Department of Energy

Washington, DC 20585

JUN 24 2008

ATTN: Document Control Desk,
Director, Spent Fuel Project Office
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Document Control Desk:

The response to the Nuclear Regulatory Commission (NRC) Request for Additional Information (RAI) for the license application for a new Fresh Fuel Shipping Container (FFSC) for the Advanced Test Reactor (ATR) at the Idaho National Laboratory (INL) was submitted on April 1, 2008, Docket No. 71-9330 and TAC No. L23105. The attached are provided in response to a telephone conference call with NRC conducted on May 6, 2008, where minor questions were discussed and resolved. Minor document changes were prepared and informally submitted for the NRC to review. NRC told DOE there were no further questions and a formal submittal of the minor document changes was requested. In addition to the one copy of this response that is being sent to the Document Control Desk, five (5) copies of this response will be delivered to Nancy Osgood, Senior Project Manager, on Tuesday June 24, 2008.

If you have any questions, please contact me at 301-903-5513.

James M. Shuler

Dr. James M. Shuler
Manager, Packaging Certification Program
Office of Packaging and Transportation
Office of Environmental Management

Enclosure

cc:
James Wade, DOE-ID
Rhonda Rohe, Battelle Energy Alliance, LLC

NMSS01

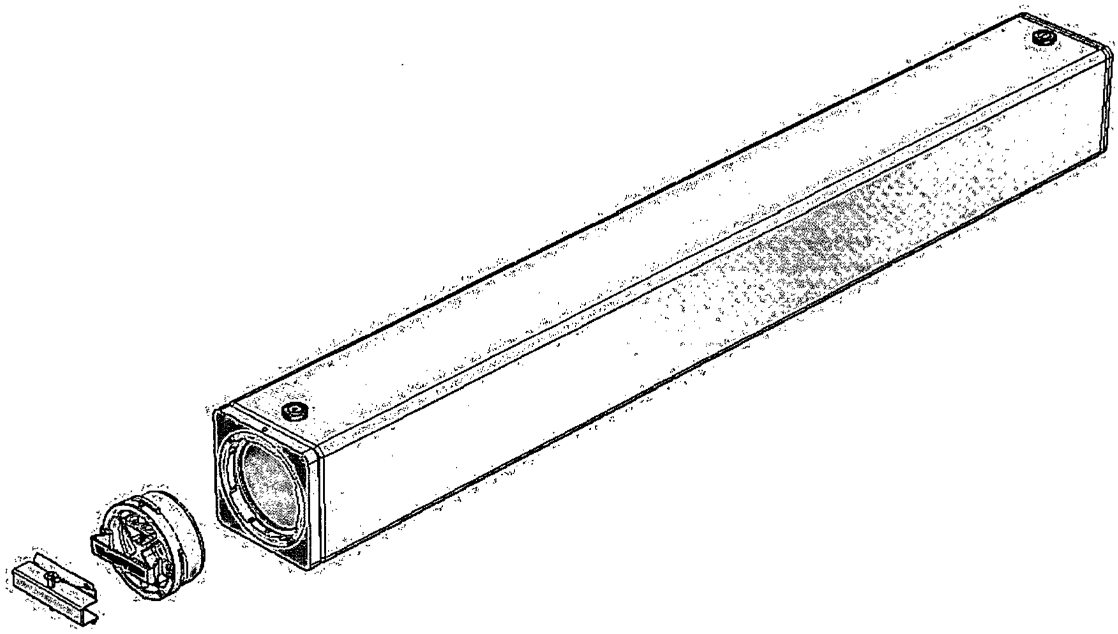
Attachment 1

Delete/Insert Instructions

Revision 2 of the ATR FFSC SAR

SAR Section	Delete Pages from Rev. 1	Insert Pages to Rev. 2
Cover and Spine	Cover and Spine	Cover and Spine
Title Page (Same as Cover)	Title Page	Title Page
Table of Contents	i-iv	i-iv
Chapter 1	1-1 through 1-10	1-1through 1-11
	Drawing 60501-10 Rev. 1 (5 sheets)	Drawing 60501-10 Rev. 2 (5 sheets)
Chapter 2	2-4,2-14 through 2-18	2-4, 2-14 through 2-18
Chapter 3	3-1,3-3, and 3-11	3-1,3-3, and 3-11
Chapter 6	6-11 and 6-12	6-11 and 6-12
Chapter 7	7-1 through 7-5	7-1 through 7-6
Chapter 9	9-11	9-11

Safety Analysis Report



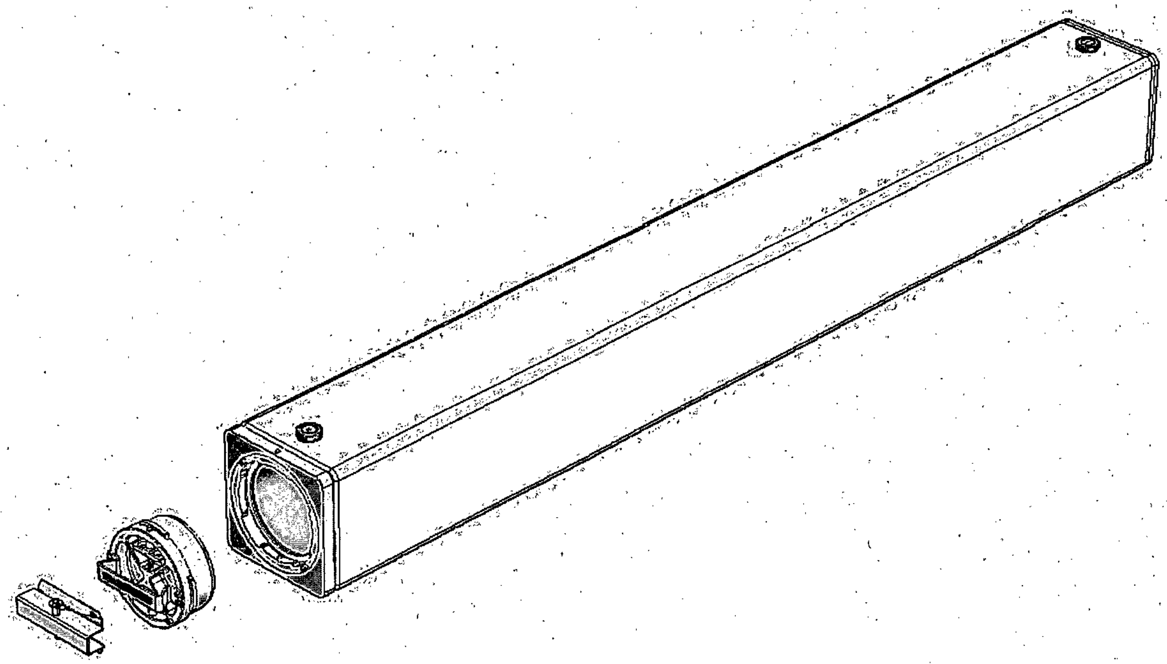
Advanced Test Reactor Fresh Fuel Shipping Container (ATR FFSC)

Revision 2, May 2008

Docket 71-9330

Prepared by:	*Prepared for:*
AREVA AREVA Federal Services LLC	INL Idaho National Laboratory Battelle Energy Alliance, LLC (BEA)

Safety Analysis Report



Advanced Test Reactor Fresh Fuel Shipping Container (ATR FFSC)

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AREVA AREVA Federal Services LLC	Idaho National Laboratory Battelle Energy Alliance, LLC (BEA)

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1.0 GENERAL INFORMATION

This chapter of the Safety Analysis Report (SAR) presents a general introduction and description of the Advanced Test Reactor (ATR) Fresh Fuel Shipping Container (FFSC).[1] This application seeks validation of the ATR FFSC as a Type AF fissile materials shipping container in accordance with Title 10, Part 71 of the Code of Federal Regulations (10CFR71).

The major components comprising the package are discussed in Section 1.2.1, *Packaging*, and illustrated in Figure 1.2-1 through Figure 1.2-6. Detailed drawings of the package design are presented in Appendix 1.3.2, *Packaging General Arrangement Drawings*. A glossary of terms is presented in Appendix 1.3.1, *Glossary of Terms*.

1.1 Introduction

The ATR FFSC has been designed to transport unirradiated fuel. The principal payload is the ATR fuel used in the Advanced Test Reactor located in Idaho Falls, Idaho. This fuel consists of 19 aluminum-clad uranium aluminide (UAl_x) plates containing high-enriched uranium (HEU) enriched to a maximum of 94% U-235. The package can transport one ATR fuel element.

Additionally, the package is designed to transport fuel element plates that have either not yet been assembled into a fuel element or have been removed from an unirradiated fuel element. The fuel plates may be either flat or rolled to the geometry required for assembly into a fuel element.

Since the A_2 value of the payloads is low and radiation is negligible, the only safety function performed by the package is criticality control. This function is achieved, in the case of a transport accident, by confining the fuel element within the package and by maintaining separation of fuel in multiple packages. The ATR fuel itself is robust and inherently resists unfavorable geometry reconfiguration while contained within the package. For ease of handling and property protection purposes, the fuel assembly is contained within a lightweight aluminum housing referred to as the fuel handling enclosure. The loose fuel plates are contained in a loose plate basket which prevents the fuel from reconfiguring into an unfavorable geometry.

For the ATR fuel, the criticality control function is demonstrated via full-scale testing of a prototypic package followed by a criticality analysis using a model which bounds the test results, ensuring that the calculated $k_{eff} + 2\sigma$ is below the upper subcritical limit (USL) in the most limiting case. Two full-scale prototype models are used to perform a number of performance tests including normal conditions of transport (NCT) free drop and hypothetical accident condition (HAC) free drop and puncture tests.

