4,570 mm (179.92 in.) | 3,000 mm (118.11 in.) | 579 mm (22.80 in.) | 4,064.0 mm (160 in.) | 2,495.6 mm (98.25 in.) |
| Small | 457 mm (18.00 in.) | 4,570 mm (179.92 in.) | 3,000 mm (118.11 in.) | 430 mm (16.93 in.) | 4,140.2 mm (163 in.) | 2,565.4 mm (101 in.) |

### 3.2.3 Materials

The DOE SNF canisters shall be made of SA-312, type 316L stainless steel for the shell and SA-240, type 316L for all other parts, including the heads, labels, and lifting rings. The optional plugs shall be SA-479 type 316L stainless steel. All stainless steel materials shall be annealed and pickled. A total value of 1.27 mm (0.050 inches) of pressure boundary wall thickness reduction has been established as the erosion and corrosion value to be used for canister design purposes.

The canisters will be subjected to a radiation environment. Radiation fields ($10^7$ rad/hr or less) are expected but no significant material damage or degradation is anticipated for the stainless steel material.

Both the inner and outer surfaces of the canisters shall have a finished condition such that acceptable nondestructive examinations can be performed in order to satisfy ASME B&PV Code, Section III, Division 3 requirements. However, no specific surface finish is specified for the DOE SNF canisters. Any burrs, sharp edges, and weld edges shall not exceed 0.5 mm (0.0197 inches). The interior surfaces shall be smooth enough to allow easy loading of any DOE SNF or internals (baskets, spacers, sleeves, dividers, cans, etc.) so as to not damage the SNF.

### 3.2.4 Contents

The DOE SNF canisters shall be designed for the total maximum allowable weights (canister plus contents) listed in the table below:

**Table 3.2.** DOE SNF canister maximum total allowable weights.

| Canister Size | Nominal Outer Diameter | Long Canister Maximum Total Weight | Short Canister Maximum Total Weight |
|---|---|---|---|
| Large | 610 mm (24.00 in.) | 4,535 kg (10,000 $lb_f$) | 4,080 kg (8996 $lb_f$) |
| Small | 457 mm (18.00 in.) | 2,721 kg (6,000 $lb_f$) | 2,270 kg (5,005 $lb_f$) |

When loading the DOE SNF, the center-of-gravity of the entire contents (SNF, baskets, spacers, sleeves, dividers, etc.) shall be within 127.0 mm (5 inches) of the canister centerline for the 457 mm (18.00 inches) nominal OD canister and within 203.2 mm (8 inches) of the canister centerline for the 610 mm (24.00 inches) nominal OD canister. These loading restrictions are to avoid excessive lop-sided loading situations and to limit resulting stresses in the lifting ring and adjacent skirt portion of the canister to stress limits that satisfy the requirements of ANSI N14.6. When possible, the center-of-gravity of the loaded DOE SNF canister will be as close to the canister centerline as reasonably achievable. The axial location of the center-of-gravity of a loaded DOE SNF canister shall be within 609.6 mm (24.0 inches) of the canister centroid. Sites performing SNF loading may make separate evaluations of center-of-gravity locations if the indicated center-of-gravity limitations are exceeded. However, all acceptance criteria shall still be satisfied.

### 3.2.5 Canister Sealing

Sealing of the DOE SNF canisters may be required for interim storage, depending on the type of storage system utilized. However, if the storage system permits it, the DOE SNF canisters may be sealed after interim storage. Incorporated into the DOE SNF canister design is the option of a threaded plug in the top and bottom head. However, prior to transportation and repository disposal, the DOE SNF canister must be seal-welded closed. The DOE SNF canisters shall be backfilled with an inert cover gas (e.g., helium) inside of the canister at a pressure of 13.8 to 27.6 kPa (2 to 4 psig). The final canister weld shall implement a welding procedure that can be qualified to yield leaktight welds. A leaktight weld shall be considered equal to or better than the required leak rate necessary to satisfy the applicable 10 CFR Parts 71 and 72 requirements.

