AREVA

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

RDM-07-017
December 6, 2007

U.S. Nuclear Regulatory Commission,
ATTN: Jessica Glenny, Project Scientist
Division of Spent Fuel Storage and Transportation,
Office of Nuclear Material Safety and Safeguards,
Washington, DC 20555-0001

Subject: **Clarification of Responses to NRC Request for Additional Information, Docket No. 71-9319, TAC No. 24069.**

Reference: **1) AREVA NP Inc Letter dated 10/24/07, "Response to NRC Request for Additional Information for the MAP-12/MAP-13 Packages".**

2) NRC Request for Additional Information for Review of the Model No. MAP-12 and MAP-13 Packages, dated September 6, 2007, Docket No. 71-9319, TAC No. 24069.

3) AREVA NP Inc Letter dated 03/13/07, "Application for a Certificate of Compliance for the MAP-12/MAP-13 Packages, Revision 0, Docket No. 71-9319".

Ms. Glenny:

AREVA NP Inc. hereby submits the attached clarifications to the Request for Additional Information (RAI) as originally provided in Reference 1, as discussed between the NRC and AREVA personnel on 11/28/07. Clarified responses are provided for RAIs 1-3, 4-1, 4-2, 6-2, 6-3, and 6-6. AREVA appreciates the continued discussions and thorough review given to the Safety Analysis Report. Included within this submittal are the following documents:

- Three (3) paper copies of updated information for the Safety Analysis Report (SAR) for the MAP-12/MAP-13 Packages (Attachment A), including response to RAI questions (Attachment B), provided in three separate folders.
- Three (3) electronic copies are provided in PDF format of the updated SAR, including response to RAI questions (Attachment C).

The electronic copies are contained on CDs in three separate envelopes labeled, "MAP-12/MAP-13 Docket 71-9319, Revision 2".

One copy of each (paper copy and CD) is also being sent to the NRC Document Control Desk.

Revised sections and/or page changes that make up revision 2 to the MAP SAR, in response to the NRC RAI, are provided with revision bars in the right page margin. In addition, a summary description of the nature of page changes is provided with a further description of the sections and/or page changes to update revision 1 of the MAP SAR to revision 2 status.

AREVA NP INC.
An AREVA and Siemens company

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FORM: 22709VA-1 (4/1/2006)

NMSS01

If you or your staff have any questions, require additional information, or wish to discuss the matter further, please contact me at 434-832-5172. Please reference the unique document identification number in any correspondence concerning this letter.

Sincerely,

Richard D. Montgomery

Richard D. Montgomery, Advisory Engineer
Nuclear Criticality Safety & Shipping Containers

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

Attachment A

Paper Copy
MAP-12/MAP-13 Package
Safety Analysis Report (SAR)

AREVA NP INC.
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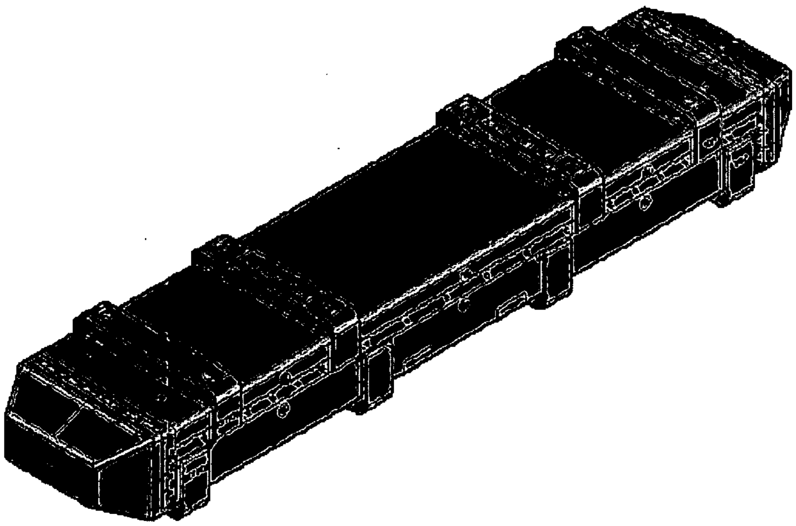
AREVA

AREVA NP Inc.,



Document Identification No.
51-9026593-001

Application for Certificate of Compliance for the MAP Series of PWR Fuel Shipping Packages

NRC Certificate of Compliance USA/9319/B(U)F-96 Docket 71-9319

Revision 2
December 2007

AREVA

AREVA NP Inc.,

Document Identification No.
51-9026593-001

Application for Certificate of Compliance for the MAP Series of PWR Fuel Shipping Packages

NRC Certificate of Compliance USA/9319/B(U)F-96 Docket 71-9319

Revision 2
December 2007

Safety Analysis Report

AREVA NP Inc.,

MAP PWR Fuel Shipping Package

Certificate of Compliance No: USA/9319/B(U)F-96

Docket No: 71-9319

Record of Revisions
Revision 0 – March 2007
Revision 1 – October 2007
Revision 2 – December 2007

Nature of Changes
Revision 2

Item	Paragraph or Page(s)	Description and Justification
1	Section 1.1	Add discussion for modeled package array and justification for calculated CSI value of 2.8 (RAI 1-3)
2	Section 1.3.1	Changed description of neutron absorber plates as borated aluminum to metal matrix composite – Boral, on License Drawing 9045393, Sheets 1 and 2 (RAI 6-2)
3	Section 2.12.1.5	Added more detail regarding the inspection, testing, and time interval between the conduct of HAC tests and final rod inspections to demonstrate that rod containment (cladding) was maintained (RAI 4-2).
4	Section 2.12.1.5	Changed last sentence in section to identify that the pellet-clad gap is modeled as flooded to meet the regulatory requirement without exemption as opposed to for added conservatism (RAI 6-4)
5	Section 4.2.3	Changed leakage rate from 3E-08 to 1E-07 ref-cc/sec for consistency with Section 8 (RAI 4-1).
6	Section 6.2.1.4.2	Clarified Nylon 6,6 properties important to the design, the design basis for Nylon 6,6 in the MAP package, and provided reference to Nylon 6,6 properties (RAI 6-3)
7	Section 6.4.5.1.3	Clarified the criticality assessment relative to the dimensional and density studies and that the density has a negligible effect. Clarified the Nylon 6,6 design basis for use in the MAP package and that the modeled design configuration is very conservative with respect to the HAC test. Further clarified that the criticality evaluation considers the most reactive credible configuration consistent with the damaged condition of the package and the chemical and physical form of the contents and meets the requirements of 10 CFR 71.55 (RAI 6-3)
8	Section 8.1.4	Changed leakage rate from 1E-07 atm-cm^3/sec to 1E-07 ref-cc/sec for consistency with Section 4 (RAI 4-1).
9	Section 8.2	Changed Section headers 8.1.8 through 8.1.14 to 8.2.1 through 8.2.6 to correctly correspond to Section 8.2

Nature of Changes
Revision 1

Item	Paragraph or Page(s)	Description and Justification
1	Section 1.1	Add discussion and footnote for modeled package array and justification for calculated CSI value of 2.8 (RAI 1-3)
2	All	Changed description of neutron absorber plates as borated aluminum to either Boral or borated metal matrix composite (RAI 6-2)
3	All	Deleted reference to shipment of loose rods and use of loose rod container (RAI 1-2). Deleted Sections 1.2.1.4,