[1] In the remainder of this Safety Analysis Report, *Advanced Test Reactor Fresh Fuel Shipping Container* will be abbreviated as *ATR FFSC*. In addition, the term 'packaging' will refer to the assembly of components necessary to ensure compliance with the regulatory requirements, but does not include the payload. The term 'package' includes both the packaging components and the payload of ATR fuel.

Authorization is sought for a Type A(F)-96, fissile material package per the definitions delineated in 10 CFR §71.4[2]. Each ATR fuel element contains up to 1,200 grams of U-235 enriched to a maximum of 94% U-235. When shipping loose plates, the package is limited to a maximum fissile payload of 600 grams U-235.

The Criticality Safety Index (CSI) for the package, determined in accordance with the definitions of 10 CFR §71.59, is 4.0. The CSI is based on the number of packages for criticality control purposes (the method and the CSI determination are given in Chapter 6.0, *Criticality Evaluation*).

1.2 Package Description

This section presents a basic description of the ATR FFSC. General arrangement drawings are presented in Appendix 1.3.2, *Packaging General Arrangement Drawings*.

1.2.1 Packaging

1.2.1.1 Packaging Description

The ATR FFSC is designed as Type AF packaging for transportation of two payload types; ATR fuel elements and unassembled ATR fuel element plates. The packaging is rectangular in shape and is designed to be handled singly with slings, or by fork truck when racked. Package components are shown in Figure 1.2-1. Transport of the package is by highway truck. The maximum gross weight of the package loaded with an ATR fuel element is 280 pounds. The maximum gross weight of the package loaded with the ATR unassembled fuel plate payload is 290 pounds.

The ATR FFSC is a two part packaging consisting of the body and the closure. The body is single weldment that features square tubing as an outer shell and round tubing for the payload cavity. Three 1-inch thick ribs maintain spacing between the inner and outer shells. The components of the packaging are shown in Figures 1.2-2, 1.2-3, and 1.2-4 and are described in more detail in the sections which follow. With the exception of several minor components, all steel used in the ATR FFSC is ASTM Type 304 stainless steel. Components are joined using full-thickness fillet welds (i.e., fillet welds whose leg size is nominally equal to the lesser thickness of the parts joined) and full and partial penetration groove welds.

[2] Title 10, Code of Federal Regulations, Part 71 (10 CFR 71), *Packaging and Transportation of Radioactive Material*, 1-1-06 Edition.

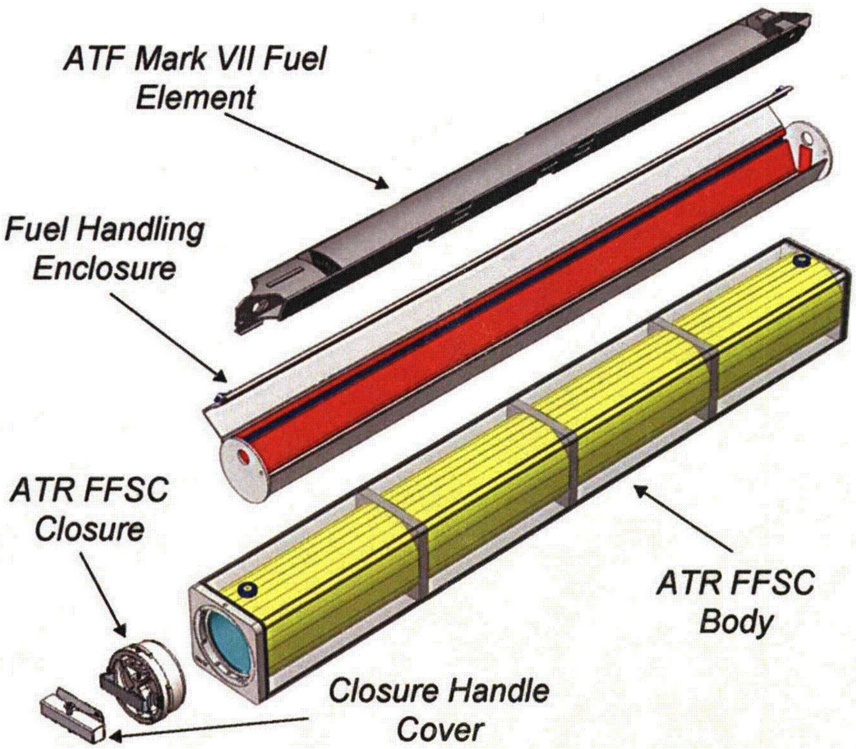

Figure 1.2-1 - Overview of the ATR FFSC (Outer Body Shell Shown Transparent)

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Figure 1.2-2 - Top End Body Sectional View

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Figure 1.2-3 - Bottom End Body Sectional View

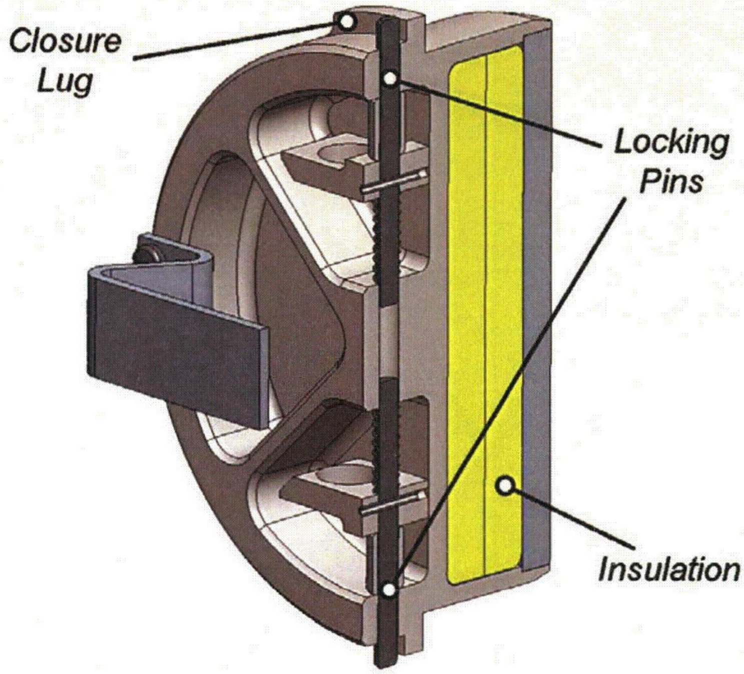

Figure 1.2-4 - Closure Sectional View

1.2.1.1.1 ATR FFSC Body

The ATR FFSC body is a stainless steel weldment 73 inches long and 8 inches square weighing (empty) approximately 230 lbs. It consists of two nested shells; the outer shell a square stainless steel tube with a 3/16 inch wall thickness and the inner shell a 6 inch diameter, 0.120 inch wall, stainless steel round tube. There are three 1 inch thick stiffening plates secured to the round tube by fillet welds at equally spaced intervals. The tube is wrapped with thermal insulation and the insulation is overlaid with 28 gauge stainless steel sheet. The stainless steel sheet maintains the insulation around the inner shell. This insulated weldment is then slid into the outer square tube shell and secured at both ends by groove welds. Thermal insulation is built into the bottom end of the package as shown in Figure 1.2-3, and the closure provides thermal insulation at the closure end of the package as shown in Figure 1.2-4.

1.2.1.1.2 ATR FFSC Closure

The closure is a small component designed to be easily handled by one person. It weighs approximately 10 pounds and is equipped with a handle to facilitate use with gloved hands. The closure engages with the body using a bayonet style design. There are four lugs, uniformly spaced on the closure, that engage with four slots in the mating body feature. The closure is secured by retracting two spring loaded pins, rotating the closure through approximately 45°, and releasing the spring loaded pins such that the pins engage with mating holes in the body. When the pins are properly engaged with the mating holes the closure is locked.

A small post on the closure is drilled to receive a tamper indicating device (TID) wire. An identical post is located on the body and is also drilled for the TID wire. For ease in operation, there are two TID posts on the body. There are only two possible angular orientations for the closure installation and the duplicate TID post on the body enables TID installation in both positions.

A cover is placed over the closure handle during transport to render the handle inoperable for inadvertent lifting or tiedown. Figure 1.2-5 illustrates the placement of the handle cover. The profile of the cover depicted in Appendix 1.3.2, *Packaging General Arrangement Drawings*, is optional and may be modified to fit other handle profiles to ensure lifting and tiedown features are disabled as required by 10 CFR §71.45. As an option, the closure handle may be removed for transport rather than installing the handle cover.

1.2.1.1.3 ATR FFSC Fuel Handling Enclosure

The Fuel Handling Enclosure (FHE) is a hinged thin gauge aluminum weldment used with the fuel assembly. The FHE is a cover used to protect the fuel from handling damage during ATR FFSC loading and unloading operations. It is a thin walled aluminum fabrication featuring a hinged lid and neoprene rub strips to minimize fretting of the fuel element side plates where they are in contact with the container.

During transport the FHE does not add strength to the package, or satisfy any safety requirement. For purposes of determining worst case reactivity, the FHE is assumed to be not present.

1.2.1.1.4 ATR FFSC Loose Fuel Plate Basket

The Loose Plate Fuel Basket is comprised of four identical machined segments joined by threaded fasteners (reference Figure 1.2-8). The fasteners joining the segments in the lengthwise direction are permanently installed. The package is opened/closed using the 8 hand tightened fasteners. For criticality control purposes during transport the loose fuel plate basket maintains the fuel plates within a defined dimensional envelope.

