AREVA

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U.S. Nuclear Regulatory Commission
Director, Division of Spent Fuel Storage
And Transportation
Attn: Document Control Desk
11555 Rockville Pike
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Rockville, MD 20852

Subject: Supplemental License Application for AREVA NP Inc. Model SP-1, SP-2, and SP-3 Shipping Containers; NRC Certificate of Compliance No. 9248; Docket No. 71-9248

Enclosed please find a supplemental license application to amend the license for AREVA's Model SP-1, SP-2, and SP-3 shipping containers (Package Identification No. USA/9248/AF). The primary purpose of the amendment is to make a limited number of minor language changes to the license application to correct certain internal inconsistencies and/or to clarify the intended meaning of certain other requirements. The changes were identified as part of the comprehensive review of AREVA's SP-series container fleet and associated license and procedural requirements that has been conducted as part of the transitioning of the ownership of the fleet to AREVA NP Inc.'s sister-company Transnuclear Inc.

Two of the issues were discussed with R. Temps and B. White of the Division of Spent Fuel Storage and Transportation on March 20, 2012. Since the SP review was still ongoing at that time, it was decided to delay submittal of a license amendment application until the review was complete so as to incorporate any other identified changes at that time. This amendment application reflects the completion of that review. As in the case of the lumber crack and fastener corrosion criteria discussed earlier, the other identified changes constitute clarifications, improvements to internal consistency, and/or minor editorial changes. The requested changes do not change or decrease the safety basis of the container.

If you have questions, please feel free to contact me at 509-375-8409. AREVA's technical contact for this amendment request is J.K. Davis of my staff. Jim can be reached on 509-375-8464.

Very truly yours,

Calvin D Manning for

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NMSS01

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EMF-1563
Revision 13

Supplemental License Application for AREVA NP, Inc. Model SP-1, SP-2, and SP-3 Shipping Containers

June 2012

AREVA NP, Inc.

EMF-1563
Revision 13

Supplemental License Application for AREVA NP, Inc. Model SP-1, SP-2 and SP-3 Shipping Containers

Certificate of Compliance No. 9248
Docket No. 71-9248

Prepared: J. K. Davis 6/26/2012
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Date

Approved: Robert Link 6/26/12
R. E. Link, Manager
Environmental, Health, Safety & Licensing
Date

Nature of Changes

Item	Paragraph or Page(s)	Description and Justification
1.	Throughout	Framatome ANP and FANP changed to AREVA NP. Justification: New company name.
2.	1.4.1.2	First sentence changed to match breather valve descriptions in 1.5.1.2, 1.5.2.2, and 1.5.3.2, and added a note that the functional description of the breather valve by GE in Appendix 2B was in error. Justification: The original description of the breather valve was not technically correct.
3.	1.5.4.1	In third paragraph changed RA-3 to SP-1. Justification: This was a legacy typographical error from the original SP-1 license application EMF-1563 Revision 0.
4.	7.1	In sixth bullet changed “wooden thrust block” to “thrust block”. Justification: Zone 1E of license drawing EMF-304-406 R/14 allows the thrust block (called a support block) to be made from wood, metal, or plastic.
5.	8.2.2	Revised first bullet into two separate bullets; with the first bullet dealing with crack criteria for 2x4's and second bullet dealing with crack criteria for 2x10's and 2x12's. In each case, depth was changed to a length criterion. Justification: Depth is not a dimension and its use was confusing. Depth was not meant to convey thickness. Through thickness cracks in wood are common and unavoidable.
6.	8.2.2	Revised old fifth bullet to change “rusted” to “heavily corroded”, and added statement that superficial surface rust on all carbon steel fasteners was allowed. Justification: The term rust in the original sentence was not meant to imply that carbon steel nuts, bolts, nails, or screws could not have any rust. The term rusted was meant to convey that nuts, bolts, nails, or screws that were corroded to such an extent that the structural integrity of the fasteners was affected would be replaced. Superficial surface rust on carbon steel fasteners was always meant to be acceptable.

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1. Introduction

1.1 *History*

On April 7, 1992 the NRC notified AREVA NP that NRC Certificate of Compliance 4986 for the RA-2 and RA-3 shipping containers, under which AREVA NP had been a registered user, was being revised for General Electric's use exclusively and that AREVA NP should submit an interim application for a one-year certificate. The notice further stated that a consolidated application would have to be submitted by the expiration date of the one-year certificate. In response to that notice AREVA NP submitted an abbreviated application for the SP-1 container on May 15, 1992. Subsequently, on December 15, 1992, AREVA NP submitted an amendment application to add the SP-2 container. The SP-1 and SP-2 containers are virtually identical to the General Electric Company's RA-3 and RA-2 containers, respectively.

Revision 0 of Certificate of Compliance 9248 for the SP-1 container was issued June 17, 1992 with an expiration date of June 30, 1993. Subsequent revisions have added the SP-2 and SP-3 container.

1.2 *This Application*

The purpose of this amendment is to make four minor language changes to the license application in order to make the statements consistent with other statements in the application or to clarify otherwise unclear requirements. The changes are in Section 1.4.1.2, Section 1.5.4.1, Section 7.1, and in Section 8.2.2 (two changes). In addition, the company name has been updated throughout. All changes are highlighted in yellow.

1.3 *General Package Description*

The SP-series package consists of a right rectangular metal inner container transported in a wooden outer container. The wooden outer container includes cushioning material. The inner metal container has two internal channel sections which may contain one fuel assembly each or group of unassembled rods each. Descriptions of the containers which comprise the SP-series package and the structural evaluations thereof are included in the subsequent chapters of this consolidated application.

The original GE-designed RA-1 inner container was modified to accommodate a longer bundle. This was accomplished by adding a larger end cap to the existing RA-1 body and identifying this design version as the RA-2 (AREVA NP's SP-2) inner container. Subsequently, out of consideration for fabrication and handling, the longer bodied (short end cap) RA-3 (AREVA NP's SP-1) was introduced. Currently in use are three models of the SP series inner containers, SP-1, SP-2 and SP-3. These models are presently being used with the SP-1 wooden outer container. In addition, loose rods containing gadolinia may be shipped in place of fuel assemblies if they are contained in the Gadolinia Rod Container or the five-inch, schedule 40 product container.