When using the optional threaded plugs, it is necessary to seal-weld the threaded plugs in order to establish an acceptable containment boundary per ASME B&PV Code, Section III requirements. The seal weld shall cover any exposed threads on the plug.

### 3.2.6 Shielding

For the purposes of this design specification, it is assumed that the DOE SNF canisters do not require additional shielding beyond that provided by the canisters themselves or in conjunction with shielding provided by the facilities handling the DOE SNF canisters or the storage or transportation systems.

### 3.2.7 Criticality

For the purposes of this design specification, it is assumed that adequate attention to the types and amounts (proper fissile limits) of SNF to be loaded into the canisters or proper configuration using properly designed internals (baskets, spacers, sleeves, dividers, cans, etc.) will preclude any criticality concerns.

### 3.2.8 Weight

The weight considerations listed in Table 3.2 are for all of the DOE SNF canister geometries. The DOE canisters shall not be horizontally or vertically stacked at any time with any other canisters without a proper evaluation of all possible consequences. Interim storage, transportation, and disposal scenarios are situations where the canisters are within other enclosures or facilities and these canister placements shall be properly evaluated.

The lifting fixture is not part of the canister design specification. However, the design of the lifting fixture does have an affect on the resulting design of the canister. Therefore, some insights regarding design requirements of the lifting fixture should be indicated. The lifting fixture shall provide at least three locations to engage the canister lifting ring, with the capability to engage and disengage remotely. The lifting fixture shall be capable of engaging and disengaging while remaining within the projected perimeter of the DOE SNF canisters. The lifting fixture must also allow the reading of the canister label appearing on the lifting ring while the lifting fixture is engaged. The amount of engagement provided by the lifting fixture shall be determined so that ANSI N14.6 stress criteria for the canister are satisfied. With a proper lifting fixture available, the DOE SNF canister shall be designed so that the canisters can be lifted and moved safely.

1. The DOE SNF canisters shall be designed to be vertically lifted with a lifting fixture that remotely engages underneath the 12.7-mm (1/2-inch) thick lifting ring. Material temperature limits for lifting the canisters shall be 148.9$^{o}$C (300$^{o}$F). Due to the symmetry of the specified DOE SNF canister design (see the engineering drawings Appendix A), either end shall be capable of being used to lift the canister. The Maximum Normal In-Plant Handling Pressure (MNIP) shall be considered to be acting coincidentally.

2. With respect to recovering from an accidental canister drop or tip-over (regardless of severity), the canisters shall be designed to be picked up from both extreme ends or tilted back upright from a horizontal position. Stresses resulting from this action shall satisfy normal operating condition stress limits defined in the ASME B&PV Code, Section III, Division 3. Worst case temperatures and pressures shall be considered to be acting coincidentally. The weight of the contents shall be assumed to be lumped at the centroid of the canister.

### 3.2.9 Pressure

The following specified pressure loadings are listed for all of the DOE SNF canister geometries.

1. The Maximum Normal In-Plant Handling Pressure (MNIP) is the maximum pressure that would develop in a DOE SNF canister during initial handling, interim storage, transportation, or initial repository handling or disposal container loading prior to actual emplacement in a repository drift under the most severe conditions of normal in-plant handling operations. The DOE SNF canister shall be designed for a MNIP not to exceed 344.8 kPa (50 psig) per the criteria of the ASME B&PV Code, Section III, Division 3. (For potential ASME B&PV Code, Section III, Division 1, Subsection NB evaluations, the MNIP shall be considered to be the design pressure.)

2. The Maximum Normal Operating Pressure (MNOP) is the maximum pressure that would develop in a DOE SNF canister during initial handling, interim storage, transportation, or initial repository handling or disposal container loading prior to actual emplacement in a repository drift without venting. The DOE SNF canister shall be designed for a MNOP not to exceed 151.7 kPa (22 psig) per the criteria of the ASME B&PV Code, Section III, Division 3. (For potential ASME B&PV Code, Section III, Division 1, Subsection NB evaluations, the MNOP shall be considered to be the operating pressure.)