Item	Paragraph or Page(s)	Description and Justification
4	Sections 1.2.2 and 1.2.2.2	Change reference from ^{234}U to ^{236}U with regard to Type B material designation (RAI 1-1)
5	Table 1-1	Changed use of Gadolinia to Absorbers
6	Table 1-3	Add entry for typical rod pressures of 145 to 450 psig (RAI 4-5)
7	Section 2.11	Corrected cited references to Sections 2.12.1 and 4.0 (RAI 4-2)
8	Section 2.12.1	Minor format changes for consistency
9	Table 2.12.1-3	Add further details regarding testing of CTU3 in regards to thermal test duration, condition of assembly and moderator after tests (RAI 2-1)
10	Sections 2.12.1.4.1, 2.12.1.4.2, 2.12.1.4.4	Add further details including figures and discussion regarding fuel assembly geometry, fuel cavity geometry and condition of rod cladding after HAC testing (RAI 4-2)
11	Section 2.12.1.4.4	Provide further clarification of thermal test and results with added discussion and figures. Provided summary table and figures for all moderator segments post HAC testing. Changed reporting basis for moderator from volume to mass for consistency between pre test calculated and post test measured results. Clarified 85% credit assumed for Lid moderator (RAI 2-1, 3-4, and 3-7)
12	Section 2.12.1.5	Add further clarification regarding fuel assembly geometry, fuel cavity geometry, condition of rod cladding, and condition of moderator after HAC testing (RAI 2-1, 3-4, 3-7, and 4-2)
13	Section 2.12.1.6.2	Add further clarification regarding fuel rod pressure for simulate payload (RAI 4-5)
14	Section 3	Revised identified pages to incorporate omitted references (RAI 3-1)
15	Sections 3.3, 3.3.1.1, and 3.5.2	Modified sections and added new Figure 3-2 to present enlarged view of transient shown in Figure 3-1 (RAI 3-2)
16	Sections 3.2.1 and 3.5.2	Modified sections to describe how the solar absorptivity values listed in Table 3-6 of the SAR were applied to the thermal model (RAI 3-3)
17	Section 3.4.2	Modified section to clarify the sequence of events related to the fire test of the MAP (RAI 3-4)
18	Section 3.4.2	Modified section to include justification for the heat input ratio between the regulatory and fire test results (RAI 3-5)
19	Section 3.2.2 and 3.4.3	Modified Sections 3.2.2 and 3.4.3 to provide clarification of the basis for the estimated temperatures reached during the fire (RAI 3-6)
20	Section 3.4.3.1	Add more detailed discussion as further provided in Section 2.12.1 (RAI 3-7)
21	Section 3.5.3	Modified Section 3.5.3 (RAI 3-8, 3-10, and 3-11)
22	Section 4.2.3	Leakage rate change to be consistent with Section 8.1.4 (RAI 4-1)
23	Section 4	Revised section discussion to indicate that test results are documented in Section 2.12.1 (RAI 4-2)
24	Section 4.2.1.2	Add discussion of weight of fuel equivalent to an A quantity (RAI 4-4)
25	Section 4 and 2.12.1	Add discussion of initial pressure for fuel rods (RAI 4-5)
26	Section 6.2.1.3.2.1	Revised description and allowed form of borated-aluminum neutron absorber to Boral or borated metal matrix composite (RAI 6-1 and 6-2)
27	Sections 6.2.1.4.2, 6.4.5.1.3	Add details and reference for Nylon 6,6 moderator including credit for 90% for the moderator block and 100% for theoretical density (RAI 6-3)
28	Sections 6.3.1, 6.4.2.1, and 6.4.5	Revised Table 6-3 and applicable sections to include summary parameters and calculation results for flooded-gap calculations (RAI 6-4 and 6-5)
29	Section 6.7.7	Revised section and Figure 6-29 to explain the keff curves (RAI 6-6)

Item	Paragraph or Page(s)	Description and Justification
30	Section 8	Revised page 8-3, upper limit of thermal conductivity acceptance criteria for foam from 0.25 to 0.30 for consistency with General Plastics reported range. The thermal protection offered by the foam is primarily a function of its density, which determines how much energy is required to char the foam. A relatively small change (0.05 BTU-in/hr-ft^2-°F) to the thermal conductivity of un-charred foam would have little to no perceptible change on the package temperatures for NCT or HAC.

Description of Section/Page Changes
Revision 2

Section or Page Removed	Section or Page Inserted	Basis for Change
Cover Page, Record of Revisions, pages *i* and *ii*, revision 1	Replace with Cover Page, Record of Revisions, pages *i* and *ii*, and add pages *iii* and *iv*, revision 2	Response to RAI
Section 1, pages 1-*i*, and 1-1 through 1-4, revision 1	Replace with Section 1, revision 2 pages 1-*i*, and 1-1 through 1-4	Response to RAI
Section 1.3.1, License Drawings 9045393, Sheets 1 and 2, revision 0	Replace with Section 1.3.1, License Drawings 9045393, Sheets 1 and 2, revision 1	Response to RAI
Section 2.12.1-*ii*, 2.12.1-41 through 2.12.1-43, revision 1	Section 2.12.1-*ii*, 2.12.1-41 through 2.12.1-43, and add 2.12.1.44, revision 2	Response to RAI
Section 4, page 4-3, revision 1	Replace with Section 4, page 4-3, revision 2	Response to RAI
Section 6.2.1.4.2, page 6-9 and 6-10, revision 1	Replace with Section 6.2.1.4.2, pages 6-9 and 6-10, revision 2	Response to RAI
Section 6.4.5.1.3, page 6-28 and 6-29, revision 1	Replace with Section 6.4.5.1.3, pages 6-28 and 6-29, revision 2	Response to RAI
Section 8, page 8-2, revision 0	Replace with Section 8, page 8-2, revision 2	Response to RAI
Section 8, pages 8-*i*, 8-6 and 8-7, revision 0	Replace with Section 8, pages 8-*i*, 8-6 and 8-7, revision 2	Subsection numbering error

Description of Section/Page Changes
Revision 1

Section or Page Removed	Section or Page Inserted	Basis for Change
Cover Page, Record of Revisions, revision 0	Replace with Cover Page, Record of Revisions, revision 1	Response to RAI
Section 1, revision 0	Replace with Section 1, revision 1	Response to RAI
Section 2, pages 2-1, 2-3, 2-25, and 2-54, revision 0	Replace with Section 2, pages 2-1, 2-3, 2-25, and 2-54, revision 1	Response to RAI
Section 2.12.1, revision 0	Replace with Section 2.12.1, revision 1	Response to RAI
Section 3, revision 0	Replace with Section 3, revision 1	Response to RAI
Section 4, revision 0	Replace with Section 4, revision 1	Response to RAI
Section 6, revision 0	Replace with Section 6, revision 1	Response to RAI
Section 8, page 8-3, revision 0	Replace with Section 8, page 8-3, revision 1	Consistency with General Plastics reported range

Table of Contents

Page

1.0 GENERAL INFORMATION

1.1 INTRODUCTION

The MAP package is designed to transport both Type A and Type B fissile material in the form of unirradiated nuclear fuel assemblies containing sintered uranium dioxide fuel pellets enriched up to 5.0 weight percent ^{235}U. The Criticality Safety Index (CSI) for the MAP is 2.8 when transporting fuel assemblies. The criticality assessment documented in Section 6 modeled a 36 package array for optimum conditions that remained below the derived Upper Safety Limit (USL) as further defined in Section 6[1]. The CSI value of 2.8 is based upon the HAC flooded gap results for an array of 36 containers listed in Table 6-23 and illustrated in Figure 6-30. The results show that $k_{eff} + 2\sigma$ for an array containing up to 36 packages satisfies the defined USL of 0.94 (Section 6.8.2). The bounding value occurs for a 5x6 array of packages containing Type 1a fuel assemblies with $k_{eff} + 2\sigma = 0.9380 \pm 0.0018 = 0.9398 < 0.94$. Sensitivity studies for packages containing the other fuel assembly types (Figure 6-31) verify that the Type 1a fuel assembly provides the bounding values for HAC conditions with flooded rod gaps. For an infinite array of packages under normal conditions, $k_{eff} + 2\sigma = 0.2127$ (Table 6-11).