Additional aluminum plates may be used as dunnage to fill gaps between the fuel plates and the basket payload cavity. The dunnage is used for property protection purposes only.

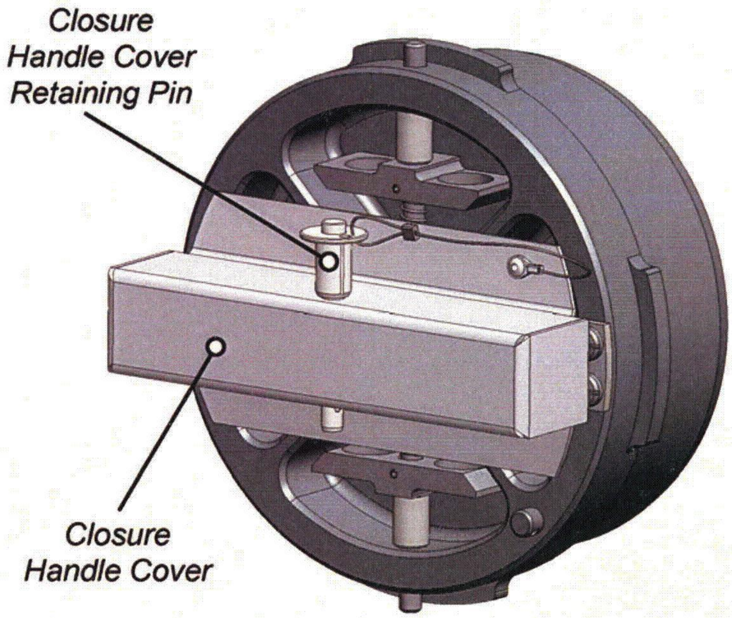

Figure 1.2-5 – Closure Handle Cover

1.2.1.2 Gross Weight

The maximum shipped weight of the ATR FFSC with the ATR fuel element is 280 lbs and the maximum shipped weight with the loose fuel payload is 290 lbs. Further discussion of the gross weight is presented in Section 2.1.3, *Weights and Centers of Gravity*.

1.2.1.3 Neutron Moderator/Absorption

There are no moderator or neutron absorption materials in this package.

1.2.1.4 Heat Dissipation

The uranium aluminide payload produces a negligible thermal heat load. Therefore, no special devices or features are needed or utilized in the ATR FFSC to dissipate heat. A more detailed discussion of the package thermal characteristics is provided in Chapter 3.0, *Thermal*.

1.2.1.5 Protrusions

The closure handle protrudes 1 3/8-inches from the face of the closure. The handle is secured to the closure by means of four 10-24 UNC screws. The screws will fail prior to presenting any significant loading to either the closure engagement lugs or the locking pins.

On one face of the package body, two index lugs are secured to the package to facilitate stacking of the packages. The opposite face of the package has pockets into which the index lugs nest. Each index lug is secured to the package by means of a 3/8-16 socket flat head cap screw. Under any load condition, the screw will fail prior to degrading the safety function of the package.

1.2.1.6 Lifting and Tiedown Devices

The ATR FFSC may be lifted from beneath utilizing a standard forklift truck when the package is secured to a fork pocket equipped pallet, or in a package rack. Swivel lift eyes may be installed in the package to enable package handling with overhead lifting equipment. The swivel eyes are installed after removing the 3/8-16 socket flat head cap screws and index lugs.

The threaded holes into which the swivel lift eyes are installed for the lifting the package are fitted with a 3/8-16 UNC screw and an index lug (see Figure 1.2-6) during transport. When the packages are stacked and the index lugs are nested in the mating pockets of the stacked packages, the index lugs can serve to carry shear loads between stacked packages.

1.2.1.7 Pressure Relief System

There are no pressure relief systems included in the ATR FFSC design. There are no out-gassing materials in any location of the package that are not directly vented to atmosphere. The package insulation, located in the enclosed volumes of the package, is a ceramic fiber. The insulation does not off-gas under normal or hypothetical accident conditions. The closure is not equipped with either seals or gaskets so that potential out-gassing of the ATR fuel tray neoprene material and fuel plastic bag material will readily vent without significant pressure build-up in the payload cavity.

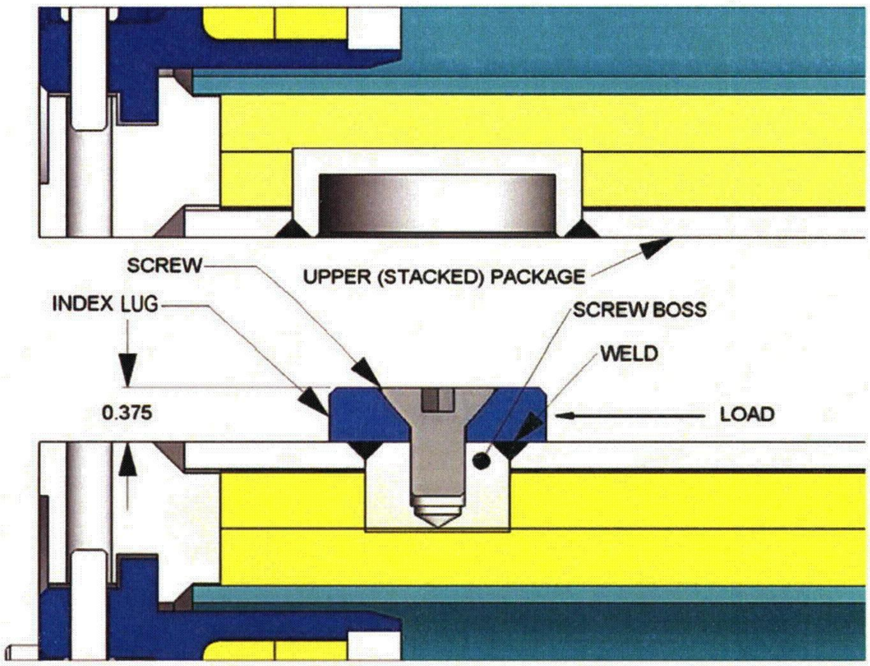

Figure 1.2-6 - Index Lug and Mating Pocket of Stacked Packages

1.2.1.8 Shielding

Due to the nature of the uranium aluminide payload, no biological shielding is necessary or specifically provided by the ATR FFSC.

1.2.2 Contents

The ATR FFSC is loaded with radioactive contents consisting of un-irradiated ATR fuel elements, enriched to a maximum of 94% U-235. The weight percents of the remaining uranium isotopes are 1.2 wt.% U-234 (max), 0.7 wt.% U-236 (max), and 5.0-7.0 wt.% U-238. Each fuel element contains a maximum of 1,200 g U-235. The fuel element (ATR Mark VII) fissile material is uranium aluminide (UAl_x). The fuel element weighs not more than 25 lbs, is bagged, and is enclosed in the FHE weighing 15 lbs.

There are four different ATR Mark VII fuel element types designated 7F, 7NB, 7NBH, and YA. The construction of these fuel elements are identical, varying only in the content of the fuel matrix. In the 7F fuel element, all 19 fuel plates are loaded with enriched uranium in an aluminum matrix with the eight outer plates (1 through 4 and 16 through 19) containing boron as a burnable poison. The fuel element with the greatest reactivity is the 7NB which contains no burnable poison. The 7NBH fuel element is similar to the 7NB fuel element except that it contains one or two borated plates. The YA fuel element is identical to the 7F fuel element except that plate 19 of the YA fuel element is an aluminum alloy plate containing neither uranium fuel nor boron burnable poison. The total U-235 and B-10 content of the YA fuel element is reduced accordingly. A second YA fuel element design (YA-M) has the side plate width reduced by 15 mils.

The ATR fuel elements contain 19 curved fuel plates. A section view of an ATR fuel element is given in Figure 1.2-7. The fuel plates are rolled to shape and swaged into the two fuel element side plates. Fuel plate 1 has the smallest radius, while fuel plate 19 has the largest radius. The fissile material (uranium aluminide) is nominally 0.02-in thick for all 19 plates. Fuel element side plates are fabricated of ASTM B 209, aluminum alloy 6061-T6 or 6061-T651 and are approximately 0.19-in thick. The fuel plates are typically spaced with a 0.08-in gap between plates.

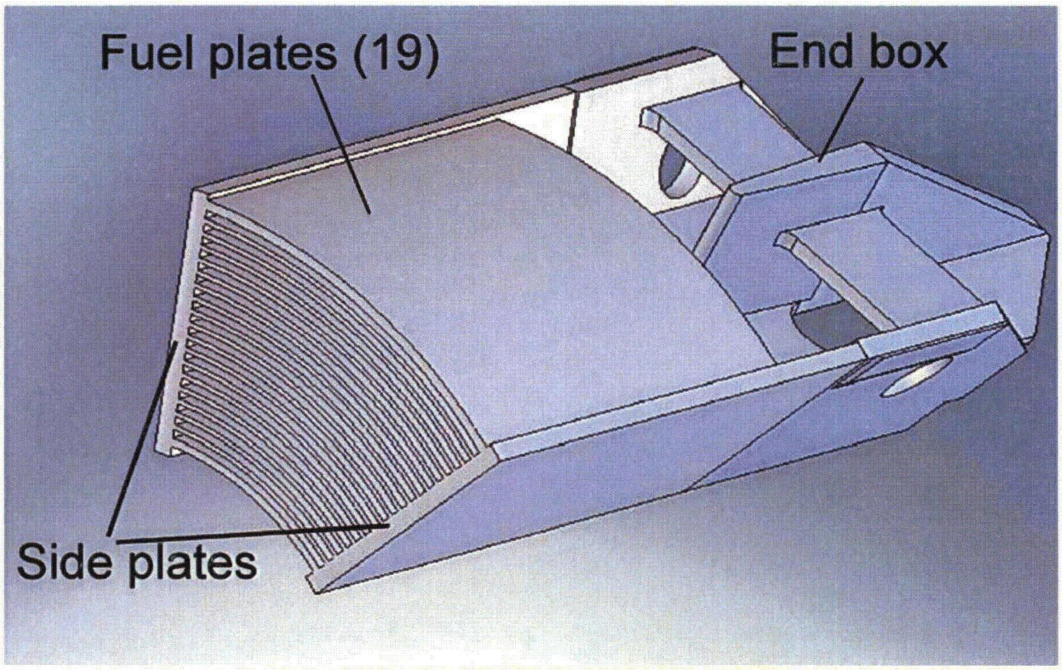

Figure 1.2-7 - ATR Fuel Element – Section View

The maximum weight of the ATR fuel loose plate payload (Figure 1.2-8) is 50 lbs. This weight is made up of the maximum basket contents weight of 20 lbs and the loose fuel plate basket weight of 30 lbs.

