Amendment Process for the Mixed Oxide Fresh Fuel Package - 9388

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ABSTRACT

The United States Department of Energy's National Nuclear Security Administration (NNSA) is overseeing the construction the Mixed Oxide (MOX) Fuel Fabrication Facility (MFFF) on the Savannah River Site. The new facility, being constructed by NNSA's contractor Shaw AREVA MOX Services, will fabricate fuel assemblies utilizing surplus plutonium as feedstock. The fuel will be used in designated commercial nuclear reactors.

The MOX Fresh Fuel Package (MFFP), which has been licensed by the Nuclear Regulatory Commission (NRC) as a type B package (USA/9295/B(U)F-96), was originally licensed to transport the fabricated fuel assemblies from the MFFF to the nuclear reactors.

Due to the need for broader MFFP payload capabilities, it was necessary to submit an amendment to the Nuclear Regulatory Commission for the following possible transports:

1. Individual unirradiated MOX rods in the ARB-17 rod box. The ARB-17 is transported in an MFFP in place of a standard MOX fuel assembly.
2. Excess MOX rods and an excess material assembly (EMA) from the Eurofab lead test assembly campaign.
3. Los Alamos National Laboratory Test Area-18 (TA-18) MOX rods. These MOX rods fall in two categories: Pacific Northwest Laboratory (PNL) rods and Exxon rods.

This paper will describe the basis for these new payloads, the design and analysis of the rod boxes necessary to transport these items, and the safety analysis revision process including adherence to NRC Part 71 requirements.

INTRODUCTION

The Amendment Process

Transportation packaging for MOX fuel must conform to the requirements of 10 CFR 71, *Packaging and Transportation of Radioactive Material* [1]. A Safety Analysis Report (SAR) is generated to document that the packaging meets the applicable requirements of 10 CFR 71. The SAR is a summary of the testing and/or analysis performed to support the design. Disciplines include structural, thermal, shielding, and criticality. Also, information is provided on the contents, containment, operating procedures, and required maintenance. The MFFP currently has an active transportation license from the NRC.

The allowable contents in the original SAR were limited to intact MOX fuel assemblies. Fuel rods unattached to a fuel assembly were not allowed. Because a need has arisen to transport individual MOX rods, the license must be amended to allow individual rods as contents. Also, rod containers must be designed to contain the individual rods and interface with the existing design.

In order to minimize the impacts on the original SAR, the new information was added as separate appendices to the main SAR. Three appendices were developed. The AREVA Rod Box-17 (ARB-17) is described in Appendix A, the AREVA Federal Services-B (AFS-B) rod container and EMA are described in Appendix B, and the AREVA Federal Services-C (AFS-C) rod container is described in Appendix C. Each Appendix has eight chapters and follows the format of a standard SAR. Only new information unique to that Appendix is included in the amendment. Organizing the amendment in this manner facilitates document preparation and review. Alternately, all new information could have been integrated into the main body of the SAR. The SAR, including the three new appendices, was then submitted to the NCR for review. Although the NRC review was focused on the new appendices, any information in the original SAR is open for comment during the amendment process.

MOX FRESH FUEL PACKAGE

The MOX Fresh Fuel Package (MFFP) will be utilized to transport MOX fresh fuel assemblies via a conveyance from the MOX Fresh Fuel Facility (MFFF) to the Mission Reactors. The packaging is designed to provide a safe means of transporting up to three fresh MOX PWR fuel assemblies, with or without burnable poison rod assemblies (BPRAs) installed. Figure 1 delineates the major components of the MFFP and Figure 2 shows the Certification Test Unit of the MFFP used in the NRC 10 CFR Part 71 testing.