1.4 *Compliance*

This section generally describes the tests and evaluations carried out on the RA series of containers by General Electric. The results of such tests and evaluations are applicable also to

the SP series of containers. The tests and evaluations are further described in Appendices 2A, 2B, 2C, 2D, and 2E.

The General Electric Model RA series fuel shipping container has been subjected to normal transport condition tests and evaluations specified in Appendix A of 10CFR71 and the hypothetical accident condition tests and evaluations, in the sequence specified in Appendix 2B.

It is concluded that the RA series packaging has successfully passed the acceptance criteria demonstrated as follows:

1.4.1 Normal Transport Condition Tests

1.4.1.1 Heat and Cold

None of the components of the fuel assemblies or the inner metal container on which containment integrity and nuclear safety depend are significantly affected by temperatures within the range of -40°F to 130°F.

1.4.1.2 Pressure

A standard breather relief valve installed on the outer shell of the end cap is set to re-seat at a 0.5 psi pressure difference between the inside and outside of the inner container and is capable of airflow adequate for surface or air transport. Therefore, there is no effect on the packaging from an environmental difference of 0.5 atmosphere. Note: The functional description of the breather valve by GE in Appendix 2B Section 1.3 third paragraph is in error and shall be disregarded.

1.4.1.3 Vibration

A 3 inch thick layer of honeycomb cushioning material surrounds the inner metal container at the sides, top and bottom with an additional 9 inch thickness at the ends. Alternatively, there are 3 inches of honeycomb on top and bottom of the inner container and 2 inches on the sides. The inner container is not free to shift during transport since the ethafoam cushioning is slightly compressed during final closure, and the wooden outer container is bolted shut. Since the bolted assemblies in the metal container are held either by clips on the nuts or by lock washers, they cannot loosen during normal transport vibration or shock even if all vibration is not eliminated by the cushioning material.

1.4.1.4 Water Spray

Since the package is designed to remain subcritical assuming any degree of credible in-leakage, water inside the outer container would have no effect on criticality safety considerations. In addition, the effectiveness of the impact limiters and the wooden box structure was not substantially reduced as a result of the water spray test conducted on September 25, 1981. Results of the water spray test showed a maximum reduction of honeycomb compressive strength of 1-1/2% for one side, 3% for the other side, 5% for the bottom, and an undetectable amount for the ends since no wetting of the end honeycomb could be observed.

1.4.1.5 Drop Test

The complete package is designed to protect the fuel assemblies within the inner metal container from loss of containment integrity or change in nuclear safety reliability by virtue of thick cushioning material surrounding it. The shock absorption to the corners, edges and at all joints in the plywood, supplemented by the inherent elasticity of bolts and nails used in final closure of the outer package, constitute a more than adequate buffer against the subject tests. Additionally, the RA outer container provides added protection to the end cap and cover of the inner RA container during an accident.

1.4.1.6 Corner Drop

Test not required since the package weight exceeds 110 pounds.

1.4.1.7 Penetration

Tests were conducted in which the flat circular end of a vertical steel cylinder 1-1/4 inches in diameter weighing 13 pounds was dropped four feet onto the center of the ½ inch plywood outer container. No damage resulted after four drop tests.

1.4.1.8 Compression

Tests were conducted in which six loaded packages (15,750 lbs.) were stacked for 24 hours. There was no visible or measurable damage to the container on the bottom of the stack. The test weight was greater than either of the conditions specified in 10CFR71 Appendix A.

1.4.2 Hypothetical Accident Conditions

1.4.2.1 Free Drop

Four individual drop tests through a distance of 30 feet have been conducted on the RA containers in 1966, 1974, 1978, and 1980. The test packages contained two dummy fuel assemblies to simulate the actual weight of a loaded RA inner container (1,865 lbs.). In all tests, the cover and end caps remained intact. The inside angle spacers maintained the annulus required so that criticality safety considerations were not affected. The maximum annular reduction of approximately 1% was produced by the test in 1966.

There were no ruptured fuel rods in any of the tests. Therefore, the fuel pellets would remain contained inside the fuel rods.

1.4.2.2 Puncture

A puncture test on the inner metal container conducted in 1980 produced an indentation, but no puncture. There were no ruptured fuel rods, and even though the container was bowed approximately 2 inches, the angle spacers maintained the spacing required so that criticality safety considerations were not affected. This test was conducted on an inner container only, without the protection of the outer wooden box. It easily can be seen that the damage would be considerably less with both the outer and inner container packages. Furthermore, the inner package is designed to remain subcritical with water in-leakage such as that which could result from puncture.

1.4.2.3 Thermal

A thermal test was conducted in 1980 that produced a maximum temperature of 1640°F flame temperature. An actual gasoline fire test was selected to be most representative of the accident considered. The gasket and other combustible materials inside the container, including foamed polyethylene cushioning and plastic rod spacers, completely burned away during the thirty minute test.

Five hundred gallons of gasoline were consumed during the test, and no abnormal thermal distortion was observed. The pressure relief valve and the burnt gasket permitted the pressure inside to be vented away and prevented rupture of the container.

1.4.2.4 Water Immersion

After the fire test mentioned above, a water immersion test was performed. Water leaked into the container since the gasket was consumed during the fire. Residue and debris remaining did not restrict the free flow of water into and out of the container. The presence of water for 8 hours caused no damage to the fuel rods.

There was no significant deformation or distortion of the container that reduced the effectiveness of the annulus to flooding by water entering through the closure joints since the gasket had burnt away.

These conditions were considered in the criticality calculations which showed the reactivity of such an array when flooded to be subcritical.

1.5 ***SP Series Shipping Packages***

1.5.1 SP-1 Inner Container

1.5.1.1 Description

The SP-1 inner container is a right rectangular metal box used inside an SP-1 outer wooden container for shipping fuel assemblies (maximum of two per inner container) or groups of fuel rods in specified containers.

The inner container consists of an outer shell and perforated inner basket separated by structural angle iron. The outer shell is formed of minimum 16-gauge carbon steel plate with an integral welded end of the same material. Four angle stiffeners made of 11-gauge carbon steel are welded on approximately four inch centers to the outer end surface of the container. Approximate dimensions of this inner container are 11-1/2 inches high, 18 inches wide, and 179 inches long.