The loose plate payload is limited to 600 grams U-235. The plates may either be flat or rolled to the geometry required for assembly into the ATR fuel element. For handling convenience, the loose plate basket will be loaded with either flat or rolled plates. Additionally, the plates may be banded or wire tied in a bundle.

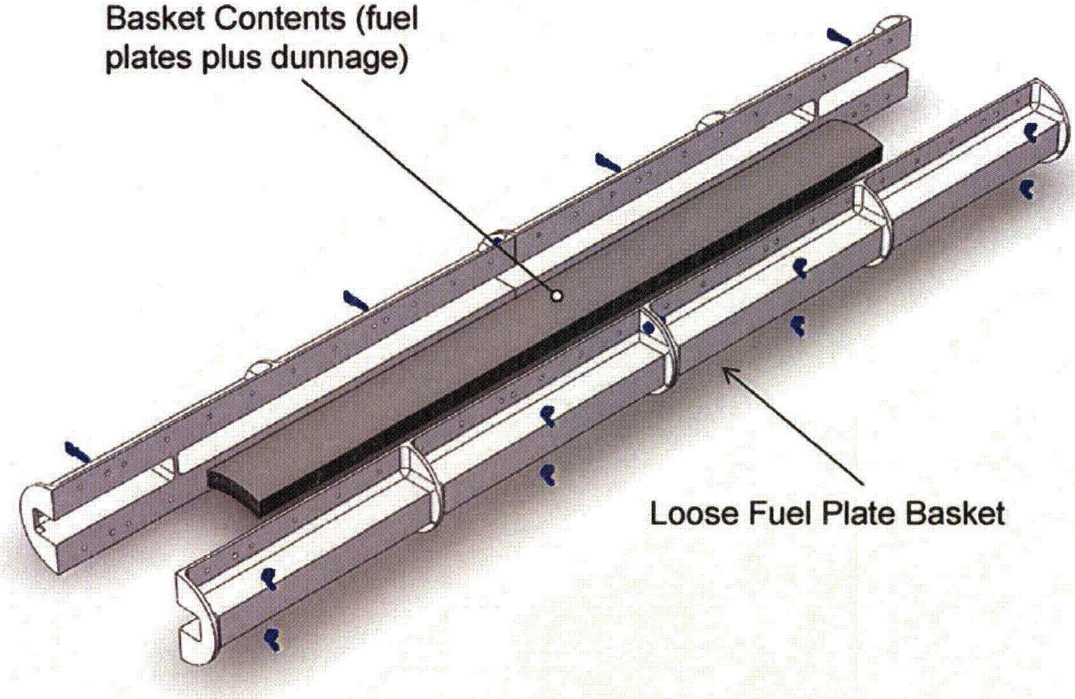

Figure 1.2-8 - Loose Fuel Plate Basket – Exploded View

1.2.3 Special Requirements for Plutonium

Because the ATR FFSC does not contain any plutonium, this section does not apply.

1.2.4 Operational Features

There are no operationally complex features in the ATR FFSC. All operational features are readily apparent from an inspection of the drawings provided in Appendix 1.3.2, *Packaging General Arrangement Drawings*. Operation procedures and instructions for loading, unloading, and preparing an empty ATR FFSC for transport are provided in Chapter 7.0, *Operating Procedures*.

1.3 Appendix

1.3.1 Glossary of Terms

ANSI –	American National Standards Institute.
ASME B&PV Code –	American Society of Mechanical Engineers Boiler and Pressure Vessel Code.
ASTM –	American Society for Testing and Materials.
AWS –	American Welding Society.
HAC –	Hypothetical Accident Conditions.
NCT –	Normal Conditions of Transport.
Closure –	The ATR FFSC package component used to close the package.
Body –	The ATR FFSC package component which houses the payload.
Index lug –	A thick washer like component secured to the package body at the lift point locations. The index lug provides shear transfer capability between stacked packages.
Pocket –	A recessed feature on the package body that accepts the index lug when packages are stacked.
Fuel Handling Enclosure (FHE)–	A sheet aluminum fabrication used to protect the ATR Fuel Element from handling damage. The enclosure is faced with neoprene at locations where the fuel element contacts the FHE to minimize fretting of the at the contact points.
Loose plate basket –	A machined aluminum container in which the unassembled ATR fuel element plates are secured during transport in the ATR FFSC. The loose plate basket is a geometry based criticality control component.

1.3.2 Packaging General Arrangement Drawings

The packaging general arrangement drawings consist of:

- 60501-10, *ATR Fresh Fuel Shipping Container SAR Drawing,* 5 sheets
- 60501-20, *Loose Plate Basket Assembly ATR Fresh Fuel Shipping Container SAR Drawing,* 1 sheet
- 60501-30, *Fuel Handling Enclosure, ATR Fresh Fuel Shipping Container SAR Drawing,* 1 sheet

Figure Withheld Under 10 CFR 2.390

Figure Withheld Under 10 CFR 2.390

Figure Withheld Under 10 CFR 2.390

Figure Withheld Under 10 CFR 2.390

Figure Withheld Under 10 CFR 2.390

Table 2.1-1 – ATR FFSC Component Weights

Item	Weight, lb	
	Component	Assembly
ATR FFSC Packaging	- -	240
Body Assembly	230	- -
Closure Assembly	10	- -
Payload – Fuel Assembly	- -	40
Fuel Assembly	25	- -
Fuel Handling Enclosure	15	- -
Payload – Fuel Plates	- -	50
Loose Fuel Plates (including optional dunnage)	20	- -
Loose Fuel Plate Basket	30	- -
Total Loaded Package (maximum)		290

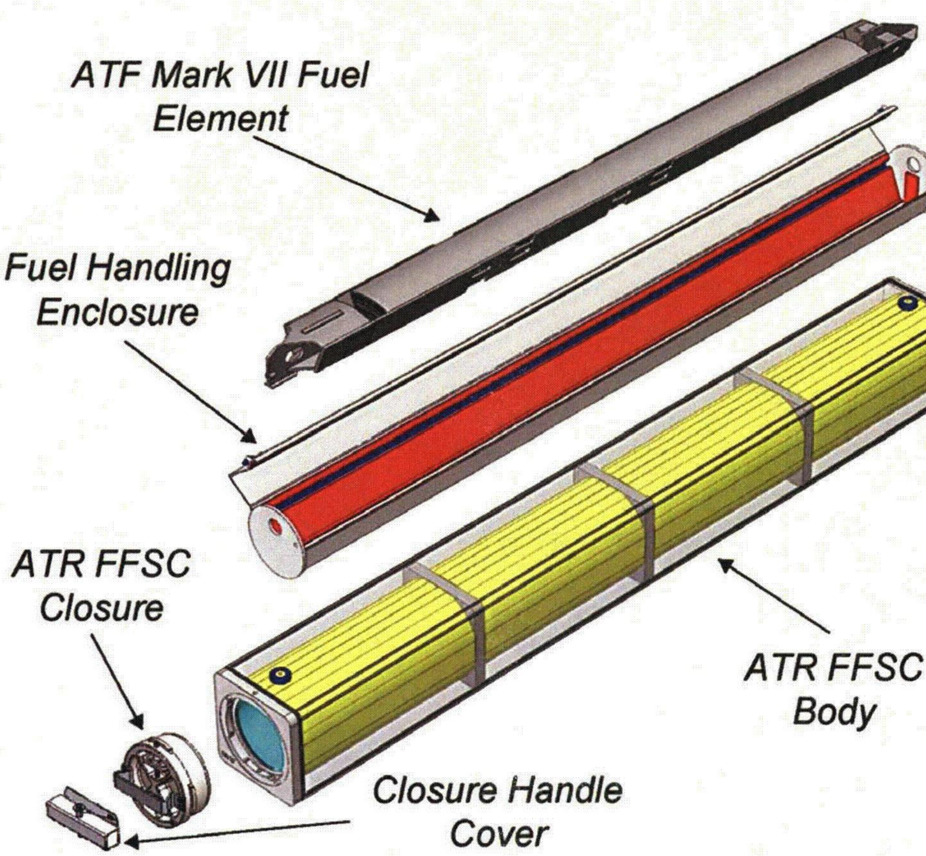

Figure 2.1-1 – ATR FFSC Package Components (With Fuel Element)