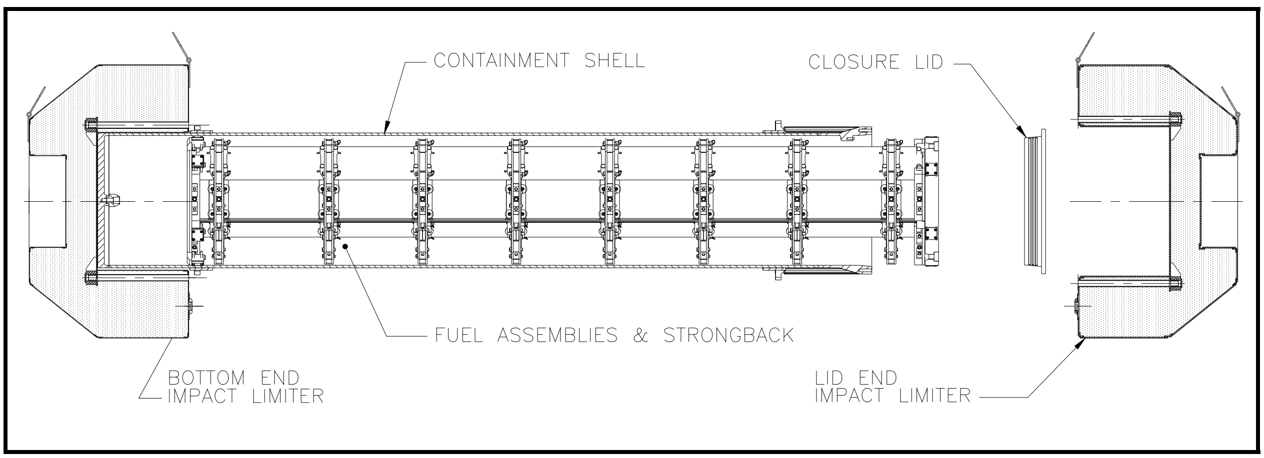

Figure 1. MOX Fresh Fuel Package

Figure 2. Certification Test Unit of the MFFP during Testing

The strongback, as shown in Figure 3, is where the fuel assemblies and the new rod boxes will be inserted and secured for transport.

Figure 3. MFFP Strongback

After approval of the MFFP license submittal by the NRC, it was recognized that additional payload configurations were needed to support the MOX Project transportation mission. Specifically, a need was identified to transport spare MOX rods instead of complete fuel assemblies and to provide an option for retrieving Excess Eurofab MOX rods stored at LANL. In addition, a rod box was designed to allow transport of LANL TA-18 MOX rods at the direction of DOE.

ROD BOX DESCRIPTIONS

ARB-17

The AREVA Rod Box (ARB)-17 is designed to transport up to 17 MOX rods. The ARB-17 itself is part of the contents and not part of the packaging. For shipping less than a total of three fuel assemblies and ARB-17 containers, non-fuel dummy fuel assemblies are utilized in the unoccupied strongback locations to balance the weight. Any combination of ARB-17, standard fuel assembly, and dummy fuel assembly is acceptable (e.g., 1 ARB-17 and 2 fuel assemblies; 1 ARB-17, 1 fuel assembly, and 1 dummy fuel assembly; 3 ARB-17s, etc.). The exterior enclosure of the ARB-17 consists of 1.9 cm (0.75 inch) thick stainless steel side walls with a 3.8 cm (1.5 inch) thick stainless steel top end closure plate and a 1.9 cm (0.75 inch) thick stainless steel bottom end closure plate. The outside envelope of the ARB-17 is 21.4 cm (8.43 inches) square by 406.02 cm (159.85 inches) long (not including the swivel hoist ring). A swivel hoist ring is mounted to the top of the ARB-17 to facilitate vertical handling.

Each ARB-17 may contain up to 17 MOX fuel rods, which may be either undamaged, slightly damaged, or a combination of both. Slightly damaged fuel rods may be bent, scratched, or dented, but under no circumstances may exhibit cladding breach. A 5.1 cm (2-inch), Schedule 40 pipe mounted with pipe clamps against one wall of the ARB-17 is used to transport both undamaged or slightly damaged fuel rods. Slightly damaged fuel rods may be transported within this pipe only if the bending in the fuel rod is minor. Examples of allowable ARB-17 loading are shown in Figure 4.