The inner basket is constructed of 16-gauge carbon steel plate with 3/4 inch perforations on 1-3/4 inch centers. It is welded to the upper edge of the outer shell to form two U-shaped channels approximately 6-7/8 inch square in cross-section. The channels may be lined with low-density ethafoam cushioning cemented in place with perforations matching the size and location of those in the inner basket as described on Figure 1.1. To support the inner basket within the outer shell, four angle iron spacers made of 1/8 inch thick carbon steel are positioned longitudinally along the entire length of the body. Two similar angle iron spacers are positioned longitudinally in the cover.

The SP-1 inner metal container is designed with a longer body and shorter end cap than the SP-2 inner container. The SP-3 inner metal container, like the SP-1, is designed with a longer body and shorter end cap than the SP-2 inner container. The SP-1 and SP-2 inner containers are used interchangeably for shipping assemblies and rods while the SP-3 is limited to two types of assemblies. All may be used in the SP-1 wooden outer container.

The cover and end cap of the inner container are of similar construction to the box to provide an approximately two inch annulus around the fuel, except at the ends, when the box is closed. A gasket of approximately 1/2 inch thick hollow rubber (isoprene or neoprene) provides a completed seal with the cover in place. Closure of the box is effected by bolted assemblies.

The SP-1 inner container may be welded, riveted and/or screwed, or all welded construction. In the welded, riveted and/or screwed inner container, the cover liner is removable and the cavity is of riveted and welded construction.

1.5.1.2 Containment Vessel Penetrations

A standard breather relief valve installed on the outer shell of the end cap is set to re-seat at a 0.5 psi pressure difference between the inside and outside of the inner container and is capable of airflow adequate for surface or air transport.

1.5.1.3 Safety

The SP-1 inner container's safety was demonstrated to be acceptable based on a hypothetical accident condition test conducted in 1980 in accordance with criteria for compliance with 1OCFR71.36. See Appendix 2B for the Test Report.

1.5.2 SP-2 Inner Container

1.5.2.1 Description

The SP-2 inner container is a right rectangular metal box used inside an SP-1 outer wooden container for shipping fuel assemblies (maximum of two per inner) or groups of fuel rods strapped together (sometimes referred to as bundles).

The inner container consists of an outer shell and perforated inner basket separated by structural angle iron. The outer shell is formed of minimum 16-gauge carbon steel plate with an integral welded end of the same material. Four angle stiffeners made of 11-gauge carbon steel are welded on approximately four inch centers to the outer end surface of the container.

Approximate dimensions of this inner container are 11-1/2 inches high, 18 inches wide, and 179 inches long.

The inner basket is constructed of 16-gauge carbon steel plate with 3/4 inch perforations on 1-3/4 inch centers. It is welded or riveted to the upper edge of the outer shell to form two U-shaped channels approximately 6-7/8 inch square in cross-section. The channels may be lined with low-density ethafoam cushioning cemented in place with perforations matching the size and locations of those in the inner basket. To support the inner basket within the outer shell, four angle iron spacers made of 1/8 inch thick carbon steel are positioned longitudinally along the entire length of the body. Two similar angle iron spacers are positioned longitudinally in the cover.

The cover and end cap of the inner container are constructed similar to the body to provide an approximately two inch annulus around the fuel, except at the ends, when the body is closed. The end cap of the SP-2 container is approximately seven inches long. A gasket of approximately 1/2 inch thick hollow rubber (isoprene or neoprene) provides a completed seal with the cover in place. Closure of the box is effected by bolted assemblies.

The SP-3 inner metal container, like the SP-1, is designed with a longer body and shorter end cap than the SP-2 inner container. The SP-1 and SP-2 inner containers are used interchangeably for shipping assemblies and rods while the SP-3 is limited to two types of assemblies. All may be used in the SP-1 wooden outer container.

1.5.2.2 <u>Containment Vessel Penetrations</u>

A standard breather relief valve installed on the outer shell of the end cap is set to re-seat at a 0.5 psi pressure difference between the inside and outside of the inner container and is capable of airflow adequate for surface or air transport.

1.5.2.3 <u>Safety</u>

The SP-2 inner container's safety was demonstrated to be acceptable based on tests performed on the GE RA-1 inner container as described in Appendix 2 and according to the current engineering evaluation performed on the RA series containers as discussed in Appendix 2A.

1.5.3 <u>SP-3 Inner Container</u>

1.5.3.1 <u>Description</u>

The SP-3 inner container is a right rectangular metal box used inside an SP-1 outer wooden container for shipping fuel assemblies (maximum of two per inner container) or groups of fuel rods in specified containers.

The inner container consists of an outer shell and perforated inner basket separated by structural angle iron. The outer shell is formed of minimum 16-gauge carbon steel plate with an integral welded end of the same material. Four angle stiffeners made of 11-gauge carbon steel are welded on approximately four inch centers to the outer end surface of the container.

Approximate dimensions of this inner container are 11-1/2 inches high, 18 inches wide, and 179 inches long.

The inner basket is constructed of 16-gauge carbon steel plate with 3/4 inch perforations on 1-3/4 inch centers. It is welded to the upper edge of the outer shell to form two U-shaped channels approximately 6-7/8 inch square in cross-section. The channels may be lined with low-density ethafoam cushioning cemented in place with perforations matching the size and location of those in the inner basket as described on Figure 1.1. To support the inner basket within the outer shell, four angle iron spacers made of 1/8 inch thick carbon steel are positioned longitudinally along the entire length of the body. Two similar angle iron spacers are positioned longitudinally in the cover. The body and cover angle iron spacers create a minimum spacing of 1-5/8 inches between the inner basket and the outer shell compared to 1-15/16 in the SP-1 and SP-2 containers. This is the only difference between the SP-1 and SP-3.

The SP-3 inner metal container, like the SP-1, is designed with a longer body and shorter end cap than the SP-2 inner container. The SP-1 and SP-2 inner containers are used interchangeably for shipping assemblies and rods while the SP-3 is limited to two types of assemblies. All may be used in the SP-1 wooden outer container.