1.2 PACKAGE DESCRIPTION

The major components of the MAP package are presented in Figure 1-1 through Figure 1-7. Detailed drawings are included in Appendix 1.3.1. There are two versions of the MAP packaging: the MAP-12 and the MAP-13. The primary difference between the two versions is the active fuel length of the payload assembly: the MAP-12 is used to ship 144" nominal active fuel and the MAP-13 is used to ship 150" nominal active fuel lengths. The packaging for the two versions is essential identical with the exception of the longer package length.

[1] For the 36 package array, 2N=36, N=18 and the CSI is derived by 50/18 which is rounded conservatively to 2.8.

1.2.1 Packaging

The MAP package is designed to carry two (2) PWR fuel assemblies. The package consists of two basic components: a Base and a Lid. A typical cross-section showing the components of the package is depicted in Figure 1-2 and Figure 1-3. Figure 1-2 is a cross sectional view of the package at the inner stiffeners of the Base and Lid. Figure 1-3 is a cross-sectional view of the package at the location of the moderator and absorber interface within the Base and Lid. The Lid includes independent impact limiters at opposite ends of the package. A close-up view of the package closure is shown in Figure 1-4.

1.2.1.1 MAP Base

The Base consists of a fixed stainless steel strong-back which supports the fuel assembly or Rod Container. The "W" shaped strong-back is secured in the Base using a riveted construction through a fiberglass thermal barrier. A series of inner stiffeners are secured to the underside of the strong-back to provide additional support to the fuel assembly during transport. A neutron moderator and absorber are positioned directly beneath the strong-back between each inner stiffener. The Base inner stiffeners are further retained by a stainless steel cover. The Base stiffener region is not filled with polyurethane foam; however, this volume of the package is sealed from the elements. Each stiffener is perforated to reduce weight and prevent partial flooding of the region during HAC.

Exterior to the cover is a layer of rigid polyurethane foam and an outer shell of 11 gauge stainless steel. An additional 12 gauge stainless steel sheet is provided between the two middle stiffeners to provide local protection against HAC puncture. Four stainless steel outer stiffeners support the package Base and further allow stacking.

The payload rests on the "W" shaped strong-back (referred to as a W-plate) and is held in place with hinged and latched aluminum doors. Inserts are used, as necessary, to provide support for shorter fuel assembly designs at the upper and lower end fittings of the Fuel Assembly. A hold-down bar provides positive axial pressure on the upper end fitting to prevent shifting of the payload during shipment.

1.2.1.2 MAP Lid

The construction of the MAP Lid is very similar to that of the Base – a "W" shaped stainless steel inner shell is fitted with a series of inner stiffeners, neutron moderator and absorbers, and a stainless steel cover is fitted over the stiffeners. A layer of rigid polyurethane foam provides impact and thermal protection and the outer shell of the packaging is fabricated using 11-gauge stainless steel. An additional 12 gauge stainless steel sheet is provided between the two middle stiffeners to provide local protection against HAC puncture. Unlike the inner stiffeners in the Base of the package, the Lid inner stiffeners are not fully imbedded in the polyurethane foam. The outer stiffeners on the Lid are offset from the Base outer stiffeners to allow for stacking, and are reinforced at the package lift points.

The MAP Lid is fitted with trapezoidal impact limiters at each end. The impact limiters are constructed from rigid polyurethane foam encased by the package outer stainless steel skin. Both the Base and the Lid include end plates with interfacing angles. These angles interlock when the package is assembled, providing strength to the closure and limiting fire ingress during HAC. Figure 1-5 shows a lengthwise cross sectional view. Figure 1-6 provides an enlarged view of the end impact limiters. Figure 1-7 shows an enlargement of the interlocking angle of the Base with the end impact limiters of the Lid.

The polyurethane foam in the Lid and Base is insulated from the outer shell with two layers of ceramic fiber paper. The Lid and Base for a stepped joint with a fibrous high temperature seal and closure using ball lock fasteners.

1.2.1.3 MAP Materials of Construction

The MAP is primarily constructed from: stainless steel, aluminum, and rigid polyurethane foam. Other materials used are fiberglass reinforced polyester resin, refractory insulation, Nylon 6,6 and borated metal matrix composite. Each end impact limiter contains 10 lb/ft^3 polyurethane foam. The balance of the polyurethane foam used is 6 lb/ft^3. The foam is rigid, closed cell polyurethane that is an excellent impact absorber and thermal insulator and has well defined characteristics that make it ideal for this application. Fiberglass strips and a fibrous high temperature seal provide a thermal barrier between the exterior shell and the strong-back. The neutron absorber consists of a borated metal matrix composite in the form of a thin plate. Blocks of Nylon 6,6 are used as a neutron moderator. This thermoplastic is self-extinguishing and has a relatively high melting point. The neutron moderator and absorber are significant components used for criticality safety. Further discussion is presented in Section 6, Criticality Evaluation, and Section 8, Acceptance Tests and Maintenance Program.

1.2.1.4 Containment System

The Containment System for the MAP is the fuel rod cladding. Requirements for containment are described in Section 4.

1.2.1.5 Package Weights and Dimensions

MAP-12 (144-in Nominal Fuel Length)

- Maximum Gross Weight — 8,630 pounds (3,923 kg)
- Maximum Payload Weight — 3,400 pounds (1,545 kg)
- Overall Outer Dimensions — 208" x 45" x 31" high (5,283 mm x 1,143 mm x 787 mm)

MAP-13 (150-in Nominal Fuel Length)

- Maximum Gross Weight — 8,630 pounds (3,923 kg)
- Maximum Payload Weight — 3,400 pounds (1,545 kg)
- Overall Outer Dimensions — 221" x 45" x 31" high (5,613 mm x 1,143 mm x 787 mm)

NOTES, UNLESS OTHERWISE SPECIFIED:

1. INTERPRET DRAWING PER ASME Y14.5M. INTERPRET WELDS PER ANSI / AWS 4.
2. WELDING PROCEDURE AND QUALIFICATION SHALL BE PER AWS D1.2, D1.6 OR ASME SECTION IX. ALL WELDS SHALL BE VISUALLY INSPECTED ON THE FINAL PASS. NO UNDERCUT OF MINIMUM MATERIAL THICKNESS IS ALLOWED.
3. SPLICE WELDS FOR STAINLESS STEEL SHEETS ARE NOT SHOWN, BUT MAY BE UTILIZED AND SHALL BE FULL PENETRATION BUTT WELDS GROUND FLUSH ON BOTH SURFACES.
4. UNLESS OTHERWISE SPECIFIED, FILLET WELD LEG SIZE IS THE MINIMUM BASE METAL THICKNESS.
5. NON-STRUCTURAL SEAL WELDS MAY BE USED AS REQUIRED AND ARE NOT SHOWN.
6. ANY CREVICES NOT SEAL WELDED MAY BE SEALED WITH A WEATHER RESISTANT MATERIAL.
7. ALIGN ANTI-TAMPER BRACKET, (ITEM 8) WITH BOTTOM EDGE OF OUTER LID SPACER.
8. DIMENSION STACK; UPPER DIMENSION REFERS TO THE LONG CONFIG. MAP-13, LOWER DIMENSION REFERS TO THE SHORT CONFIG. MAP-12. WHERE ONE DIMENSION IS SHOWN, IT IS THE SAME FOR BOTH CONFIG.
9. SHIPPING: A MINIMUM OF TWO LATCHES IS REQUIRED ON DOORS. FOUR LATCHES ON END DOORS OF PACKAGE MUST BE IN LATCHED POSITION.
10. MINIMUM STRENGTH OF RETENTION DEVICE IS 4,400 LB.
11. MAXIMUM SPAN BETWEEN DOORS OF 4-INCHES.