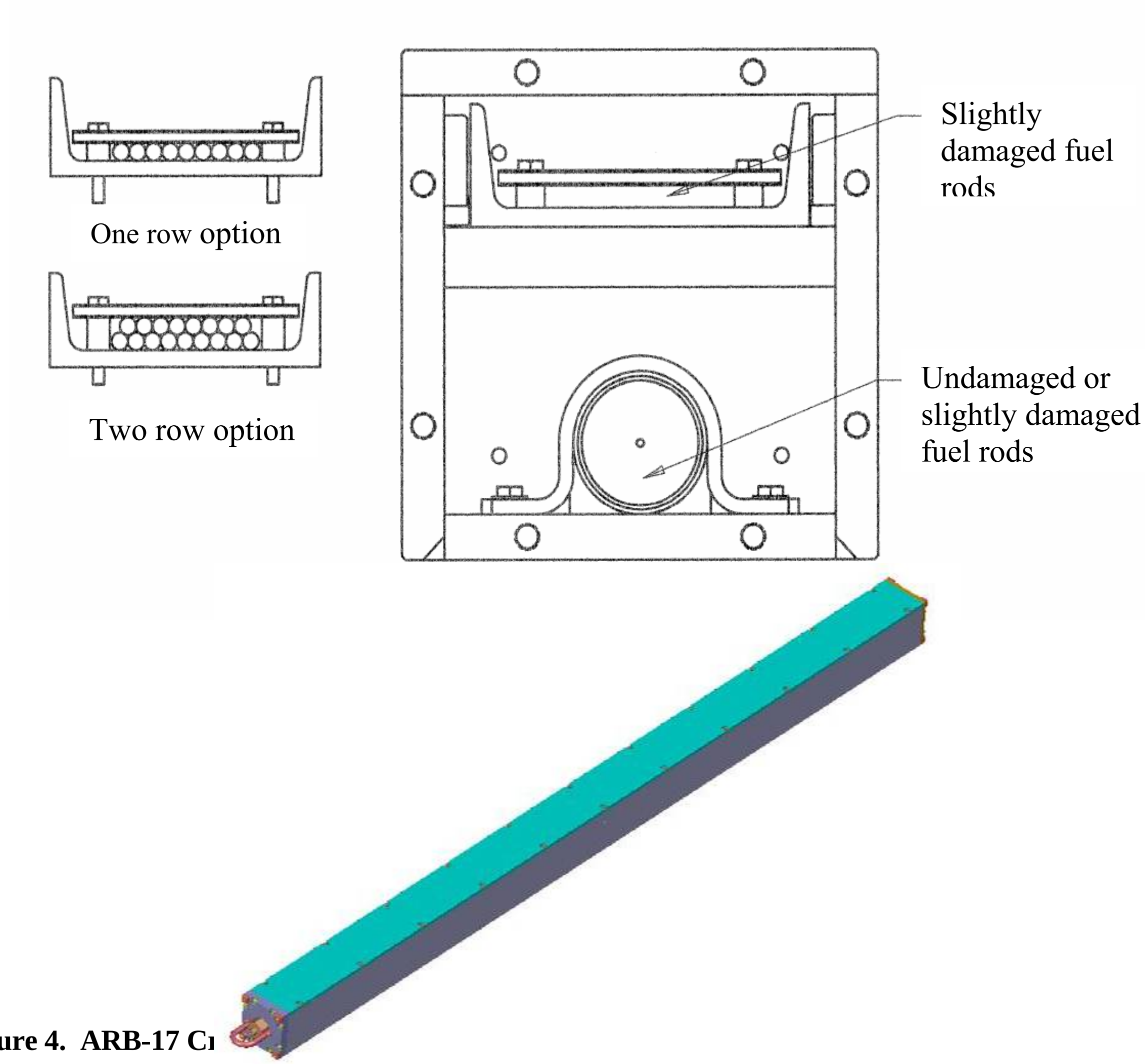

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Figure 4. ARB-17 C

A Buna-N rubber pad is used at the top of the fuel support pipe to cushion the ends of the fuel rods. To limit movement of the fuel rods during shipment, stainless steel dunnage rods are used as needed to fill the remaining void within the fuel support pipe (the pipe component may fit a maximum of 22 fuel and dunnage rods). Each undamaged fuel rod is inserted into a polypropylene sleeve that is 0.01 cm (0.004 inches) thick and ≤ 5.1 cm (2 inches) in circumference to prevent scratching of the cladding.