The cover and end cap of the inner container are of similar construction to the box to provide an approximately 1-5/8 inch annulus around the fuel, except at the ends, when the box is closed. A gasket of approximately 1/2 inch thick hollow rubber (isoprene or neoprene) provides a completed seal with the cover in place. Closure of the box is effected by bolted assemblies.

The SP-3 inner container may be welded, riveted and/or screwed, or all welded construction. In the welded, riveted and/or screwed inner container, the cover liner is removable and the cavity is of riveted and welded construction.

1.5.3.2 Containment Vessel Penetrations

A standard breather relief valve installed on the outer shell of the end cap is set to re-seat at a 0.5 psi pressure difference between the inside and outside of the inner container and is capable of airflow adequate for surface or air transport.

1.5.3.3 Safety

The SP-3 inner container's safety was demonstrated to be acceptable based on a hypothetical accident condition test conducted in 1980 in accordance with criteria for compliance with 10CFR71.36. See Appendix 2B for the Test Report.

1.5.4 SP-1 Outer Container

1.5.4.1 Description

The all-wood outer container is a right rectangular box with nominal dimensions of between 31 inches and 33 inches high, 30 inches and 32 inches wide, and up to 207 inches long. It is fabricated of 1/2 inch plywood, cleated with nominal 2 inch x 4 inch studs, and mounted on a 30 to 32 inch wide platform constructed of nominal 2 inch x 10 inch planks and with bolted-on skids of nominal 4 inch x 4 inch wood.

Internal cushioning consists of kraft fiber honeycomb impregnated with phenolic resin. Cushioning nominally 8-1/2 inches to 9 inches thick is used to line the inside of the box at the ends, while one layer of between 2 inches and 3 inches thick material is used for the top, bottom, and sides.

Additional cushioning consists of pads of expanded polyethylene material. Five pads 3 inches thick x 18 inches x 20-1/2 inches are located over the transverse skids at the bottom and at the top, while five pads of material 1/2 inch thick x 18 inches x 12 inches are located at related positions on each side of the box. The SP-1 outer container has a 1/2 inch plywood sheet faced with 1/8 inch steel sheet at each end of the box.

The box has no attached lifting or tiedown devices.

The SP-1 outer container is used primarily to reduce shocks and vibrations to the packaged fuel assemblies which are encountered in normal material handling, warehousing, and transportation. The SP-1 outer container also provides a degree of impact reduction capability for protecting the packaged assemblies against damage in rough material handling, dropping while loading or unloading and in impacts due to low speed accidents. In addition, the outer container provides added protection to the end cap and cover of the SP-1, SP-2 and SP-3 inner containers during an accident.

1.5.4.2 Safety

The SP-1 outer container's safety has been determined as the result of a drop test to be acceptable for the purpose it was designed. See Appendix 2A of this section for the Test Report.

1.6 *Contents of Shipping Containers*

The contents allowed to be shipped in the SP-1, SP-2 and SP-3 containers include BWR fuel assemblies with a maximum enrichment of 5 wt% U-235 and individual fuel rods enriched to a maximum of 5.0 wt% U-235 and containing a minimum gadolinia content of 1.0 wt%. The payload of the SP-3 is limited to category 8 and 9 fuel assemblies as discussed in Chapter 6 and Appendices 6H and 6I.

Each fuel assembly is enclosed in an unsealed polyethylene sheath. The ends of the sheath are neither taped nor folded in any manner that would prevent the flow of liquids into or out of the ends of sheathed fuel assemblies.

Individual rods are shipped either in a product container or the gadolinia rod shipping container. The product container consists of a five-inch schedule 40 stainless steel pipe fitted with either a screw type or flanged closure. The gadolinia rod shipping container is shown in Figure 1.3.

Specific descriptions of fuel assemblies and rods to be shipped in the SP-1, SP-2 and SP-3 containers are given in Chapter 6.

TABLE 1.1	
Summary Listing of Applicable Licensing Drawings	
Reference Figure No.	**Drawing No. and Description**
1.1	EMF-304, 416, Rev. 14 SP-1, 2, & 3 Inner Shipping Container Assembly
1.2	EMF-306, 272, Sh. 1, Rev. 10 SP-1 Outer Shipping Container
1.3	EMF-309, 141, Rev. 1 Gadolinia Rod Shipping Container

2. Structural Evaluation

The structural evaluations of the SP-1, SP-2 and SP-3 containers under normal transport and hypothetical accident conditions are described in Appendices 2A,2B,2C,2D, and 2E. These appendices are comprised of the appendices of Section 2 of General Electric's March 17, 1992 Consolidated Application for the RA-Series Shipping Package. The SP-1 and SP-2 are virtually identical to the RA-3 and RA-2, respectively. The SP-3 is identical to the SP-1 except for the spacing differences described in 1.5.3.1. Appendices 2A,2B,2C,2D and 2E cover structural, thermal, and containment evaluations of these containers.

3. Thermal Evaluation

The thermal evaluations of the SP-1, SP-2 and SP-3 containers under normal transport and hypothetical accident conditions are described in Appendices 2A,2B,2C,2D, and 2E. These appendices are comprised of the appendices of Section 2 of General Electric's March 17, 1992 Consolidated Application for the RA-Series Shipping Package. The SP-1 and SP-2 are virtually identical to the RA-3 and RA-2, respectively. The SP-3 is identical to the SP-1 except for the spacing differences described in 1.5.3.1. Appendices 2A,2B,2C,2D, and 2E cover structural, thermal, and containment evaluations of these containers.

4. Containment Evaluation

The evaluations of containment of contents under normal transport and hypothetical accident conditions of the SP-1, SP-2 and SP-3 containers are described in Appendices 2A,2B,2C,2D, and 2E. These appendices are comprised of the appendices of Section 2 of General Electric's March 17, 1992 Consolidated Application for the RA-Series Shipping Package. The SP-1 and SP-2 are virtually identical to the RA-3 and RA-2, respectively. The SP-3 is identical to the SP-1 except for the spacing differences described in 1.5.3.1. Appendices 2A,2B,2C,2D, and 2E cover structural, thermal, and containment evaluations of these containers.

5. Shielding Evaluation

Because the SP-1, SP-2 and SP-3 shipping containers are designed to carry low enriched unirradiated fuel, there is no need for shielding to reduce radiation. Typical dose rates at the outer surface of a loaded container are 0.05-0.1 mSv/hr (5-10 mr/hr).