QTY	ITEM NO.	PART NO.	DESCRIPTION	SPECIFICATION
14	1		SHEET, .09 THK (13 GA)	ASTM A240, A276 TYPE 304
A/R	2		SHEET, .12 THK (11 GA)	ASTM A240, A276 TYPE 304
16	3		SHEET, .14 THK (10 GA)	ASTM A240, A276 TYPE 304
4	4		SHEET, .10 THK (12 GA)	ASTM A240, A276 TYPE 304
40	5		BAR OR PLATE, 1.0 X 17.0 X 2.3	ASTM B209, B211 OR B221, 2024-T351
A/R	6		SHEET, .13 THK (10 GA)	METAL MATRIX COMPOSITE - BORAL
A/R	7		SHEET, .13 THK (10 GA)	ASTM B209 ALUM ALY 6061-T6
4	8		SHEET, 3.3 X 11.5 X .188 THK	ASTM 240, TYPE XM-19
40	9		PLATE OR BAR, 1.0 X 1.0 X 2.7 LG	ASTM A564, TYPE 630 COND H1100
10	10		BAR ROD, 1.0 DIA X 10.52 LG	ASTM A564, TYPE 630 COND H1100
6	11		ANGLE, .75 X .12 THK	ASTM A240, A276 TYPE 304
6	12		ANGLE, 1.0 X .12 THK	ASTM A240, A276 TYPE 304
8	13		ANGLE, 1.5 X .19 THK	ASTM A240, A276 TYPE 304
2	14		ANGLE, 5.0 X .38 THK	ASTM A276 TYPE 304
2	15		ANGLE, 4.0 X .25 THK	ASTM A276 TYPE 304
20	16		BAR OR PLATE, 1.50 X .50 THK	ASTM A240, A276 TYPE 304
1	17		BAR OR PLATE, 1.75 X .75 THK	ASTM A240, A276 TYPE 304
1	18		BAR OR PLATE, 3.0 X 4.5 X 32.5	ASTM B209, B211 OR B221, 6061-T6
2	19		BAR OR PLATE, 4.2 X 6.0 X 1.8 THK	ASTM A240, A276 TYPE 304
1	20		BAR OR PLATE CENTER, 2.2 X 3.3 X 6.5	ASTM A240, A276 TYPE 304
A/R	21		BAR OR PLATE, 7.9 X 35.0 X .12 THK	ASTM B209, 6061-T6
20	22		PLATE, .7.9 X 35.0 X .25 THK	ASTM B209, 6061-T6
1	23		PLATE, .25 THK	ASTM A240, A276 TYPE 304
28	24		PLATE, 1.5 X 5.0 X .25 THK	ASTM A240, A276 TYPE 304
4	25		PLATE, 1.5 X 11.3 X .25 THK	ASTM A240, A276 TYPE 304
8	26		PLATE, 3.7 X 11.0 X .25 THK	ASTM A240, A276 TYPE 304
20	27		AA CHANNEL, 2.0 X 1.0 X .13 THK	ASTM B209, B211 OR B221, 6061-T6
2	28		CHANNEL, 2.0 X .25 THK	ASTM A240, A276 TYPE 304
8	29		Z-BRACKET, 2.0 X 6.0 X .12 THK (11 GA)	ASTM A240, A276 TYPE 304
80	30		L-BRACKET, 1.0 X 1.25 X 2.0 X .125 THK (11 GA)	ASTM A240, A276 TYPE 304
20	31		END PLATE, 1.0 X 2.0 X .12 THK	ASTM B209, 6061-T6
2	32		BRACKET, ANTI-TAMPER .19 THK	ASTM A240, A276 TYPE 304
40	33		PLATE OR BAR, 1.0 X 1.3 X 3.0 LG	ASTM 564, TYPE 630 COND H1100
2	34		TEE, 3.0 X 3.0 X .25 THK	ASTM 554, TYPE 304
4	35		TUBE, 1.50 X .12 WALL	ASTM 554, TYPE 304
3	36		ROD BAR 1 1/8 DIA X 3.0 LG	ASTM 564, TYPE 630 COND H1100
A/R	37		SHEET, .13 THK	NYLON 66
10	38		ANGLE, 1.0 X .13 THK	ASTM A240, A276 TYPE 304
4	39		BAR ROD, 1.5 DIA X 1.0 LG	ASTM A240, A276 TYPE 304

REVISION HISTORY

REV.	DESCRIPTION	REL	DATE
0	INITIAL RELEASE		

REL	
APPD	
APPD	
ENGR	
QA	
CHECK	
DRAWN	PETE PIKULIN

AREVA NP INC

UNLESS OTHERWISE SPECIFIED:
INTERPRET DRAWINGS & TOLERANCES PER ASME Y14.5M
INTERPRET WELD CALLOUTS PER ANSI/AWS A2.4
DIMENSIONS ARE IN INCHES

MACHINE TOLERANCES:
FRACTIONS ± 1/4 ANGLES ± 5° 3 PLACE DECIMALS ± .1 2 PLACE DECIMALS ± .5 1 PLACE DECIMALS ± 1.0

WELD & FORMED TOLERANCES:
FRACTIONS ± 1/4 ANGLES ± 5° 3 PLACE DECIMALS ± .5 2 PLACE DECIMALS ± 1.0 1 PLACE DECIMALS ± 2.0

SCALE: [illegible] WT: LB [illegible]
REV 1 SHEET [illegible]
DWG SIZE D DWG NO 9045393

NOTES, UNLESS OTHERWISE SPECIFIED: CONT'D

12. HINGE AND BOLT MAY BE REPLACED WITH EQUIVALENT STRENGTH FASTENERS.

13. STENCIL INSTRUCTION: MARK USA/9319/B(U)F-96, TYPE B, IN HALF INCH HIGH OR LARGER LETTERS ON EXTERIOR SIDE OF ASSEMBLY IN APPROXIMATE AREA.

14. MARK A STAINLESS STEEL NAMEPLATE WITH THE FOLLOWING DATA:
USA/9319/B(U)F-96, MODEL MAP XX (12 OR 13)
MAXIMUM GROSS WEIGHT: 8,630 LB (3,923 KG)
SERIAL NUMBER: (SUPPLIES BY AREVA NP INC)

15. POLYURETHANE FOAM (ITEM 46, 47, AND 75) MAY BE MACHINED FROM BLOCKS OR POURED IN PLACE. IF POURED IN PLACE, A COVER PLATE EQUAL TO THE SHELL THICKNESS, 1 INCH LARGER IN DIAMETER MAY BE USED TO COVER THE FOAM POUR HOLES THAT MAY BE UP 4 INCHES IN DIAMETER

16. ADJUSTABLE HINGE AND LATCH MAY HAVE SPACERS UNDER EACH FOR ADJUSTMENT.

17. INTERNAL STIFFENER, (ITEM 3) 10 GAGE PLATE MAY BE NOTCHED AS REQUIRED TO CLEAR THETHREADED HINGE AND LATCH EOLT BLOCKS (ITEM 16)

18. GASKET (ITEM 40 AND 41) IS ASSEMBLED BY FULLING 1 INCH BRAIDED SLEEVING THROUGH 1.5 INCH BRAIDED SLEEVING. HIGH TEMPERATURE BRAIDED SLEEVING SHALL HAVE A WORKING TEMPERATURE OF 1,800 °F

19. ADHESIVE MAY BE USED TO MOUNT NEOPRENE (ITEM 42 AND 49)

20. MISCELLANEOUS HARDWARE, SUCH AS PLACARD HOLDERS, NAME PLATES, ACCELEROMETERS AND HOLDERS ARE FOR HANDLING AND CUSTOMER INTERFACE. THE NUMBER LOCATION AND DESIGN OF THESE ITEMS ARE OPTIONAL. THEREFORE, THEY ARE NOT ITEMIZED ON THESE DRAWINGS.