$$\frac{0.125}{2}+\frac{0.375}{2}=0.25\ in$$

The bending force on the weld, as a vertical component, is

h = height of applied load to index lug = 0.25 in

$$M=P_h\cdot h=3{,}242\cdot 0.25=811\,in\cdot lb$$

$$f_b=\frac{M}{S_w}=\frac{811}{0.785}=1{,}033\ lbf/in$$

The vertical and horizontal loads are perpendicular, therefore the combined load is:

$$f_r=\sqrt{f_b{}^2+f_h{}^2}=\sqrt{(1{,}033)^2+(1{,}033)^2}=1{,}461\ lbf/in$$

The required grove weld is:

$$w=\frac{f_r}{w_{allow}}=\frac{1{,}461}{18{,}000}=.081\ in$$

Thus the weld margin of safety is:

$$MS_{weld}=\frac{.125}{.081}-1=+0.54$$

The load required to fail the weld is:

$$f_r=w\cdot(0.6\cdot w_{ult})=(0.125)\cdot(0.6\cdot 75{,}000)=5{,}625\ lbf/in$$

Since $f_b = f_h$: $f_h=\sqrt{f_r{}^2/2}=\sqrt{(5{,}625)^2/2}=3{,}977\ lbf/in$

The load required to fail the weld is:

$$P_{h-failure}=f_h\cdot A_w=(3{,}977)\cdot(3.14)=12{,}488\ lbf$$

2.5.2.5 Conclusion

From the above analysis, the index lugs adequately withstand the combined horizontal tiedown g-loads for the fully loaded package. Furthermore, it is shown that the index lug screw will fail prior to the weld. This satisfies the requirements of 10 CFR §71.45(b)(1).

2.5.3 Closure Handle

The closure handle, deemed a structural part of the package, must be rendered inoperable for lifting and tiedown during transport in compliance with 10 CFR §71.45. To satisfy this requirement, a cover will be secured over the closure handle during transport to prevent any straps or hooks from being attached to the handle or to prevent any hardware from being placed between the handle and closure as illustrated in Figure 1.2-5. As an option, the handle may also be removed during transport.

The attachment of the closure handle to the closure assembly is evaluated here to show that its failure will not impair the ability of the package to meet other requirements. A lifting or tiedown load applied to the closure handle is expected to deform the handle and fail the closure screws causing the handle to become detached from the closure assembly. The closure handle is used only for operator convenience in handling the 10 lb closure assembly by hand. The four small fasteners securing the handle to the closure are designed to fail under light loads and well before impairment of any safety related packaging feature.

This evaluation conservatively neglects any tension (pulling) on the handle and handle screws since a load in this direction would pull on the closure locking tabs and not the locking pins. A simple comparison between the area of the closure tabs and the area of the handle screws shows that the closure tabs consist of significantly more material and the screws will fail well before any significant loads are applied to the closure tabs.

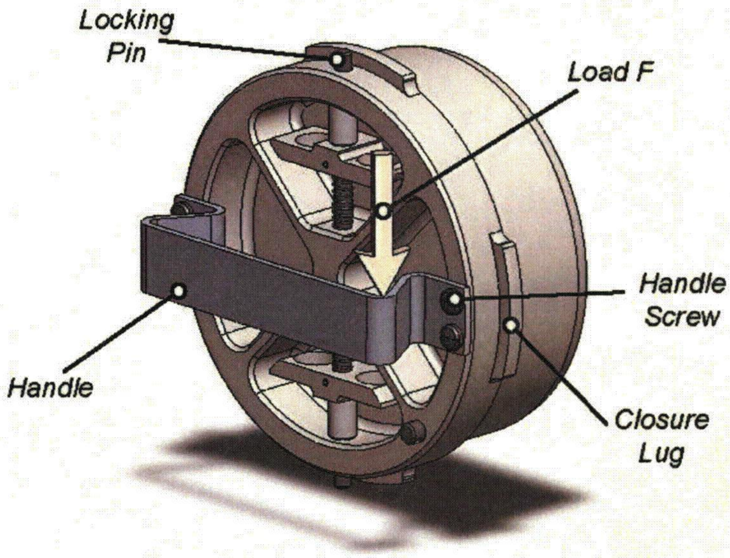

Figure 2.5-3 – Closure Assembly Handle

2.5.3.1 Handle Fasteners

The closure handle is secured by four #10-24 UNC screws (two per side). For this evaluation the load *F* is applied at the outside edge of the handle: 0.5 inches radially out from the screws and 0.5 inches above the face of the closure assembly.

This evaluation is based on the load *F* necessary to fail the handle screws. The load will be a function of the ultimate strength of the handle screws, which are given as a minimum of 72,000 psi for 18-8 material. To account for possible strain hardening due to the manufacturing process, that value will be conservatively multiplied by a factor of 2. Therefore:

$$\sigma_{\text{ultimate}} = 144{,}000 \text{ psi}$$

For the handle screws, the area across the threads is equal to the area of the minor diameter. For a #10-24UNC screw the minor diameter is 0.1389 inches.

$$A_s = \frac{\pi d_m^{\ 2}}{4} = \frac{\pi(0.1389)^2}{4} = 0.0152 \text{ in}^2$$

The shear force in each screw is now determined. The largest forces will be at the two screws closest to the applied force. See Figure 2.5-4.

$$M = F \cdot r = 3.25\ F\ in \cdot lb$$

$$r = 3.25\ in\ (dist. to\, centroid)$$

Where r is taken as the maximum distance possible for any handle configuration.

The primary shear is:

$$n = 4 \text{ (number of screws)}$$

$$S' = \frac{F}{n} = \frac{F}{4} = 0.25F \text{ lb}$$

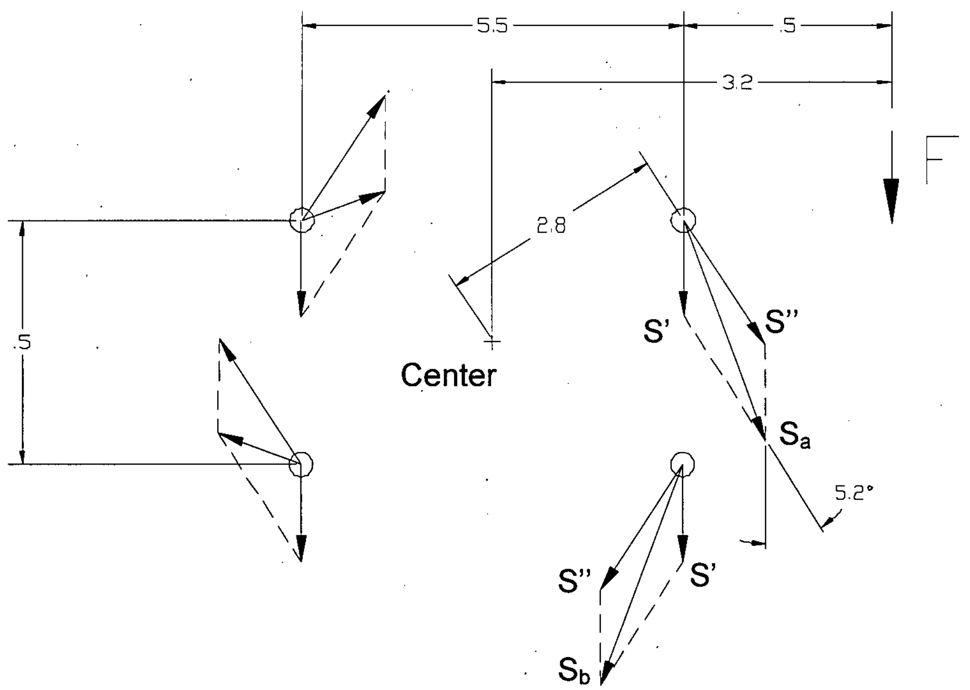

Figure 2.5-4 – Screw Pattern Diagram

The secondary shear is:

$$S'' = \frac{M}{4 \cdot R} = \frac{3.25F}{4 \cdot 2.8} = 0.29F \text{ lb}$$

$$R = 2.8 \text{ in. (dist. to centroid)}$$

The combined shear force is:

$$S_a = S_b = 0.29F + 0.25F(\cos 5.2) = 0.29F + 0.249F = 0.539F$$

The shear stress is:

$$\tau = \frac{S_a}{A_s} = \frac{0.539F}{0.0152} = 35.46F \text{ psi}$$

The tensile load on the screws due to the load *F* is applied to only two of the four screws, since the handle, due to its flexibility, cannot effectively transfer the load to the screws on the opposite side of the handle. The tensile load on the two screws closest to the load is:

$$\sum M_A = F \cdot (0.5) - R_1 \cdot (0.25) - R_2 \cdot (0.75) = 0$$

$$F = 0.5R_1 + 1.5R_2$$

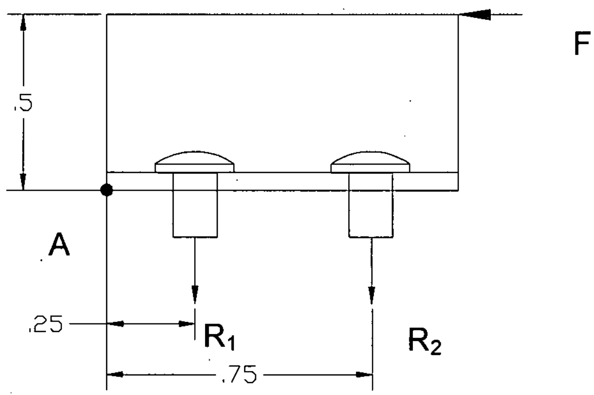

Figure 2.5-5 – Screw Prying Diagram

The relation between the screws is:

$$\frac{R_1}{R_2} = \frac{0.25}{0.75}$$

$$R_1 = \frac{1}{3} R_2$$

Substitute into the sum of moments equation:

$$F = 0.5R_1 + 1.5R_2$$

$$F = (\frac{1}{3} 0.5R_2) + 1.5R_2$$

$$R_2 = 0.6F \ lb$$

$$R_1 = 0.2F \ lb$$

The peak tension appears in R_2. The maximum tensile stress is:

$$\sigma = \frac{R_2}{A_s} = \frac{0.6F}{0.0152} = 39.47F \text{ psi}$$

Combine the shear and tensile stresses to find the force necessary to fail the screws:

$$\sigma_{\text{ultimate}} = \sqrt{\sigma^2 + 4\tau^2} = \sqrt{(39.47F)^2 + 4(35.46F)^2}$$

$$144{,}000 = \sqrt{6{,}588F^2} = 81.17F$$

$$F = 1{,}774 \text{ lb}$$

2.5.3.2 Locking Pin Loading

To show that the handle attachment fails prior to the closure components of the package, the force necessary to fail the screws is applied to the two locking pins. The yield strength of the locking pins is conservatively used in the comparison.