6. Criticality Evaluation

6.1 *Introduction*

The evaluations of the SP-1, SP-2 and SP-3 containers to retain their contents under both normal transport and hypothetical accident conditions are documented in Appendices 2A-2E.

6.2 *Description of Contents*

There are eight fuel assembly types, plus fuel rods outside of assemblies which constitute the contents to be shipped under this application. They are described below.

6.2.1 Type G1 (Category 1) Fuel Assemblies

UO_2 fuel assemblies in a 7 x 7, an 8 x 8, or a 9 x 9 square array with a maximum fuel cross-section area of 25 square inches, maximum fuel length of 174 inches and maximum average enrichment of 3.3 wt% U-235. Minimum zircaloy clad thickness is 0.025 inches; maximum pellet diameter is 0.555 inches. Any number of water rods in any arrangement are permitted.

6.2.2 Type G2 (Category 2) Fuel Assemblies

UO_2 fuel assemblies in a 7 x 7, an 8 x 8, or a 9 x 9 square array with a maximum fuel length of 174 inches, and a maximum average enrichment between 3.3 wt% to 4.0 wt% U-235. Pellet and cladding dimensions and nuclear poison specifications are to be in accordance with the limits specified in Appendix 6A.

6.2.3 10 x 10 (Category 3) Fuel

UO_2 fuel assemblies with a maximum enrichment of 5.0 wt% U-235, and a maximum average enrichment of 4.0 wt% U-235. Each fuel assembly is made up of fuel rods in a 10 x 10 square array, with a maximum fuel cross section of 5.022 inches square, a nominal pitch of 0.511 inch, and a maximum fuel length of 174 inches. The maximum pellet diameter is 0.3356 inch, the minimum clad thickness is 0.0225 inch, and the maximum U-235 enrichment in any edge rod is 4.0 percent by weight. Each assembly contains at least 6 rods with minimum nominal 2 weight percent Gd_2O_3, which are symmetric about the diagonal, and each assembly contains at least 4 water rods in the 4 central rod positions.

6.2.4 Fuel Rods (Category 4)

UO_2 fuel rods with a maximum U-235 enrichment of 5.0 wt.% and a minimum gadolinia content of 1.0 wt%. The maximum pellet diameter is 0.5 inch and the maximum rod length is 169 inches. The rods may be clad with zircaloy, steel, or aluminum. Rods meeting the above requirements may be placed into the "Gadolinia Rod Container" or the five-inch schedule 40 stainless steel pipe product container and shipped in the SP-1, SP-2 or SP-3 in lieu of one or two fuel assemblies.

6.2.5 10x10 (Category 5) ATRIUM Fuel Assemblies

UO_2 fuel assemblies with maximum U-235 enrichment (wt.%) constraints as follows: perimeter rods: 4.0%; UO_2-Gd_2O_3 ("gadolinia") Rods: 5.0%; All other interior rods: 4.0% average and no rod shall exceed 5.0%. Each assembly is composed of a 10x10 array of fuel rods and water rods. A water channel is required in the central 3x3 rod positions. Any number of additional water rods in any arrangement is permitted including part length rods. The maximum fuel dimensions are 5.0 inches by 5.0 inches by 174 inches. The maximum pellet diameter is 0.35 inches and the minimum clad thickness is 0.018 inches. Each assembly shall include at least twelve rods with at least 2.0 wt.% gadolinia in all axial regions with enriched pellets in a pattern symmetric about one of the assembly diagonals. At least eight of the twelve gadolinia rods shall be located in rows 2 and 9 and columns 2 and 9. The nominal diameter of the gadolinia pellets shall be not less than that of the UO_2 (non-gadolinia) pellets.

6.2.6 Additional 10x10 (Category 6) ATRIUM Fuel Assemblies

UO_2 fuel assemblies with a maximum U-235 enrichment of 5.0 wt.%. Each assembly is composed of a 10x10 array of fuel rods with a water channel or water rods located in a central 3x3 array of rods location. Any number of additional water rods or water channels in any arrangement is permitted including part length rods. The maximum fuel dimensions are 5.0 inches by 5.0 inches by 174 inches. The maximum pellet diameter is 0.35 inches and the minimum clad thickness is 0.018 inches. Each assembly shall contain at least eight rods with at least 2.0 wt.% gadolinia in all axial regions with enriched pellets. Additional gadolinia rod specifications are given in Appendix 6G.

6.2.7 9x9 (Category 7) ATRIUM Fuel Assemblies

UO_2 fuel assemblies with a maximum U-235 enrichment of 5.0 wt.%. Each assembly is composed of a 9x9 array of fuel rods with a water channel or water rods in the center 3x3 rod locations. Any number of additional water rods or water channels in any arrangement is permitted. The maximum fuel dimensions are 5.0 inches by 5.0 inches by 174 inches. The maximum pellet diameter is 0.40 inches and the minimum clad thickness is 0.015 inches. Each assembly shall contain at least eight rods with at least 2.0 wt.% gadolinia in all axial regions with enriched pellets. Additional gadolinia rod specifications are given in Appendix 6G.

6.2.8 Additional 9x9 (Category 8) ATRIUM Fuel Assemblies

UO_2 fuel assemblies in a 9x9 square array with a maximum fuel cross-section of 25 square inches, maximum fuel length of 174 inches, and a maximum average enrichment of 4.0 w/o U-235. The nominal pellet diameter is 0.370 inch. At least the center 3x3 rod locations shall be a water channel. Each assembly must include at least eight rods with a minimum nominal gadolinia (Gd_2O_3) content of 2.0 w/o in all axial regions with enriched pellets. Additional gadolinia rod specifications are given in Appendix 6H.

6.2.9 Additional 10x10 (Category 9) ATRIUM Fuel Assemblies

UO_2 fuel assemblies in a 10x10 square array with a maximum fuel cross section of 5.0 inches square and a maximum fuel length of 174 inches. The maximum U-235 enrichment is 5.0 weight percent, the maximum U-235 enrichment for all edge rods is 4.75 weight percent, the maximum enrichment for the four corner edge rods is 3.05 weight percent, and the maximum

U-235 enrichment for the eight edge rods immediately adjacent to the four corner edge rods is 3.55 weight percent. The pellet diameter is between 0.30 and 0.3957 inch and a nominal pitch of 0.510 inch. Each assembly must have a water channel in a central 3x3 position. Each assembly must include at least ten rods with a minimum nominal content of 2.0 weight percent gadolinia (Gd_2O_3) in all axial regions with enriched pellets and in a pattern symmetric about one of the assembly diagonals. Polyethylene shipping shims may be inserted between the fuel rods and between the upper tie plate and the fueled region. Additional gadolinia rod specifications are given in Appendix 6I.