### 3.2.10 Thermal

The DOE SNF canisters are assumed to have adequate room (diameter and length) for stress-free thermal expansion during all uses.

1. The Primary Service Temperature for a DOE SNF canister when it is not inside any other container (by itself, in a 25$^{o}$C (77$^{o}$F) calm air environment) is 176.7$^{o}$C (350$^{o}$F), and 343.3$^{o}$C (650$^{o}$F) after placement within another enclosed container (e.g., a storage industry canister for interim storage, a transportation cask, or the waste package at the repository), possibly with other heat generating DOE SNF canisters or HLW canisters. (For potential ASME B&PV Code, Section III, Division 1, Subsection NB evaluations, the Primary Service Temperature shall be considered to be the design temperature.)

2. The maximum operating temperature for a DOE SNF canister when it is not inside any other container (by itself, in a 25$^{o}$C (77$^{o}$F) calm air environment) is 148.9$^{o}$C (300$^{o}$F), and 315.5$^{o}$C (600$^{o}$F) after placement within another enclosed container (e.g., a storage industry canister for interim storage, a transportation cask, or the waste package at the repository), possibly with other heat generating DOE SNF canisters or HLW canisters.

3. The DOE SNF canisters shall be designed for 20 full MNIP and temperature cycles of a canister achieving its maximum steady state operating temperature of 315.5$^{o}$C (600$^{o}$F) inside of another container and then suddenly being exposed to an external calm air temperature environment of 10$^{o}$C (50$^{o}$F) while the canister simultaneously loses its internal pressure. The maximum thermal gradient associated with this event shall be evaluated per the criteria of the ASME B&PV Code, Section III, Division 3. If the canisters are subjected to any other significant fatigue loads due to initial SNF loading, interim storage, transportation, or loading into a disposal container at the repository, a detailed fatigue analysis shall be performed per WB-3221.9(e). If necessary, cumulative usage factors from all uses (SNF loading, canister handling, storage, or transportation) shall be evaluated once these values are known.

4. The DOE SNF canisters shall be capable of maintaining containment in temperature environments that range from -40$^{o}$C to 343.3$^{o}$C (-40$^{o}$F to 650$^{o}$F), excluding accidental drop scenarios or other accidental events when being handled by itself or inside of the waste package at the repository.

### 3.2.11 Other Normal Operating Condition Loads

1. For situations requiring specific design evaluations where significant compressive stresses occur in the canister, the buckling stress shall be taken into account. Acceptance criteria for buckling evaluations shall be obtained from the ASME Nuclear Code Case N-284. Buckling situations need to be considered in terms of being able to remove the canister from the enclosing container (either the storage industry canister or the transportation cask).

2. The DOE SNF canisters shall be designed for any other normal operating condition loads resulting from initial handling, interim storage, transportation, or handling and loading into a disposal container at the repository once the loads and environments have been defined.

### 3.2.12 Hypothetical Accident Loads and Environmental Conditions

Anytime a DOE SNF canister is being handled by itself, the canister shall be within a high efficiency particulate air (HEPA) filtered building or facility. This eliminates the requirement of specifically designing the DOE SNF canisters to any specific ASME B&PV Code stress limits for accidental drop events. However, when the DOE SNF canister is enclosed within a storage industry canister for interim storage purposes or within a transportation cask, the DOE SNF canister shall be designed in accordance with the criteria in the ASME B&PV Code, Section III, Division 3 stress limits identified in WB-3224 or Section III, Division 1, Subsection NB-3225 as required. For the repository waste package drop or tip-over event, the canister shall be considered adequate as-developed (per the engineering drawings in Appendix A) since the only requirement is to remove the DOE SNF canister from the damaged waste package and place it into another undamaged waste package.