AFS-B Rod Box

The AFS-B rod container is designed to hold up to 175 MOX fuel rods of the type used in the MOX fuel assemblies. The container has outer cross sectional dimensions of 21.3 cm (8.4 inches) square, a length from bottom to top of 406.1 cm (159.9 inches), and an overall length (to the lift ring bolt head) of 409.4

cm (161.2 inches). The primary material of construction of the container is ASTM 6061-T651 aluminum alloy. The two side walls, the bottom plate, and the lid are all 1.9 cm (¾ inches) thick. The side plates are attached to the bottom plate with two longitudinal, 0.95 cm (3/8-inch) groove welds. The lid is attached with twenty-two (22) zinc-plated, 3/8-16 UNC, SAE J429 Grade 8, hex head cap screws. The two square end pieces are made of solid aluminum alloy, and each are attached to the container with eight (8) zinc-plated SAE J429 3/8-16 UNC hex head cap screws made of Grade 8 alloy steel. The lower square end piece is 6.1 cm (2.4 inches) thick and the upper square end piece is 7.6 cm (3.0 inches) thick. Each bolt is secured in place using a thin stainless steel lock tab. Two of the eight bolts on each end go horizontally into the lid, in addition to the 22 cap screws on the top of the lid. Figure 5 shows the external view of the AFS-B.

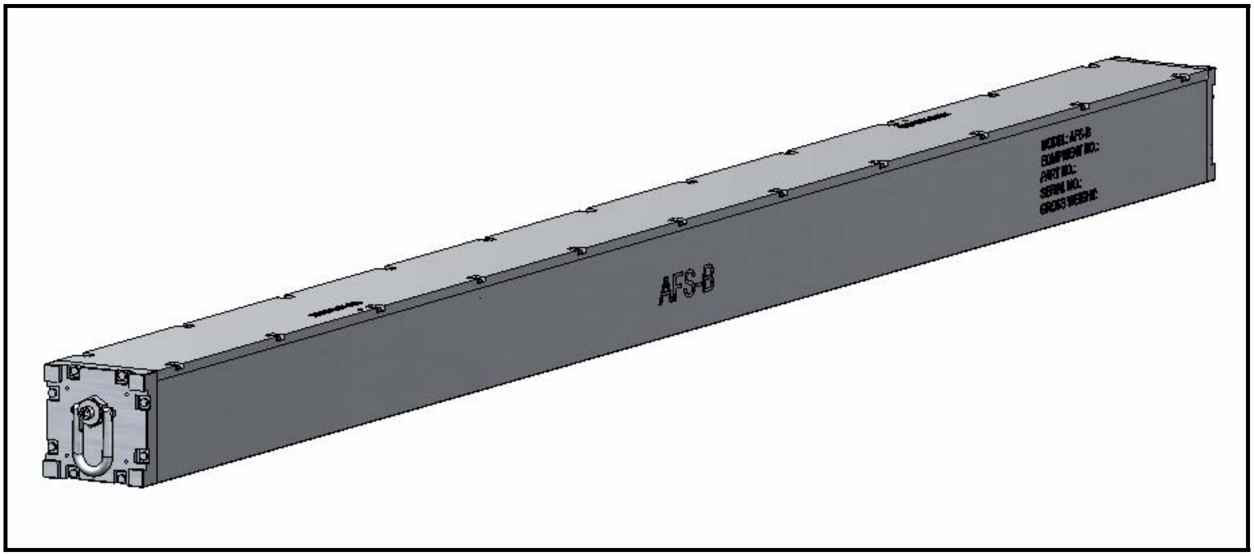

Figure 5. AFS-B Rod Box

Inside the container is a 1.3 cm (½-inch) thick shelf, made of the same aluminum alloy, which fits into 0.64 cm (¼-inch) deep grooves in each side wall. The shelf is supported by 0.64 cm (¼-inch) thick aluminum support plates on 38.9 cm (15.3-inch) centers. The region between the shelf and the lid is the rod cavity, which is 17.5 cm (6.9 inches) wide, 8.6 cm (3.4 inches) deep, and 389.9 cm (153.5 inches) long. The support plates and the shelf are located with intermittent 0.318 cm (1/8-inch) fillet welds, none of which are load bearing. Along the inside of the two side plates are two, 5.3 cm (2.1-inch) wide grooves, 1.0 cm (0.4 inches) deep. These grooves accommodate the bulkheads used in the AFS-C rod container, but they have no function in the AFS-B container. The components of the AFS-B feature numerous small holes that ensure the AFS-B will not hold pressure. Figure 6 shows a cross section of the AFS-B rod box.