The locking pins are 0.25 inch in diameter and made of ASTM A276, Type S21800 material, having a yield strength of σ_{yield} = 50,000 psi. The pin area is:

$$A_p = \frac{\pi d^2}{4} = \frac{\pi(.25)^2}{4} = 0.049 \text{in}^2$$

The load *P* must be calculated from the screw failure load *F*. The distance from the center of the closure assembly to the point of shear in the locking pin is half of the diameter of the closure at the location of the pin, or r_p = 5.97/2 = 2.99 inches. The distance from the center of the closure assembly to the load *F* is 3.25 inches.

$$P = \frac{3.25F}{2.99} = 1{,}928 \text{ lb}$$

The shear stress for each pin is:

$$\tau = \frac{1}{2} \cdot \frac{P}{A} = \frac{1{,}928}{2(.049)} = 19{,}673 \text{ psi}$$

The margin of safety on the locking pins (against pin yield) at the point of handle screw failure is:

$$MS = \frac{0.6\sigma_{yield}}{\tau} - 1 = \frac{0.6 \times 50{,}000}{19{,}673} - 1 = +0.52$$

where the factor of 0.6 converts the tensile yield of the pin material to shear yield. Thus, should the closure handle be incorrectly used as a tiedown device, the handle screws will break off before the pins yield.

2.5.3.3 Conclusion

From the above analysis, should a force be applied to the closure handle, the handle screws will fail before the closure locking pins yield. Therefore, adverse loading of the closure handle does not impair the ability of the package to meet other requirements.

3.0 THERMAL EVALUATION

This chapter identifies and describes the principal thermal design aspects of the Advanced Test Reactor (ATR) Fresh Fuel Shipping Container (FFSC). Further, this chapter presents the evaluations that demonstrate the thermal safety of the ATR FFSC package[1] and compliance with the thermal requirements of 10 CFR 71[2] when transporting a payload consisting of either an assembled, un-irradiated ATR fuel element or a payload of loose, un-irradiated ATR fuel plates. The loose fuel element plates may be either flat or rolled to the geometry required for assembly into a fuel element.

Specifically, all package components are shown to remain within their respective temperature limits under the normal conditions of transport (NCT). Further, per 10 CFR §71.43(g), the maximum temperature of the accessible package surfaces is demonstrated to be less than 122 °F for the maximum decay heat loading, an ambient temperature of 100 °F, and no insolation. Finally, the ATR FFSC package is shown to retain sufficient thermal protection following the HAC free and puncture drop scenarios to maintain all package component temperatures within their respective short term limits during the regulatory fire event and subsequent package cool-down.

3.1 Description of Thermal Design

The ATR FFSC package, illustrated in Figure 1.2-1 through Figure 1.2-6 from Section 1.0, *General Information*, consists of three basic components: 1) a Body assembly, 2) a Closure assembly, and 3) either a Fuel Handling Enclosure (FHE) or a Loose Fuel Plate Basket (LFPB). The FHE is configured to house an assembled ATR fuel element, while the LFPB is configured to house loose ATR fuel element plates. The maximum gross weight of the package loaded with an FHE and ATR fuel element is approximately 280 pounds. The maximum gross weight of the package loaded with a LFPB containing its maximum payload is approximately 290 pounds.

The ATR FFSC is designed as a Type AF packaging for transportation of an ATR fuel element or a bundle of loose ATR fuel element plates. The packaging is rectangular in shape and is intended to be transported in racks of multiple packages by highway truck. Since the payload generates essentially no decay heat, the worst case thermal conditions will occur with an individual package fully exposed to ambient conditions. The package performance when configured in a rack of multiple packages will be bounded by that seen for an individual package.

The principal components of the packaging are shown in Figure 1.2-1 and described in more detail below. With the exception of minor components, all steel used in the ATR FFSC

[1] In the remainder of this chapter, the term 'packaging' refers to the assembly of components necessary to ensure compliance with the regulatory requirements, but does not include the payload. The term 'package' includes both the packaging components and the payload of ATR fuel.

[2] Title 10, Code of Federal Regulations, Part 71 (10 CFR 71), *Packaging and Transportation of Radioactive Material*, 01-01-03 Edition.

Cross-sectional views showing key elements of the ATR FFSC body are provided in Figure 1.2-2 and Figure 1.2-3. Figure 1.2-2 illustrates a cross sectional view at the top end closure of the package and 1.2-3 presents a similar cross sectional view of the package at the bottom end closure.

3.1.1.2 ATR FFSC Closure

The ATR FFSC closure engages with the body using a bayonet style engagement via four uniformly spaced lugs on the closure that engage with four slots in the mating body feature. The closure incorporates 1 inch of ceramic fiber thermal insulation to provide thermal protection and is designed to permit gas to easily vent through the interface between the closure and the body. The closure weighs approximately 10 pounds and is equipped with a handle to facilitate use with gloved hands.

A cross sectional view of the ATR FFSC closure is illustrated in Figure 1.2-4.

3.1.1.3 Fuel Handling Enclosure (FHE)

The Fuel Handling Enclosure (FHE) is a hinged, aluminum weldment used to protect the ATR fuel element from damage during loading and unloading operations. It is fabricated of thin wall (i.e., 0.09 inch thick) 5052-H32 aluminum sheet and features a hinged lid and neoprene rub strips to minimize fretting of the fuel element side plates where they contact the FHE. The surface of the FHE is neither anodized nor coated, but is left as an 'unfinished' aluminum sheet. Figure 1.2-1 presents an illustration of the FHE.

3.1.1.4 ATR FFSC Loose Fuel Plate Basket (LFPB)

The Loose Fuel Plate Basket (LFPB) serves to maintain the fuel plates within a defined dimensional envelope during transport. The four identical machined segments are machined from a billet of 6061-T651 aluminum and are joined by threaded fasteners (see Figure 1.2-8). A variable number of ATR fuel plates may be housed in the basket, with the maximum payload weight being limited to 20 lbs. or less. The empty weight of the loose fuel plate basket is approximately 30 lbs. Like the FHE, the surface of the LFPB is neither anodized nor coated, but is left with its 'as machined' finish.

3.1.2 Content's Decay Heat

The ATR FFSC is designed as a Type AF packaging for transportation of an un-irradiated ATR fuel element or a bundle of loose, un-irradiated ATR fuel plates. The decay heat associated with un-irradiated ATR fuel is negligible. Therefore, no special devices or features are needed or utilized in the ATR FFSC packaging to dissipate the decay heat. Section 1.2.2, *Contents*, provides additional details.

3.1.3 Summary Tables of Temperatures

Table 3.1-1 provides a summary of the package component temperatures under normal and accident conditions. The temperatures for normal conditions are based on an analytical model of

Table 3.2-2 – Thermal Properties of ATR Fuel Materials

Material	Temperature (°F)	Thermal Conductivity (Btu/hr-ft-°F)	Specific Heat (Btu/lbm-°F)	Density (lbm/in³)
Aluminum Type 6061-0	32	102.3	-	0.0976
	62	-	0.214	
	80	104.0	-	
	170	107.5	-	
	260	109.2	0.225	
	350	109.8	-	
	440	110.4	0.236	
	530	110.4	-	
	620	109.8	0.247	
	710	108.6	-	
	800	106.9	0.258	
	890	105.2	-	
	980	103.4	0.269	
	1080	101.1	0.275	
ATR Fuel Plate 1①	-	46.6	0.193	0.120
ATR Fuel Plates 2 to 18①	-	69.6	0.210	0.112
ATR Fuel Plate 19①	-	38.9	0.188	0.122

Notes:

① Values determined based on composite value of aluminum cladding and fuel core material (see Appendix 3.5.2.4). Thermal conductivity value is valid for axial and circumferential heat transfer within fuel plate.

6.3 General Considerations

Criticality calculations for the ATR FFSC are performed using the three-dimensional Monte Carlo computer code MCNP5[2]. Descriptions of the fuel assembly geometric models are given in Section 6.3.1, *Model Configuration*. The material properties for all materials used in the models are provided in Section 6.3.2, *Material Properties*. The computer code and cross section libraries used are provided in Section 6.3.3, *Computer Codes and Cross-Section Libraries*. Finally, the most reactive configuration is provided in Section 6.3.4, *Demonstration of Maximum Reactivity*.