21. PRESCRIBED TOLERANCE DOES NOT APPLY TO REFERENCE DIMENSIONS SHOW IN PARENTHESIS.

QTY	ITEM NO.	PART NO.	DESCRIPTION	SPECIFICATION
2	40		GASKET, 1.0 X .065 WALL	WESTERN INDUSTRIAL CERAMICS
2	41		GASKET, 1.5 X .035 WALL	WESTERN INDUSTRIAL CERAMICS
A/R	42		RUBBER PAD, 1/8 THK	NEOPRENE 40 DURO
44	43		1.25 THK	NYLON 66,
4	44		525 OR 625 EXTREN FIBERGLASS, ANGLE	4.0 X .25 THK
A/R	45	1535-L	CERAMIC FIBER PAPER, LYTHERM	LYDALL, 68.0 X .25 THK
A/R	46		POLYURETHANE, FOAM, UPPER	6 LB/CUFT
A/R	47		POLYURETHANE, FOAM, LOWER	6 LB/CUFT
30	48	4464K225	HALF COUPLING, 3/4 NPT	McMASTER-CARR OR EQUIV.
A/R	49		RUBBER PAD, 1/4 THK	NEOPRENE 40 DURO
176	50		FASTENER, THREAD CUTTING, #8 X 1.5 LG	STAINLESS STEEL
4	51		ANGLE, 1.5 X .125	ASTM A276 TYPE 304
10	52	MS20001-16	HINGE	
178	53	CR2563-8-6	1/4 RIVET	WIREDRAW CHERRYLOCK RIVET OR EQUIV
A/R	54	CR2162-6-8	FLAT HEAD RIVET, 3/16	WIREDRAW CHERRYLOCK RIVET OR EQUIV
368	55	SD814BS	1/4 POP RIVET, BLIND	HANSON OR EQUIVALENT
30	56	P-68V	PLASTIC THREADED PLUG	CAP PLUG OR EQUIV.
176	57		FASTENER, THREAD CUTTING, #8 X 1.5 LG	STAINLESS STEEL
20	58	90298A859	SHOULDER SCREW, 3/4 X 6.0 LG	McMASTER-CARR OR EQUIV.
160	59		FL HD SOC 1/4-20 UNC X 1.0 LG	ASTM F835, Zn PLATED
320	60		FL HD SOC 5/16-18 UNC X .75 LOG	ASTM F835, Zn PLATED
3	61		SOC HD CAP SCR, 1/2-13 X 3.0 LG	ASTM A574, Zn PLATED
184	62	CR2562-8-9	FLAT HD 1/4 RIVET	WIREDRAW CHERRYLOCK RIVET OR EQUIV
160	63		FLAT WASHER, HARDENED 1/4	ASTM 436, Zn PLATED
160	64		HEX NUT, 1/4-20 UNC	ASTM 194, GRADE 2H, Zn PLATED
10	65		FLAT WASHER, 3/8	
10	66		HEX NUT, 3/8-16 UNC	STAINLESS STEEL
20	67		HEX NUT, 5/8-11 UNC	STAINLESS STEEL
2	68		525 OR 625 EXTREN FIBERGLASS, ANGLE	2.0 X 1/4 OR EQUIV.
40	69	40-663WB	HEAVY DUTY ADJUSTABLE LATCH	PROTEX FASTENERS LTD OR EQUIV.
36	70	RSL0.625-1.500-174-01	"R" STYLE BALL LOCK PIN	BIG SKY PRECISION INC. OR EQUIV. CRES
12	71	RSL0.625-1.250-174-01	"R" STYLE BALL LOCK PIN	BIG SKY PRECISION INC. OR EQUIV. CRES
6	72	CL-5811-SKS	KEY INSERTS, 5/8-11	CARR-LANE
	73			
	74			
A/R	75		POLYURETHANE, FOAM IMPACT LIMITER	10 LB/CUFT

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was also no significant damage to the interior of the package including the neoprene supports for the assembly.

A visual inspection of the fuel rods in the CTU did not identify any bent or damaged rods. The test assemblies were removed from the CTU and further inspected, and no cracked or breached rods were identified visually. Thirty-five (35) days after completion of the drop tests, a random sample of rods from the most damaged assembly were checked for pressurization. The rods were punctured by inserting the fuel rod into a holding block and tightening a screw into the cladding until the cladding was breached. All rods were found to be pressurized as evidenced by a steady, audible gas release from the cladding as it was punctured. Since all of the rods sampled were found to be pressurized and the rods provided a representative sample of the worst case damage to the fuel rods, and there was no visible crack or breach in any of the test rods, it was concluded that no rod breach or leakage occurred as a result of the performance tests.

Further HAC fire testing also had no effect on the cladding. The interior of the package was coated with tars as a result of the condensation of foam off-gas; however the fuel rods, being covered by a thin sheet of polypropylene, remained in their as fabricated bright condition.

Visual inspection of the fuel rod cladding after the drop and thermal test performed for the MAP package demonstrated that the containment boundary (fuel rod cladding) remained intact and leak-free during all normal and hypothetical accident conditions. The immersion tests further specified in 10 CFR 71 (c)(5) for fissile and (6) for all packages, require immersion equivalent to an external water pressure of 21.7 lb/in^2, however intact and leak-free rods can tolerate much higher pressures and remain internally dry. As a result, the immersion tests were not performed. From these results it is also feasible to model the fuel rod fuel-cladding gap as moderator free. However, to meet the regulatory requirement without a special provision for an exemption, the criticality assessment calculations include water flooding in the fuel-cladding gap.

2.12.1.6 Certification Test Unit Description

This section describes the certification test units and simulated payload used for the normal conditions of transport (NCT) and hypothetical accident condition (HAC) tests performed in accordance with 10 CFR §71.

2.12.1.6.1 Certification Test Units

Certification tests of the MAP packaging utilized full-scale CTUs that were fabricated, inspected, and received in accordance with quality procedures.

Through the design and fabrication process, a single design was proposed and three (3) certification test units were fabricated in accordance with an NRC approved quality assurance program. The drawings presented in Appendix 1.3.1, *Packaging Drawings*, fully represent the design of these CTUs.

Additional weight was added to each CTU both internally and externally to increase the weight and provide margins for fabrication. The gross package test weight of each CTU was 8,630 lb.

Stainless steel double plates were added to the lid and base of CTU 3 prior to the lid oblique puncture test. This added 150 lb to the unit. It was clear from the three (3) 30 foot drop tests that the package integrity was not challenged, and the small additional weight (1.7%) from the doubler plates would not alter these results. The production packages will require doubler plate installation. This increases the gross package weight to 8,780 lb. Sufficient weight margin exists in the gross package tested weight of 8,630 lb such that the increased weight of the double plates does not need to be included during the initial package approval. However, this margin may need to be licensed at a later date to facilitate shipment of all fuel assembly designs in the MAP-13 package.

2.12.1.6.2 Simulated Payload

Each CTU was loaded with a dummy fuel assembly and a ballast weight. The fuel assembly design selected for testing was chosen due to its weaker structure, thinnest rod and cladding wall thickness of all current AREVA NP Inc. designs. Certification testing of the package with a fuel assembly with the above traits is likely to lead to more fuel assembly damage in all drop test orientations considered. The weaker structure is likely to lead to more assembly lattice expansion and more rod movement during the drop tests increasing the potential for rod bending and subsequent failure. The thinner rod and cladding wall thickness is also likely to increase the potential for rod bending and subsequent failure.

Each rod was loaded with Tungsten Carbide (WC) pellets with dimensions and density similar to current uranium oxide fabricated pellets. Two different rods were loaded for testing; 1) Rods with a 24" WC section in the bottom of the rod followed by 10-12" sections of lead rod followed by a WC pellet cap producing a 144" nominal length material zone, and 2) Rods loaded entirely with WC pellets producing a 144" nominal length material zone. In prior drop tests, rod bending was observed in the bottom section of the assembly generally between the end fitting and the first grid. The 24" WC section will provide ample coverage for rod bending within this region. However, rods loaded entirely with WC pellets will identify any performance differences. Based on the tests documented in Section 2.12.1.4, there appeared to be no observable performance differences between either rods design.