6.2.10 Low Enriched Gadolinia Free 10x10 (Category 10) ATRIUM Fuel Assemblies

UO_2 fuel assemblies composed of fuel rods in a 10x10 square array with a maximum fuel cross section of 5.0 inches square and a maximum fuel length of 174 inches. The maximum U^{235} enrichment is 2.3 weight percent. The pellet diameter is between 0.30 and 0.3957 inch. Each assembly must have a water channel in a central 3x3 position. Any number of additional water rods in any arrangement is permitted, including part length rods. Polyethylene shipping shims may be inserted between the fuel rods. An additional upper tie plate (UTP) shipping shim may be added between the UTP and the fueled region. This UTP shim may consist of a maximum of 345 g plastic or plastic composite.

6.3 *Criticality Evaluation of Individual Fuel Types*

6.3.1 Type G1 (Category 1) Fuel Assemblies

Parameter	Value
Assembly size	5.0 inch x 5.0 inch (maximum)
Assembly array	7 x 7, 8 x 8, 9 x 9
Average water/fuel volume ratio (Vw/Vf)	1.0 (minimum)
Pellet to clad radial gap	0.003 inch (minimum)
Clad thickness	0.025 inch (minimum)
Pellet diameter	0.555 inch (maximum)
Water rods	Any number/any arrangement
Assembly-average enrichment[1]	3.3 wt% U-235 (maximum)
Gd_2O_3 requirement	None

Appendix 6A, as modified by 6F, describes the criticality analyses of the type G1 fuel assembly to be shipped in SP-1 or SP-2 containers.

6.3.2 Type G2 (Category 2) Fuel Assemblies

Parameter	Value
Assembly size	5.0 inch x 5.0 inch (maximum)

[1] UO_2 rods and UO_2-Gd_2O_3 rods may contain several inches of natural enrichment UO_2 pellets at either or both ends of the pellet stack. The assembly-average enrichment limits are for the enriched zone only; i.e., the assembly-average enrichment does not include the natural uranium at the ends of the pellet stack.

Assembly array	7 x 7, 8 x 8, 9 x 9
Average water/fuel volume ratio (Vw/Vf)	1.0 (minimum)
Pellet to clad radial gap	0.003 inch (minimum)
Clad thickness	0.025 inch (minimum)
Pellet diameter	0.555 inch (maximum)
Water rods	Any number/any arrangement
Assembly-average enrichment[1]	3.3-4.0 wt% U-235 (maximum)
Gd_2O_3 requirement	None

- Minimum number of UO_2-Gd_2O_3 rods is four in non-perimeter locations symmetric about the assembly diagonal.
- UO_2-Gd_2O_3 rods may contain various Gd_2O_3 concentrations in the enriched fuel zone but the minimum Gd_2O_3 concentration in the enriched zone to qualify as one of the four UO_2-Gd_2O_3 rods is 2.0 wt%.
- The nominal length of the UO_2-Gd_2O_3 region shall be equal to or greater than the nominal length of the enriched region in the UO_2 fuel rods.
- Gd_2O_3 is not required in the end regions with natural uranium.

Appendix 6A, as modified by 6F, describes the criticality analyses of the type G2 fuel assembly to be shipped in SP-1 or SP-2 containers. Attached Appendix 6H describes the criticality analysis of the Category 2 fuel to be shipped in the SP-3 container.

6.3.3 10x10 (Category 3) Fuel Assemblies

Parameter	Value
Edge of outer square determined by peripheral fuel rods	5.022 inch (maximum)
Enrichment of any pellet in assembly	5.0 wt% U-235 (maximum)
Enrichment of any pellet in an edge rod	4.0 wt% U-235 (maximum)
Maximum average planar enrichment[2]	4.0 wt% U-235 (maximum)
Clad thickness	0.0225 inch (maximum)
Pellet diameter	0.3356 inch (maximum)
Fuel density	98.0% TD (maximum)
Rod pitch	0.511 inch (nominal)
UO_2-Gd_2O_3 rods	6 (minimum)
Gd_2O_3 content	2.0± 0.08 wt% (minimum)
Water rods	Center 4 rods (minimum)
Poison rod arrangement	Symmetrical across the diagonal
Fuel rod array in bundle	10 x 10

[2] Maximum average planar enrichment: The average enrichment at the axial location yielding the highest planar average.

Appendix 6B, as modified by 6F, describes the criticality analyses for 10 x 10 fuel assemblies to be shipped in SP-1 or SP-2 containers.

6.3.4 Fuel Rods (Category 4)

UO_2 fuel rods with a maximum U-235 enrichment of 5.0 wt.% and a minimum gadolinia content of 1.0 wt%. The maximum pellet diameter is 0.5 inch and the maximum rod length is 169 inches. The rods may be clad with zircaloy, steel, or aluminum. Rods meeting the above requirements may placed into the "Gadolinia Rod Container" or the five-inch schedule 40 stainless steel pipe product container and shipped in the SP-1 or SP-2 in lieu of one or two fuel assemblies.

Appendix 6C, as modified by 6F, describes the criticality analyses for gadolinia-bearing rods to be shipped in the gadolinia rod container in SP-1 and SP-2 containers.

6.3.5 10x10 (Category 5)ATRIUM Fuel Assemblies

Parameter	Value
Edge of outer square determined by peripheral fuel rods	5.0 inch (maximum)
Enrichment of any pellet in assembly	5.0 wt% U-235 (maximum)
Enrichment of any pellet in an edge rod	4.0 wt% U-235 (maximum)
Maximum average planar enrichment[2] excluding Gd rods and edge rods	4.0 wt% U-235 (maximum)
Clad thickness	0.018 inch (minimum)
Pellet diameter	0.35 inch (maximum)
Fuel density	98.0% TD (maximum)
Rod pitch	0.510 inch (nominal)
UO_2-Gd_2O_3 rods	12 (minimum)
Gd_2O_3 content	2.0± 0.08 wt% (minimum)
Water rods	Center 3 x 3 rods (minimum)
Poison rod arrangement	Symmetrical across the diagonal
Fuel rod array in bundle	10 x 10

Appendix 6D, as modified by 6F, describes the criticality analyses for 10 x 10 fuel assemblies to be shipped in SP-1 or SP-2 containers.