6.3.1 Model Configuration

Models are developed for both the fuel element and loose plate basket payloads.

6.3.1.1 Fuel Element Payload

The model configuration is relatively simple. Most packaging details are conservatively ignored, particularly at the ends. Because the package is long and narrow, array configurations will stack only in the lateral directions (e.g., 5x5x1). Therefore, the end details, for both the package and the fuel element, are conservatively ignored external to the active fuel region, and these end regions are simply modeled as full-density water.

The package consists of two primary structural components, a circular inner tube and a square outer tube, as shown in Appendix 1.3.2, *Packaging General Arrangement Drawings*. The inner tube has a nominal outer diameter of 6-in and a nominal thickness of 0.12-in. The outer tube has a nominal outer dimension of 8-in and a nominal thickness of 0.188-in. A layer of insulating material 1-in thick is wrapped around the inner tube.

For the inner tube, tolerances are based upon ASTM A269[3]. The tolerance on the outer diameter (OD) is ± 0.030-in, and the tolerance on the wall thickness is ±10%. Tolerances are selected to minimize the spacing between the fuel elements in the array configuration. This spacing is minimized using the maximum OD and minimum wall thickness. Using the minimum wall thickness also reduces parasitic neutron absorption in the steel. Therefore, the modeled tube OD is 6.03-in, the modeled wall thickness is 0.108-in, and the modeled tube ID is 5.814-in.

For the outer tube, the wall thickness tolerance is ±10% based upon ASTM A554[4] (the tolerance for the optional use of ASTM A240[5] also falls within this value). Using the minimum wall thickness of 0.169-in reduces parasitic neutron absorption in the steel. Reactivity in the array cases is maximized by minimizing the outer dimensions of the square. A bounding tolerance of 0.1-in is assumed for this dimension based on drawing tolerance in Appendix 1.3.2, *Packaging*

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[2] MCNP5, "*MCNP – A General Monte Carlo N-Particle Transport Code, Version 5; Volume II: User's Guide*," LA-CP-03-0245, Los Alamos National Laboratory, April, 2003.

[3] ASTM A269-02a, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service.*

[4] ASTM A554-03, *Standard Specification for Welded Stainless Steel Mechanical Tubing.*

[5] ASTM A240-03, *Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.*

General Arrangement Drawings, for a modeled OD of 7.9-in. The as-fabricated packages will meet this tolerance.

In the NCT single package models, the inner tube, insulation, and outer tube are modeled explicitly, as shown in Figure 6.3-1 and Figure 6.3-2. Although negligible water ingress is expected during NCT, the inner cavity of the package is assumed to be flooded with water because the package lid does not contain a seal. However, the region between the insulation and the outer tube will remain dry because water cannot enter this region. The Fuel Handling Enclosure (FHE) is conservatively ignored. Modeling the FHE would decrease water reflection in the single package model. However, the neoprene along the sides of the FHE is modeled explicitly using a thickness of 1/8-in. Because neoprene will reduce the reactivity due to parasitic absorption in chlorine, chlorine is removed from the neoprene, and the density is reduced accordingly. In the model, the fuel element is conservatively positioned at the radial center of the inner tube to maximize neutron reflection. The package is reflected with 12-in of full-density water.

The HAC single package model is essentially the same as the NCT single package model. Damage in the drop tests was shown to be negligible and concentrated at the ends of the package (See Section 2.12.1). As the ends of the package are not modeled, this end damage does not affect the modeling. The various side drops resulted in only minor localized damage to the outer tube, and no observable bulk deformation of the package. Therefore, the minor damage observed will not impact the reactivity. The insulation is replaced with full-density water, and the region between the insulation and outer tube is also filled with full-density water (see Figure 6.3-3). The treatment of the FHE is the same as the NCT single package model. Cases are developed both with and without the FHE neoprene, and with and without chlorine in the neoprene.

As a result of the drop tests, limited damage to the fuel element was observed. The bottom end box sheared off from the main body, although this condition has no effect on the criticality models because the fuel element is not modeled beyond the active fuel region. Limited damage to the fuel element plates was observed at the ends, although this damage is over a short length in a region of low reactivity worth. Slight localized buckling of the fuel plates was also observed in the region of the fuel element side plate vent openings, as the fuel plates are not as well supported in these regions. Because the observed fuel element damage is minor and will have only a negligible effect on reactivity, no damaged fuel element models are developed.

In the NCT array models, a 9x9x1 array is utilized. Although the FHE would survive NCT events with no damage, the FHE is conservatively ignored and the fuel elements are pushed toward the center of the array. Because the fuel elements are transported in a thin (~0.01-in) plastic bag, this plastic bag is assumed to act as a boundary for partial moderation effects. The plastic bag is not modeled explicitly, because it is too thin to have an appreciable effect on the reactivity. Therefore, it is postulated that the fuel element channels may fill with full-density water, while the region between the fuel element and inner tube fills with variable density water. The partial moderation effects that could be achieved by modeling the FHE explicitly are essentially addressed by the partial moderation analysis using the plastic bag. Also, modeling the FHE explicitly would result in the fuel elements being significantly pushed apart, which is a less reactive condition. Axial movement of the fuel elements is not considered because axial

7.0 PACKAGE OPERATIONS

This section provides general instructions for loading and unloading operations of the ATR FFSC. Due to the low specific activity of neutron and gamma emitting radionuclides, dose rates from the contents of the package are minimal. As a result of the low dose rates, there are no special handling requirements for radiation protection.

Package loading and unloading operations shall be performed using detailed written procedures. The operating procedures developed by the user for the loading and unloading activities shall be performed in accordance with the procedural requirements identified in the following sections.

The closure handle must be rendered inoperable for lifting and tiedown during transport per 10 CFR §71.45. To satisfy this requirement either the closure handle may be removed or the cover installed. If the closure handle cover is utilized it may be stored with the closure assembly in the installed position. When stored with the closure assembly the cover must be removed prior to the package loading and unloading operations and may be reinstalled following installation of the closure. The installation of the closure handle cover is presented in Section 7.1.4, *Preparation for Transport*.

7.1 Package Loading

7.1.1 Preparation for Loading

Prior to loading the ATR FFSC, the packaging is inspected to ensure that it is in unimpaired physical condition. The packaging is inspected for:

- Damage to the closure locking mechanism including the spring. Inspect for missing hardware and verify the locking pins freely engage/disengage with the package body mating features.
- Damage to the closure lugs and interfacing body lugs. Inspect lugs for damage that precludes free engagement of the closure with the body.
- Deformation of the inner shell (payload cavity) that precludes free entry/removal of the payload.
- Deformed threads or other damage to the fasteners or body of the loose fuel plate basket.
- Damage to the spring plunger or body of the fuel handling enclosure.

Acceptance criteria and detailed loading procedures derived from this section are specified in user written procedures. These user procedures are specific to the authorized content of the package and inspections ensure the packaging complies with Appendix 1.3.2, *Packaging General Arrangement Drawings*.

Defects that require repair shall be corrected prior to shipping in accordance with approved procedures consistent with the quality program in effect.

7.1.2 Loading of Contents - ATR Fuel Assembly

1. Remove the closure by depressing the spring-loaded pins and rotating the closure 45° to align the closure locking tabs with the mating cut-outs in the body. Remove the closure from the body.
2. Remove the fuel handling enclosure if present in the payload cavity.
3. Prior to loading, visually inspect the fuel handling enclosure for damage, corrosion, and missing hardware to ensure compliance with Appendix 1.3.2, *Packaging General Arrangement Drawings*.
4. Open the fuel handling enclosure lid and place a fuel element into the holder with the narrow end of the fuel element facing the bottom side of the fuel handling enclosure. As a property protection precaution, the fuel element may optionally be inserted into a plastic bag prior to placement in the fuel handling enclosure.
    a. To open the fuel handling enclosure, release the lid by pulling on the spring plunger located at each end and rotate the lid about the hinged side.
    b. To close the fuel handling enclosure, rotate the lid to the closed position, pull the spring plunger located at each end to allow the lid to fully close, align then release the spring plungers with the receiving holes, gently lift the lid to confirm no movement and that the spring plungers are in the locked position.
5. Insert the fuel handling enclosure into the package.
6. Depress the package closure spring-loaded pins, insert closure onto package body by aligning the closure locking tabs with the mating cut-outs in the body, and rotate the closure to the locked position. Release the spring-loaded pins so that they engage with the mating holes in the package body. Observe the pins to ensure they are in the locked position as illustrated in Figure 7.1-1. The closure is fully locked when both locking pins are compressing the sleeve between the locking pin handle and the closure body.