All rods were pressurized with Helium gas to the maximum design pressure for the tested assembly type, 225 +0/-15 psig. Following the 10 CFR 71 HAC performance tests, no leakage was observed. Thus, the post-test leakage rate is the same as the pre-test leakage rate (on the order of 1E-07 ref-cc/s) and the expected leakage rate is much less that the allowable post-HAC leakage rate (2.25E+3 ref-cc/s assuming aerosol leakage) as calculated in Section 4. Thus, there is significant margin to the allowable leakage rate.

The use of WC pellets as a non-fuel replacement for uranium oxide pellets in axially oriented drop tests will conservatively envelope the dynamic response of uranium pellets. WC is harder, stronger in compressive strength and has a higher elastic modulus as compared to uranium oxide pellets. In a pure axial rod drop test these properties would make the use of WC produce at least equivalent and probably greater impact loads than uranium oxide pellets. The WC pellets used in rod fabrication do not have dished or chamfered ends as compared to uranium pellets such that movement of the WC pellet within the rod is more likely to engage the cladding and lead to more damage due to its sharper edges. In an axial drop test, the major parameter to reproduce is the mass in the clad. Mass per unit length is probably a second-order effect. In this case, WC is an appropriate replacement for uranium pellets. Should there be any lateral forces induced into the drop test, then pellet diameter, length, and mass per unit length need to be duplicated so that the cladding support, and hence the fuel rod lateral dynamics, will be reproduced. The higher density, higher modulus and higher compressive strength will cause more clad damage than uranium pellets. This will increase the conservatism of the test.

The weight of each dummy fuel assembly was increased by loading of lead in the guide and instrument tubes. This additional weight increases the likelihood of damage to the fuel assembly in either lateral or axial drop orientations. The lead did not increase the stiffness of the fuel assembly. A ballast weight consisting of stacked 1.5" steel plates and 5/8" steel threaded rod was used to simulate a second assembly and also add additional weight to the package. The fuel assembly and ballast weights were shimmed within the package fuel cavity. The total weight of fuel assembly and ballast was 3,400 lb as loaded into each CTU for package certification testing.

The packaging used for low-enriched commercial grade uranium dioxide is the same as the packaging used for the BLEU material. Additionally, the leak tests used to confirm the integrity of the BLEU fuel rods to a rate less than 1E-07 ref-cc/sec is the same as the leak tests used for the low-enriched commercial grade rods. Thus, the leakage rate of the low enriched commercial grade material following the 10CFR71.73 HAC sequence of tests is expected to be the same as that demonstrated for the BLEU material. Since the leakage requirement for low enriched uranium dioxide is no dispersal, the limit established for the package based on BLEU material bounds the limit for the low-enriched commercial grade material.

4.2.2 Pressurization of Containment Vessel

The containment boundary of the package is defined as the fuel rod cladding, and each fuel rod is internally pressurized with helium to a pressure ranging from 145 to 450 psig. Assuming the rod is filled at 68°F and attains a temperature of 131°F during Normal Conditions of Transport, the maximum internal pressure attained is 506 psig (a maximum increase of 56 psig) as calculated in Section 3.3.2 for the normal hot condition as described. The payload is a stable solid-form material to temperatures well above the Normal Hot condition; therefore, pressurization due to form changes, chemical reactions, or destabilization of the payload is not credible.

4.2.3 Containment Criterion

For the Type B payload specified by Tables 1-1 and 1-2, the maximum allowable leakage rate is 0.377 ref-cm^3/sec as bounded by the Normal condition. However, ANSI N14.5-1997 specifies 0.100 ref-cm^3/sec as an upper limit on the maximum allowable leakage rate; therefore, the maximum allowable leakage rate for the Type B payload is 0.100 ref-cm^3/sec. Leakage tests are performed on each rod fabricated to confirm the containment boundary leakage rate is less than 1E-07 ref-cc/sec prior to shipment.

4.3 Containment Requirements for Hypothetical Accident Conditions (HAC)

4.3.1 Fission Gas Products

Fission gas products are not present in the contents to be transported in the MAP.

4.3.2 Containment of Radioactive Material

The package contents, as defined in Section 1.2.2 are assumed to be completely releasable in solid form. The total radioactivity contained in the package is variable, depending upon the payload.

4.3.2.1 Type A Shipments

The containment criteria under HAC (delineated by 10CFR71.73) for the Type A payload requires no loss or dispersal of the radioactive contents. The performance testing discussed in

6.2.1.4 Neutron-Moderating Materials

Neutron-moderating materials in the MAP include materials of construction and moderator blocks that are part of the flux trap system and enhance the effectiveness of the borated plates.

6.2.1.4.1 Materials of Construction

6.2.1.4.1.1 Polyurethane Foam

Polyurethane foam has potential to act as a neutron moderator/reflector due to its hydrogen and carbon content. Chemically, polyurethane reduces to $C_3H_8(NO)_2$ and has a density of approximately 6 lbs/ft^3 (0.096 g/cm^3).

6.2.1.4.1.2 Neoprene

As a protective padding, neoprene is affixed to the bottom 'W' plate where the fuel assembly rests and on the aluminum door panels that keep the assembly firmly in place. Neoprene has a chemical formula for the monomer unit of C_4H_5Cl and a density of approximately 1.28 g/cm^3. The presence of chlorine indicates that neoprene will act as a slight absorber rather than a moderator.

6.2.1.4.1.3 Nylon in Spacers

There are small beveled nylon spacer blocks that reside within stainless steel carriers that extend downward from the inner part of the lid where the lid stainless steel 'W' plates meet in the lateral center of the container. There are 5 of these blocks spaced incrementally over the axial length of the package.

6.2.1.4.2 Moderator in Flux Trap

The Nylon used in the MAP series of packagings consists of Nylon 6,6. Nylon 6,6 is a polymer consisting of a series of bonded chains with a simplified compound structure of $C_6H_{11}NO$. Nylon 6,6 is so named because it is synthesized from two different organic compounds, each containing six carbon atoms.

Moderator blocks are attached to the outer surfaces of the borated plates and reside within the top and bottom portions of the Outer Cavity. The minimum thickness of the blocks (i.e. portions that are not beveled) is 1.25 inches (3.18 cm). The moderator is fixed in place with the neutron absorber to form the flux trap system. Many portions of the blocks have bevels at one or more surfaces. Therefore, some parts of the borated plates are not covered by the maximum thickness of moderator. Nylon 6,6 is modeled at a nominal density of 1.14 g/cm^3.

Nylon 6,6 has a manufactured density ranging from 1.13 to 1.15 g/cc. The minimum thickness (1.25") used in the MAP package is not influenced by manufacturing tolerances. Typical manufactured thicknesses range from 1.26" to 1.28". The material is a thermal-plastic with a very high melting temperature ranging from 482 to 509 °F. The flash ignition temperature for the material is about 752 °F.

Nylon 6,6 is a polymer widely used in commercial structural applications including automotive, furniture, power tool housings, and lawn and garden equipment. It is suitable for packaging applications due to it hardness, abrasion resistance, self-extinguishing ability, and high melting and flash ignition temperatures. Additional information on Nylon can be found in the Nylon Plastics Handbook, Melvin I Kohan, 1995, Hanser Gardner Publications. Manufacturing data sheets are also available that describe commercially available Nylon. Additional information can also be found via internet search.