Another design concern is to maintain permissible deformations for the DOE SNF criticality concerns. However, this design evaluation is considered to be beyond the scope of this current design specification due to the involvement of the not yet defined canister internals (baskets, spacers, sleeves, dividers, cans, etc.). Therefore, the internals shall be required to provide any necessary geometry control regarding criticality evaluations of the DOE SNF.

For situations requiring specific design evaluations where significant compressive stresses occur in the canister, the buckling stress shall be taken into account. Acceptance criteria for buckling evaluations shall be obtained from the ASME Nuclear Code Case N-284. Buckling situations need to be considered only in terms of being able to remove the canister from the enclosing container (either the storage industry canister or the transportation cask).

### 3.2.13 Quality Assurance

The designer and fabricator of the DOE SNF canisters shall establish, maintain, and execute a quality assurance program based on the criteria necessary to satisfy ASME B&PV Code, Section III, Division 3 construction criteria, 10 CFR Parts 71 (Subpart H), and 72 (Subpart G) quality assurance requirements.

10 CFR Part 60 (Subpart G) has been implemented in *DOE/RW-0333P, Revision 8, Quality Assurance Requirements and Description for the Civilian Radioactive Waste Management Program*. Currently, the DOE SNF canister is not listed on the repository's Q-list. The DOE SNF canister does not perform any required safety function at the repository. Therefore, since the DOE SNF canister is not on the repository's Q-list, compliance with 0333P is not required.

### 3.2.14 Physical Protection of SNF

Since the DOE SNF canisters are to be seal-welded for transportation and repository disposal, the DOE SNF canisters do not require the use of an NRC approved tamper-safe seal. Depending on how the DOE SNF canister is being used within an interim storage system, a tamper-safe seal may be required if the DOE SNF canister is not seal-welded.

### 3.2.15 Labeling

The DOE SNF canisters shall be capable of being properly labeled. The highlights of these requirements include:

- The label shall be an integral part of the canister [engraved to a depth no greater than 0.8 mm (1/32 of an inch)] that can be reasonably expected to remain legible for 100 years at temperatures of 25$^{o}$C (77$^{o}$F) to 400$^{o}$C (752$^{o}$F).

- The label shall have a unique alphanumeric identifier

- The label shall not impair the integrity of the canister

- The label shall be chemically compatible with the canister material

- The label shall be visible from the top of the canister with the lifting fixture engaged, with characters approximately 25.4 mm (1 inch) in height

- The label shall not cause the canister dimensional limits to be exceeded.

This specification is requiring the DOE SNF canisters to be labeled on the outer most surface of the lifting ring on the top end of the canister. The alphanumeric identifier shall be readable as if the remotely operated cameras are on the outside of the canister looking inward toward the axial centerline of the canister. Placement of an alphanumeric label on the lifting ring shall not cause any interference or loading concerns.

### 3.2.16 Documentation

The designer of the DOE SNF canisters shall provide adequate documentation, reports, and design drawings in the proper form and format to satisfy the proper quality assurance requirements and record storage requirements. In addition, adequate documentation shall also be provided that:

- Supports the acceptable design of the DOE SNF canisters and is to be certified by a qualified professional engineer (the Design Report and Design Drawings)

- Permits an independent review of all design procedures and calculations

- Identifies all software used in the design process

- Indicates appropriate validation and verification documentation of all software used for the design calculations

- Indicates the involved design personnel have the experience, education, training, and proficiency commensurate with the minimum requirements established

- Is legible and in a form suitable for reproduction, filing, and retrieval.

Additional documentation requirements (including the detailed and specific requirements associated with the testing of computer software) can be located in the quality assurance requirements that are applicable. All additional evaluations requested by this design specification shall also be included in the documentation.

# Appendix A

# Canister Design Drawings

**[Note: The English dimensions are exact. Metric equivalents are approximated.]**