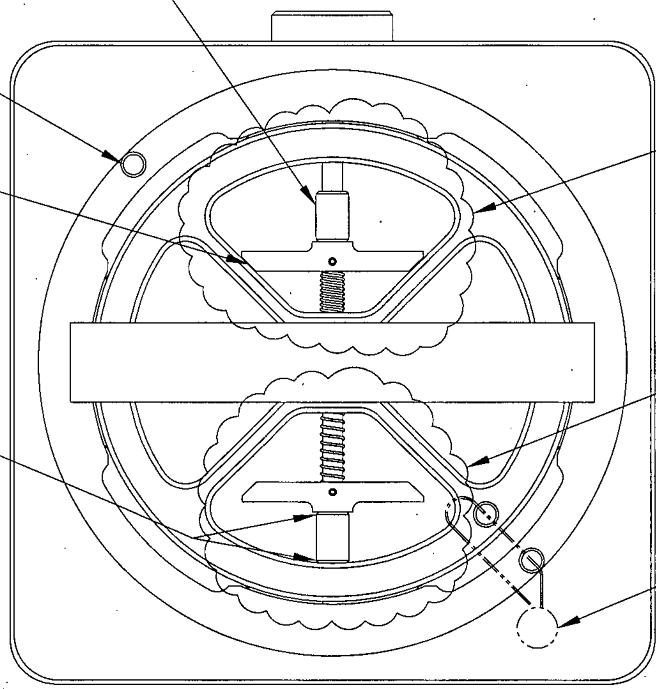

Figure 7.1-1 - Closure Locking Positions

7.1.3 Loading of Contents - Loose Fuel Plates

1. Remove the closure by depressing the spring-loaded pins and rotating the closure 45° to align the closure locking tabs with the mating cut-outs in the body. Remove the closure from the body.
2. Remove the fuel plate basket if present in the payload cavity.
3. Prior to loading, visually inspect the loose fuel plate basket for damage, corrosion, and missing hardware/fastening devices to ensure compliance with Appendix 1.3.2, *Packaging General Arrangement Drawings*.
4. Open the loose fuel plate basket by removing the 8 wing nut fasteners securing each half of the basket.
5. Place the fuel plates into one half of the loose fuel plate basket
    a. Ensure the combined weight of the loose fuel plates and optional dunnage is 20 lbs or less.
    b. Ensure the combined fissile mass of the loose fuel plates does not exceed 600 g uranium-235.
    c. Flat and curved fuel plates may not be mixed in the same basket.
    d. As a property protection precaution, the fuel plates may optionally be inserted into a plastic bag prior to placement in the fuel plate basket.

   e. Dunnage plates may also be included with the loose fuel plates to reduce any gaps with the basket cavity as a property protection precaution. The dunnage plates may be any aluminum alloy and any size deemed appropriate.

6. Close the fuel plate basket and verify the basket fasteners are installed and finger tight.
   a. With one half of the basket loaded, carefully place the second half over the fuel plates and match the fastener holes.
   b. Insert the 8 spade head screws through the holes and secure with corresponding wing nut (washer optional).
   c. Tighten the 8 wing nut fasteners finger tight.
   d. Visually check the 4 hex head screws located in the center of the basket to verify that they have not loosened. In the event the screws appear to be loose, tighten the fasteners to drawing requirements.
7. Insert the loose fuel plate basket into the package.
8. Depress the package closure spring-loaded pins, insert closure onto package body by aligning the closure locking tabs with the mating cut-outs in the body, and rotate the closure to the locked position. Release the spring-loaded pins so that they engage with the mating holes in the package body. Observe the pins to ensure they are in the locked position as illustrated in Figure 7.1-1. The closure is fully locked when both locking pins are compressing the sleeve between the locking pin handle and the closure body.

7.1.4 Preparation for Transport

1. Install the closure handle cover by aligning the cover against the handle and insert the fastener through the holes in the cover and behind the handle as illustrated in Figure 7.1-2. Once installed, the cover renders the handle inoperable for lifting or tiedown during transport. Option: In lieu of installing the cover, the closure handle may be removed as a method of rendering the handle inoperable for lifting or tiedown during transport.
2. Install the tamper indicating device between the posts on the package closure and body.
3. Perform a survey of the dose rates and levels of non-fixed (removable) radioactive contamination per 49CFR §173.441 and 49CFR §173.443, respectively. The contamination measurements shall be taken in the most appropriate locations to yield a representative assessment of the non-fixed contamination levels.
4. Complete the necessary shipping papers in accordance with Subpart C of 49 CFR §172.
5. Ensure that the package markings are in accordance with 10 CFR §71.85(c) and Subpart D of 49 CFR §172. Package labeling shall be in accordance with Subpart E of 49CFR §172. Package placarding, for either single package transport or the racked configuration, shall be in accordance with Subpart F of 49 CFR §172.
6. Transfer the package to the conveyance and secure the package(s).

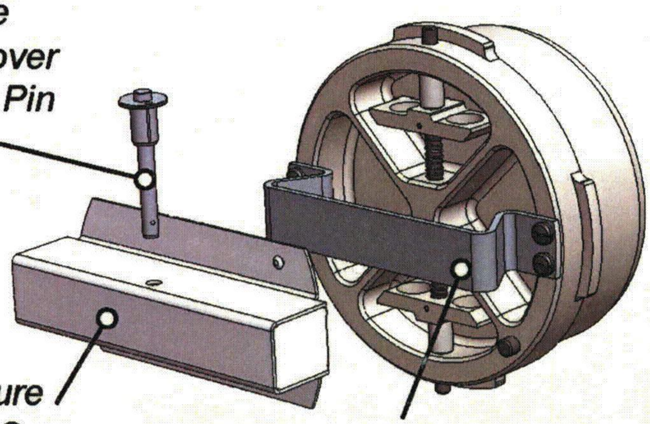

Figure 7.1-2 – Closure Handle Cover Installation

7.2 Package Unloading

7.2.1 Receipt of Package from Conveyance

Radiation and contamination surveys shall be performed upon receipt of the package and the package shall be inspected for damage as required by and in accordance with the user's personnel protection or ALARA program. In addition, the tamper indicating device (TID) shall be inspected. A missing TID or indication of damage to a TID is a Safeguards and Security concern. Disposition of such an incident is beyond the scope of this SAR.

7.2.2 Removal of Contents

1. Remove tamper indicating device.
2. Remove the package closure by depressing the spring-loaded pins and rotating the closure 45° to align the closure locking tabs with the mating cut-outs in the body. Remove the closure from the body.
3. Remove the payload container.
4. Open the payload container (fuel handling enclosure or loose fuel plate basket) and remove the contents.
    a. Open the fuel handling enclosure by releasing the spring plunger located at each end and rotate the lid about the hinged side.
    b. Open the loose fuel plate basket by removing the 8 wing nut fasteners securing each half of the basket.
5. Close the fuel handling enclosure lid or loose fuel plate basket as appropriate. If required, return the empty payload container to the package.
    a. To close the fuel handling enclosure, rotate the lid to the closed position, pull the spring plunger located at each end to allow the lid to fully close, align then release

the spring plungers with the receiving holes, gently lift the lid to confirm no movement and that the spring plungers are in the locked position.

   b. To close the loose fuel plate basket, place each half of the basket together and align the fastener holes. Insert the 8 spade head screws through the holes and secure with corresponding wing nut (washer optional). Tighten each wing nut finger tight.

6. Depress the package closure spring-loaded pins, insert closure onto package body by aligning the closure locking tabs with the mating cut-outs in the body, and rotate the closure to the locked position. Release the spring-loaded pins so that they engage with the mating holes in the package body. Observe the pins to ensure they are in the locked position as illustrated in Figure 7.1-1. The closure is fully locked when both locking pins are compressing the sleeve between the locking pin handle and the closure body.

7.3 Preparation of Empty Package for Transport

Empty packages are prepared and transported per the guidelines of 49 CFR §173.428. The packaging is inspected to ensure that it is in an unimpaired condition and is securely closed.

Any labels previously applied in conformance with subpart E of 49CFR §172 are removed, obliterated, or covered and the "Empty" label prescribed in 49 CFR §172.450 is affixed to the packaging.

7.4 Other Operations

This section does not apply.

Materials, parts, equipment, and processes essential to the function of items that are important to safety are selected and reviewed for suitability of application.

Computer programs used for design analysis or verification are controlled in accordance with approved procedures. These procedures provide for verification of the accuracy of computer results and for the assessment and resolution of reported computer program errors.

9.4 Procurement Document Control

As required by the INL Contractor Quality Program, procurement/acquisition processes and related document control activities are established and implemented to satisfy requirements of the QAPD. Requirements are to be in accordance with:

- 10 CFR 830.122(d), *Criterion 4 – Management/Documents and Records*
- 10 CFR 830.122(g), *Criterion 7 – Performance/Procurement*
- DOE Order 414C, CRD, Attachment 1, 2.a.(4), *Criterion 4 – Documents and Records*
- DOE Order 414C, CRD, Attachment 1, 2.b.(3), *Criterion 7 – Procurement*
- DOE Guide 414.1-3, *Suspect/Counterfeit Items.*

Processes and procedures are in place to ensure appropriate levels of quality are achieved in procurement of material, equipment, and services. Quality Level and Quality Category designations assigned by the Design Authority grade the application of QA requirements for procurements based on radiological material at risk, mission importance, safety of workers, public, environment, and equipment, and other differentiating criteria. Implementing procedures provide the logic process for determining Quality Levels used in procurement of equipment and subcontracting of services. Procedures ensure processes address document preparation and document control, and records management to meet regulatory requirements. Procurement records are kept in a manner that satisfies regulatory requirements.

INL Contractor procurement actions for packaging and spare parts shall be controlled. Contracts and Purchase Orders for packaging and spare parts shall require the selected vendor to implement and maintain an NRC approved 10CFR71, Subpart H QA Program.

Implementing procedures ensure procurement documents are prepared to clearly define applicable technical and quality assurance requirements including codes, standards, regulatory requirements and commitments, and contractual requirements. These documents serve as the principal documents for procurement of structures, systems and components, and related services for use in design, fabrication, maintenance and operation, inspection and testing of storage and/or transportation systems. Procedures ensure purchased material, components, equipment, and services adhere to applicable requirements. Furthermore:

- The assignment of quality requirements through procurement documents is administered and controlled.
- Procurement activities are performed in accordance with approved procedures delineating requirements for preparation, review, approval, and control of procurement documents. Revisions to procurement documents are reviewed and approved by the same cognizant groups as the original document.