6.2.1.5 Floodable Void Spaces

The MAP packaging and contents contain four floodable regions. These regions have been modeled in various flooding combinations in order to determine the most conservative accident configuration. The floodable regions are shown in Figure 6-4. Flooding is specifically addressed in Section 6.7.1. Note that the fuel-clad gap within the fuel rods in the fuel assembly is <u>not</u> considered as floodable, per the actual as-found condition after HAC testing, which is discussed in

- The lower and upper stainless steel 'W' plates (boundaries of the Fuel Cavity) are modeled at 0.13 and 0.085 inch, respectively, rather than nominal thicknesses of 0.14 inch (10GA sheet) and 0.09 inch (13GA sheet).
- The stainless steel bar running along the container length is modeled with a width (x) and height (y) of 1.70 and 0.70 inch, respectively. This represents dimensional reductions of 0.05 inch which covers tolerances.
- The stainless steel 'shell' for the central spacer blocks attached to the top 'W' plate is modeled with thickness of 0.085 inch, rather than the nominal thickness of 0.09 inch for 13GA sheet. The steel sheet material for the axial ends of the individual spacers is not modeled.
- No other metal component of the packaging are modeled, such as aluminum (for the doors and latching mechanisms), or any other components containing stainless steel. The latter would include the axial end regions beyond the length covered by the flux trap (impact limiters, sheet material at the axial ends of the base and lid weldments, and associated angles, supports, welds, etc.), the outer stiffener spacers (two on lid and two on base), the inner stiffeners, and any other structural materials within the container itself (radial baffle plates, lid and base rails/supports, angles, supports, welds, bolts, nuts, washers, etc.).

Nylon

- The moderator blocks for the flux trap system are modeled with a uniform dimensional reduction that results in ~87% (see Tables 6-7 and 6-9) of the total moderator block volume for the flux trap being modeled. The method was to remove 0.0781 inch from all block faces with the exception of the faces contacting the absorber plates. The faces created due to the axial gaps between blocks are included. This resulted in a reduction in the lid moderator blocks of ~85% due to the larger surface area (bevels) as compared to the base moderator blocks that were reduced ~90%. The moderator material is modeled at full nominal theoretical density for Nylon 6,6 (1.14 g/cc).
- The thickness reduction bounds any effective loss of the nylon resulting from the thermal test (see Section 2.12.1) and due to any density variations.

- The criticality assessment considered both dimensional and density reductions with dimensional reductions leading to higher k_{eff} results. A variation in density (1.13 to 1.15 g/cc) has a negligible effect compared to a modeled reduction in the Nylon 6,6 thickness.
- The MAP design consisted of the Nylon 6,6 modeled at a reduced thickness crediting 85% of the material for the Lid and 90% for the Base. During the HAC fire test, a single segment in the Lid experienced a material loss of 6.6% (Table 2.13.1-5) based on the minimum design moderator requirement. There was no loss of moderator in the Base. Based on the results of the fire test, the 10% minimum reduction for the Nylon 6,6 moderator blocks bounds the loss experienced in a single segment. The modeled design configuration for the Nylon 6,6 moderator block is therefore very conservative with respect to the HAC test results for both the Lid and the Base. Thus, the criticality evaluation considers the most reactive credible configuration consistent with the damaged condition of the package and the chemical and physical form of the contents, and meets the requirements of 10 CFR 71.55.
- The beveled nylon blocks, which comprise the volume of the central spacer blocks, are included in the models. Each face of the nylon blocks had 0.0781 inch removed. This results in more moderator being removed in the lid as opposed to the base.

Boron

- The ^{10}B content in the borated absorber plates is modeled at 75% of the minimum areal density for BORAL® (0.0180 g/cm^2) as specified in Section 8.

Neoprene

- The neoprene padding on the bottom (base) 'W' plates is represented by full density water in the model. This is conservative because neoprene contains chlorine (chemical formula C_4H_5Cl) which is a relatively effective neutron absorber.

Polyurethane Foam

- The polyurethane is not modeled explicitly. Rather, the region it would normally occupy is interpreted as a floodable void space in which partial water densities are possible.

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8.1.4 Leak Tests

No leak tests of the packaging are required. The fuel rod weld joints are examined at the time of fuel rod fabrication and leak tested to ensure they are sealed. The welding and leak testing of fuel rods is performed during manufacturing using a qualified process. This process assures that the fuel is acceptable for use in a nuclear reactor core and is tightly controlled. The allowable leak rate is less than 1E-07 ref-cc/s.

8.1.5 Component and Material Tests

8.1.5.1 Polyurethane Foam

The MAP packaging utilizes a closed-cell, polyurethane foam and must certified to meet the requirements and acceptance criteria for installation, inspection, and testing as defined in this section. The finished foam product shall be greater than 85% closed cell polyurethane plastic foam of the self-extinguishing variety of the density specified. The closed cell configuration will ensure that the foam will not be susceptible to significant water absorption. Nominal foam densities of 6 and 10 lb/ft^3 are used in the Package Body and Impact Limiters, respectively.

8.1.5.1.1 Density

Rigid polyurethane foam shall have a density per the following:

1.	Impact Limiter	9.5 lb/ft^3 min	11.5 lb/ft^3 max
2.	Package Body	5.7 lb/ft^3 min	6.9 lb/ft^3 max

8.1.5.1.2 Mechanical Proprieties

Exhibited foam compressive strength for 10% strain parallel to foam rise shall fall within the following range of values:

1.	Impact Limiter	316 psi min	383 psi max
2.	Package Body	136 psi min	164 psi max

8.1.7 Thermal Tests

The material properties utilized in Section 3, Thermal Evaluation, are consistently conservative for the Normal Conditions of Transport (NCT) thermal analysis performed. The Hypothetical Accident Condition (HAC) fire certification testing of the MAP package (see Section 2.12.1.4.4, *Thermal Test* and Section 3.0, *Thermal*) served to verify material performance in the HAC thermal environment. As such, with the exception of the tests required for specific packaging components, as discussed in Section 8.1.5, *Component and Material Tests*, specific acceptance tests for material thermal properties are not required or performed.

8.2 MAINTENANCE PROGRAM

This section describes the maintenance program used to ensure continued performance of the MAP package.

Visual inspection for damage of exposed surfaces will be performed before each use. Individual components will also be inspected as described in the sections below. If defects are found during inspection, the package will be segregated and dispositioned by standard site procedure before its next use.

8.2.1 Structural and Pressure Tests

The MAP packaging does not contain any structural or lifting/tiedown devices that require testing.

There is also no pressure testing requirement.

8.2.2 Leak Tests

The MAP packaging does not have any requirements for leak testing.

8.2.3 Component and Material Tests

8.2.3.1 Fasteners

Lock pins and threaded components shall be inspected prior to each use for damage. Damaged components shall be repaired or replaced prior to further use.

8.2.3.2 Braided Fibrous Sleeving

Prior to each use, visual inspection of the braided fibrous sleeving shall be performed for tears, damage, or deterioration. Unacceptable sleeving shall be replaced.

8.2.4 Thermal

No thermal tests are necessary to ensure continued performance of the MAP packaging.

Attachment B

Clarified Responses to NRC Request for Additional Information for Review of the Model No. MAP-12 and MAP-13 Packages

AREVA NP INC.
An AREVA and Siemens company

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AREVA NP Inc Clarified Responses to NRC Request for Additional Information
Docket No. 71-9319
Certificate of Compliance No. 9319
Model No. MAP-12 and MAP-13 Packages

Chapter 1.0 General Information

NRC Question 1-3:

Explain how the CSI value of 2.8 was obtained. Also explain the application of the CSI value to the loose fuel rod contents in the MAP package.

Section 1.1, page 1-1, of the application states the MAP'S CSI is 2.8 for fuel assemblies and loose fuel rods; however there is no criticality evaluation provided in the SAR for the loose fuel rods in the MAP package.

AREVA Response to Question 1-3:

The CSI value of 2.8 is based upon the HAC flooded gap results for an array of 36 containers listed in Table 6-23 and illustrated in Figure 6-30. The results show that $k_{eff} + 2\sigma$ for an array containing up to 36 packages satisfies the defined USL of 0.94 (Section 6.8.2). The bounding value occurs for a 5x6 array of packages containing Type 1a fuel assemblies with $k_{eff} + 2\sigma = 0.9380 \pm 0.0018 = 0.9398 < 0.94$. Sensitivity studies for packages containing the other fuel assembly types (Figure 6-31) verify that the Type 1a fuel assembly provides the bounding values for HAC conditions with flooded rod gaps. For an infinite array of packages under normal conditions, $k_{eff} + 2\sigma = 0.2127$ (Table 6-11).