6.3.6 Additional 10x10 (Category 6) ATRIUM Fuel Assemblies

Parameter	Value
Edge of outer square determined by peripheral fuel rods	5.0 inch (maximum)
Enrichment of any pellet in assembly	5.0 wt% U-235 (maximum)
Clad thickness	0.018 inch (minimum)
Pellet diameter	0.35 inch (maximum)
Fuel density	98.0% TD (maximum)
Rod pitch	0.510 inch (nominal)
UO_2-Gd_2O_3 rods	8 (minimum)
Gd_2O_3 content	2.0± 0.08 wt% (minimum)
Water rods	Center 3 x 3 rods (minimum)
Fuel rod array in bundle	10 x 10

Appendix 6E, as modified by 6F, describes the criticality analyses for 10 x 10 fuel assemblies to be shipped in SP-1 or SP-2 containers.

6.3.7 9x9 (Category 7) ATRIUM Fuel Assemblies

Parameter	Value
Edge of outer square determined by peripheral fuel rods	5.0 inch (maximum)
Enrichment of any pellet in assembly	5.0 wt% U-235 (maximum)
Enrichment of any pellet in an edge rod	4.0 wt% U-235 (maximum)
Maximum average planar enrichment[3]	4.0 wt% U-235 (maximum)
Clad thickness	0.015 inch (minimum)
Pellet diameter	0.40 inch (maximum)
Fuel density	98.0% TD (maximum)
Rod pitch	0.569 inch (nominal)
UO_2-Gd_2O_3 rods	8 (minimum)
Gd_2O_3 content	2.0± 0.08 wt% (minimum)
Water rods	Center 3 x 3 rods (minimum)
Fuel rod array in bundle	9 x 9

Appendix 6E, as modified by 6F, describes the criticality analyses for 9 x 9 fuel assemblies to be shipped in SP-1 or SP-2 containers.

[3] Maximum average planar enrichment: The average enrichment at the axial location yielding the highest planar average.

6.3.8 Additional 9x9 (Category 8) ATRIUM Fuel Assemblies

Parameter	Value
Assembly size	5.0 inch x 5.0 inch (maximum)
Assembly array	9x9
Average water/fuel volume ratio (Vw/Vf)	1.0 (minimum)
Pellet to clad radial gap	0.003 inch (minimum)
Clad thickness	0.025 inch (minimum)
Pellet diameter	0.555 inch (maximum)
Water rods	Center 3x3 rods
Assembly-average enrichment	4.0 wt% U-235 (maximum)
Gd_2O_3 requirement	

- Minimum number of UO_2-Gd_2O_3 rods is four in non-perimeter locations symmetric about the assembly diagonal.
- UO_2-Gd_2O_3 rods may contain various Gd_2O_3 concentrations in the enriched fuel zone but the minimum Gd2O3 concentration in the enriched zone to qualify as one of the four UO_2-Gd_2O_3 rods is 2.0 wt%.
- The nominal length of the UO_2-Gd_2O_3 region shall be equal to or greater than the nominal length of the enriched region in the UO_2 fuel rods.
- Gd_2O_3 is not required in the end regions with natural uranium.

Attached Appendix 6H describes the criticality analysis of the Category 8 fuel to be shipped in the SP-1, SP-2 and SP-3 containers.

6.3.9 Additional 10x10 (Category 9) ATRIUM Fuel Assemblies

Parameter	Value
Assembly size	5.0 inch x 5.0 inch (maximum)
Fuel rod array in bundle	10x10
Fuel length	174 inches (maximum)
Enrichment of any pellet in the assembly	5.0 wt% U-235 (maximum)
Enrichment of any pellet in an edge rod	4.75 wt% U-235 (maximum)
Enrichment of any pellet in one of the four corner edge rods	3.05 wt% U-235 (maximum)
Enrichment of any pellet in one of the eight edge rods immediately adjacent to the four corner rods	3.55 wt% U-235 (maximum)
Clad thickness	Not restricted

Pellet diameter	0.30 inch (minimum); 0.3957 inch (maximum)
Rod pitch	0.510 inch (nominal)
Fuel density	98.0% TD (maximum)
UO_2 - Gd_2O_3 rods	10 (minimum)
Gd_2O_3 content	2.0 wt% nominal (minimum)
Water rods	Center 3x3 rods (minimum)

- Each assembly must include a minimum of 10 rods with a minimum 2.0 weight percent gadolinia (Gd_2O_3) in all axial regions with enriched pellets.
- The gadolinia rods must be in a pattern symmetric about one of the assembly diagonals.
- At least ten gadolinia rods must be located in rows 2 and 9 and in columns 2 and 9 of the assembly and cannot be immediately adjacent to another one of the ten gadolinia rods, however diagonally adjacent is permitted.
- Polyethylene shipping shims may be inserted between the fuel rods up to a maximum volume fraction of 0.14 averaged over the void volume of the assembly.
- An additional upper tie plate shipping shim may be added between the upper tie plate and the fueled region. This upper tie plate shim may consist of a maximum of 345 g plastic or plastic composite.

Appendix 6I describes the criticality analyses for Category 9, 10x10 fuel assemblies to be shipped in SP-1, SP-2 or SP-3 packagings.

6.3.10 Low Enriched Gadolinia Free 10x10 (Category 10) ATRIUM™ Fuel Assemblies

Parameter	Value
Assembly size	5.0 inch x 5.0 inch (maximum)
Fuel rod array in bundle	10x10
Fuel length	174 inches (maximum)
Enrichment of any pellet in the assembly	2.3 wt% U-235 (maximum)
Clad thickness	Not restricted
Pellet diameter	0.30 inch (minimum); 0.3957 inch (maximum)
Rod pitch	0.510 inch (nominal)
Fuel density	98.0% TD (maximum)
UO_2 - Gd_2O_3 rods	0 (minimum)
Gd_2O_3 content	0.0 wt% nominal (minimum)
Water rods	Center 3x3 rods (minimum)

- Polyethylene shipping shims may be inserted between the fuel rods up to a maximum volume fraction of 0.14 averaged over the void volume of the assembly.

- An additional upper tie plate shipping shim may be added between the upper tie plate and the fueled region. This upper tie plate shim may consist of a maximum of 345 g plastic or plastic composite.

Appendix 6J describes the criticality analyses for Category 10, 10x10 fuel assemblies to be shipped in SP-1, SP-2 or SP-3 packagings.

7. Operating Procedures for Loading and Unloading SP-1, SP-2 and SP-3 Containers

7.1 *Container Handling*

Fuel assemblies and individual fuel rods are loaded for shipment into the SP-1, SP-2 and SP-3 containers in the UO2 Building in accordance with standard operating procedures. The following describes the portions of the applicable procedures pertinent to safety.

- Verify that the fuel assemblies have been completed in compliance with applicable acceptance criteria.
- Inspect fuel assemblies for cleanliness.
- Assure that the polyethylene sheath which is placed over the assembly prior to loading into containers is open at both ends and is no longer than the assembly.
- If loose (not part of a fuel assembly) rods are to be shipped in an SP container, they must be prepared as described below.
  - Only rods containing at least 1.0 wt.% gadolinia, sheathed or unsheathed, may be shipped in the SP-1, SP-2 and SP-3 containers.
  - The rods may be shipped either in the gadolinia rod shipping container, shown in Figure 1-4 or in a product container consisting of a five-inch, schedule 40, stainless steel pipe with a screw type or flange closure. The product container must be vented if it contains material that decomposes at less than 1475 °F.
- Prior to placing fuel assemblies or fuel rods into the SP inner container, visually inspect SP inner container for overall condition including:
  - Proper container preparation (presence of a "release" sticker)
  - Handles and brackets
  - Exterior welds
  - Foam padding
  - Gasket condition
  - Cleanliness
- For fuel assemblies, raise the SP inner container to the vertical position and insert the fuel assembly with the lower tie plate inserted into the thrust block to assure proper orientation. Lower the inner container to horizontal and add shimming to prevent fuel assembly movement.
- For fuel rods, the gadolinia rod shipping container and the product container are loaded into the SP inner container while it is in the horizontal position.

- Complete an inspection to assure compliance with loading procedures for the inner SP container.
- Bolt the end cap and lid of the inner container into place.
- Inspect the outer SP-1 container for structural integrity, cleanliness, and loose material.
- Load the inner container into the outer container and shim as necessary to prevent differential movement between the containers.
- Complete a second inspection to assure compliance with the procedures for loading the inner container into the outer SP container.
- Install and bolt the outer lid into place.
- Install tamper indicating seals at each end of the outer container.
- Radioactively survey for compliance with DOT regulations and release the loaded SP container for shipment.

7.2 *Shipment Procedures*

- Affix proper warning labels to each container.
- Overcheck fuel assembly or fuel rod parameters for compliance with the shipping container NRC Certificate of Compliance requirements.
- Load, tie down, and/or shore the SP containers onto a truck and radioactively survey the truck for compliance with DOT regulations.

8. Acceptance Tests and Maintenance Program

AREVA NP's radioactive material shipping containers, including the SP-1, SP-2 and SP-3 containers, are covered by its NRC-approved quality assurance program for shipping containers. The scope of this QA program includes design, procurement, fabrication, assembly, maintenance, modification and repair of such shipping containers.

8.1 *Acceptance Tests*

AREVA NP conducts quality inspections of SP-1 outer containers and SP inner containers prior to first use. The following steps are included in such inspections.

8.1.1 SP Inner Containers

Typical Characteristic Inspected	Typical Inspection Method
• Proper marking, general cleanliness, rust, cracks, and dents	Visual
• Cover and end pieces for fit and function	Visual
• Container dimensions	Measurements, based on approved drawings, to assure that minimum dimensions for criticality safety are met. Assure that overall length, width and height are within tolerance.
• Weld integrity, including closure lugs and lifting handle placement and attachment	Visual
• Gasket condition	Visual
• Pressure relief valve	Check for presence and proper operation
• Vendor's certificate of compliance	Review for completeness
• Vendor's facility and QC program	AREVA NP QA representative inspection

8.1.2 SP-1 Outer Containers

Typical Characteristic Inspected	Typical Inspection Method
• Proper marking, general cleanliness	Visual
• Cover/base for fit and function	Visual
• Container dimensions	Measurements, based on approved drawings, to assure minimum thickness of honeycomb material.
• Shipping damage	Visual
• Cover drain holes	Probe to make sure holes are not plugged
• Fit of inner container in outer container	Visual
• Vendor's certificate of compliance	Review for completeness

8.2 *Maintenance Program*

The SP inner containers and SP-1 outer containers are maintained and repaired at AREVA NP. The following steps are included in the maintenance and repair done at AREVA NP.

8.2.1 SP Inner Containers

- Repair any holes.
- Replace parts or work out dents greater that ½ inch deep.
- Replace parts or do weld repair on broken welds, seams, damaged lugs, or damaged lifting handles.
- Replace pressure relief valves which don't pass test or have been damaged.
- Replace or repair gaskets which are damaged, brittle, or flat from overcompression.
- Replace ethafoam if greater that 10% of a piece is missing.
- Replace damaged or missing fasteners.
- Repaint if needed.
- Make sure container is clean and free of loose debris.

8.2.2 SP-1 Outer Container

- Replace 2x4's if cracks exceed 25% of width or are over 6 inches long.
- Replace 2x10's and 2x12's, if cracks exceed 25% of width or length of lumber.
- Replace plywood with punctures, separating laminations, or more than a square foot of missing lamination.
- Replace damaged skids.
- Replace honeycomb if greater than 10% of a piece is missing or damaged.

- Replace damaged, heavily corroded, or missing nuts, bolts, nails, and screws. Superficial surface rust is allowed on all carbon steel fasteners.
- Make sure interior is clean and dry.
- Repaint and remark as necessary.