Section 1 of the SAR has been revised to include this description.

Chapter 4.0 Containment

NRC Question 4-1:

Correct the inconsistency for the cladding leakage rate mentioned in Section 4.2.3, page 4-3, and in Section 8.1.4, page 8-2. Also specify the type of gas used for the leak test.

Section 4.2.3, says that "the containment boundary is less than 3E-08 ref-cc/sec." Section 8.1.4 says, "the leak rate is typically less than 1 E-7 atm-cm3/sec." The post fabrication leakage test for the fuel rods should be clearly and unambiguously stated in both sections.

AREVA Response to Question 4-1:

Corrections were made to pages 4-3 and 8-2 to standardize leakage rates in units of ref-cc/sec.

NRC Question 4-2:

Provide justification in the SAR that the cladding can withstand HAC in the form of drop test and fire test results, such that the containment boundary remains unbreached. Also, describe the condition of the cladding after being subjected to HAC.

Section 4.3.2.2 states: "The performance tests documented in Section 2 [of the SAR] demonstrates that no pellets are released from the cladding as a result of the postulated hypothetical accident conditions." Contrary to this statement no material could be identified in the SAR that describes the condition of the cladding after being subjected to HAC.

AREVA Response to Question 4-2:

Section 2.12.1 has been revised to include a description of the cladding following the HAC drop and fire tests:

A visual inspection of the fuel rods in the CTU did not identify any bent or damaged rods. The test assemblies were removed from the CTU and further inspected, and no cracked or breached rods were identified visually. Thirty-five (35) days after completion of the drop tests, a random sample of rods from the most damaged assembly were checked for pressurization. The rods were punctured by inserting the fuel rod into a holding block and tightening a screw into the cladding until the cladding was breached. All rods were found to be pressurized as evidenced by a steady, audible gas release from the cladding as it was punctured. Since all of the rods sampled were found to be pressurized and the rods provided a representative sample of the worst case damage to the fuel rods, and there was no visible crack or breach in any of the test rods, it was concluded that no rod breach or leakage occurred as a result of the performance tests.

Further HAC fire testing also had no effect on the cladding. The interior of the package was coated with tars as a result of the condensation of foam off-gas; however the fuel rods, being covered by a thin sheet of polypropylene, remained in their as fabricated bright condition.

Chapter 6.0 Criticality

NRC Question 6-2:

Justify the nomenclature "borated aluminum" as used to represent the commercial product BORAL®.

Traditionally, the term "borated aluminum" has been used to represent a solid solution containing boron. It has not been used to represent a composite of powders that are formed into an absorber material. The description given for BORAL® is the type expected for a composite material.

AREVA Response to Question 6-2:

The SAR has been revised to replace the use of "borated aluminum" with either "borated metal matrix composite" or BORAL.

SAR Drawing 9045393 has also been revised to replace the description of Item 6 "borated aluminum" with "METAL MATRIX COMPOSITE – BORAL".

NRC Question 6-3:

Justify the use of 90% credit given to the moderator block, and 100% theoretical density for the moderator nylon materials.

Section 6.4.5.1.3, states, "The moderator blocks for the flux trap system are modeled with a uniform dimensional reduction that results in 90% of the total moderator block volume for the flux trap being modeled." The staff is not familiar with the nylon in question. For example, helpful information would be the data source and how manufacturing tolerances and other variables would be expected to influence pertinent properties of moderator materials.

AREVA Response to Question 6-3:

Nylon 6,6 is a polymer widely used in commercial structural applications including automotive, furniture, power tool housings, and lawn and garden equipment. It is suitable for packaging applications due to it hardness, abrasion resistance, self-extinguishing ability, and high melting and flash ignition temperatures. Additional information on Nylon can be found in the Nylon Plastics Handbook, Melvin I Kohan, 1995, Hanser Gardner Publications. Manufacturing data sheets are also available that describe commercially available Nylon. Additional information can also be found via internet search.

The criticality assessment considered both dimensional and density reductions with dimensional reductions leading to higher k_{eff} results. A variation in density (1.13 to 1.15 g/cc) has a negligible effect compared to a modeled reduction in the Nylon 6,6 thickness.

The MAP design consisted of the Nylon 6,6 modeled at a reduced thickness crediting 85% of the material for the Lid and 90% for the Base. During the HAC fire test, a single segment in the Lid experienced a material loss of 6.6% (Table 2.13.1-5) based on the minimum design moderator requirement. There was no loss of moderator in the Base. Based on the results of the fire test, the 10% minimum reduction for the Nylon 6,6 moderator blocks bounds the loss experienced in a single segment. The modeled design configuration for the Nylon 6,6 moderator block is therefore very conservative with respect to the HAC test results for both the Lid and the Base. Thus, the criticality evaluation considers the most reactive credible configuration consistent with the damaged condition of the package and the chemical and physical form of the contents, and meets the requirements of 10 CFR 71.55.

NRC Question 6-4:

a) Explain the basis of the criticality safety evaluation under the assumptions that 1) it was based on moderator exclusion; and 2) that the fuel cladding gap was not floodable.

b) Justify the ability of the fuel cladding to retain its integrity after the HAC tests so as to achieve moderator exclusion.

Section 6.2.1 .I, page 6-5, of the SAR states that the containment system of the MAP packages consists of the fuel rod cladding. Section 6.4.2.1.1, page 6-16, of the SAR states: "The fuel-clad gap is modeled as void to represent a dry gap. The fuel-clad gap within the fuel rods in the fuel assembly is not considered as floodable based upon the HAC testing results, discussed in Section 6.4.5.4." This is not consistent with the requirements set forth in 10 CFR 71.55, which requires the package to be sub-critical even if water were to leak into the containment system.

AREVA Response to Question 6-4:

Visual inspection of the fuel rod cladding after (see Response to RAI 4-2) the drop and fire tests performed for the MAP demonstrate that the containment boundary (fuel rod cladding) remains intact and leak-free during all normal and hypothetical accident conditions. The immersion tests further specified in 10 CFR 71 (c)(5) for fissile and (6) all packages, require immersion equivalent to an external water pressure of 21.7 lb_f/in2, however intact and leak-free rods can tolerate much higher pressures and remain moderator free. Thus, moderators are not expected to flood the fuel-cladding gap.

10 CFR 71.55 (c) allows exemptions provided that no single packaging error would permit leakage and appropriate measures are taken before each shipment to ensure that the containment system does not leak. Leak tests are performed as part of the manufacturing process prior to shipment to ensure the containment boundary does not leak. Furthermore, assemblies are handled and packed with great care with no event postulated as being more severe than the HAC. However, to meet the regulatory requirement without a special provision for an exemption, the calculations are revised to include water flooding in the fuel-cladding gap.

NRC Question 6-6:

Provide an explanation on the behavior of the k_{eff} curves as a function of the package array size, in Figure 6-29.

Figure 6-29 shows the change of k_{eff} as a function of package array size with the FLIP1 configuration. From this figure, it can be observed that the k_{eff} value increases first, and then goes down as the number of packages increases. Finally, the k_{eff} value jumps from 0.9356 to almost 0.9420. This curve does not seem to be consistent with common understanding of the physics of a fissile system.

AREVA Response to Question 6-6:

The primary purpose of Figures 6-29, 6-30, and 6-31 is to show that arrays with up to 36 packages satisfy the USL. Plotting $k_{eff} \pm 2\sigma$ satisfies that purpose. However, such a presentation masks the statistical uncertainty and array configuration effects inherent in the results. Increasing the number of neutron histories reduces the statistical impact of the observed trend. Plotting the data versus similar array configurations, i.e., 4x and 5x, individually provides a better illustration of trends. However, essentially all array sizes, except the array of 40 containers, are statistically equal. Input cases are provided for information.

Attachment C

CD Electronic Copy
MAP-12/MAP-13 Package
Safety Analysis Report (SAR)

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