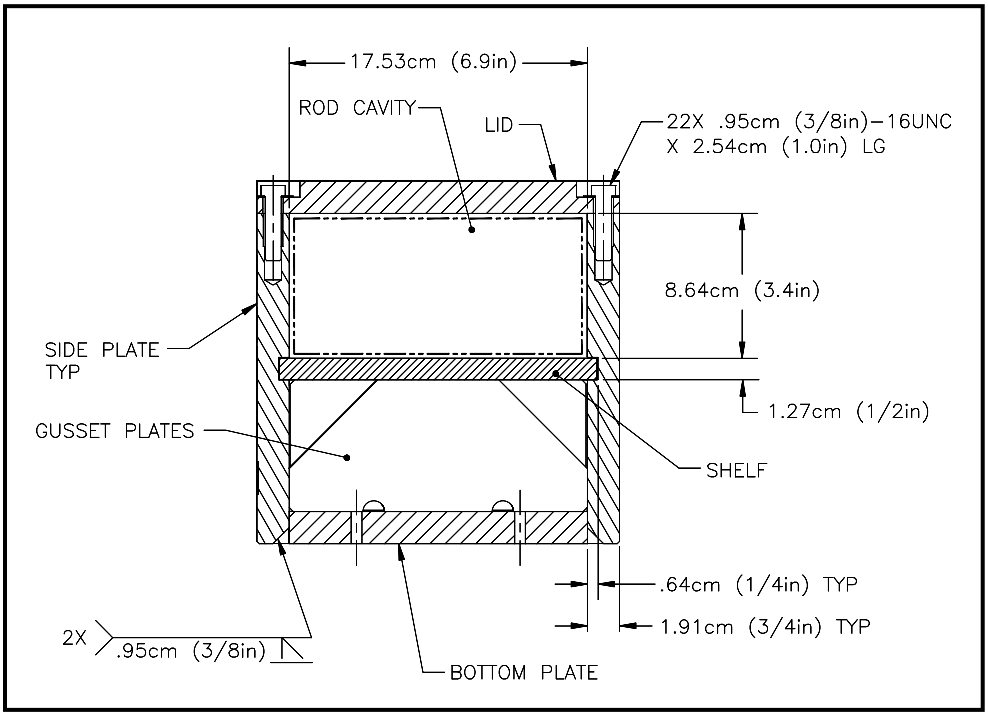

Figure 6. AFS-B Rod Box Internal Cross Section

The lid is lifted by means of two, ¼-20 UNC threaded holes in the lid. The holes are located such that at least half of the hole is blocked by the top of the sidewall, which prevents an overly-long lifting bolt from possibly damaging any fuel rods. The container is lifted from its top end using a swivel hoist ring. All threaded holes may optionally be fitted with helical-coil thread inserts. The label 'AFS-B' is painted prominently on both sides of the container. The AFS-B is finished with a clear anodize treatment.

AFS-C Rod Box

The addition of up to three (3) AFS-C rod containers containing Los Alamos Technical Area 18 (TA-18) MOX fuel rods was submitted as part of the MFFP amendment. Two types of TA-18 fuel rods are available, Exxon Nuclear (Exxon) and Pacific Northwest Laboratory (PNL). Because these rods have different outer diameters and lengths, they will be separated within the AFS-C cavity. The AFS-C may transport up to 116 Exxon rods and 69 PNL rods. The maximum number of rods is limited by the cavity size of the AFS-C. The AFS-B and C external envelope are identical except for identification markings. Internally, the AFS-C are identical with the exception of a separation piece which allows for the transport of the two TA-18 rods which are shorter than MOX rods. Figure 7 shows a view of the AFS-C internals.

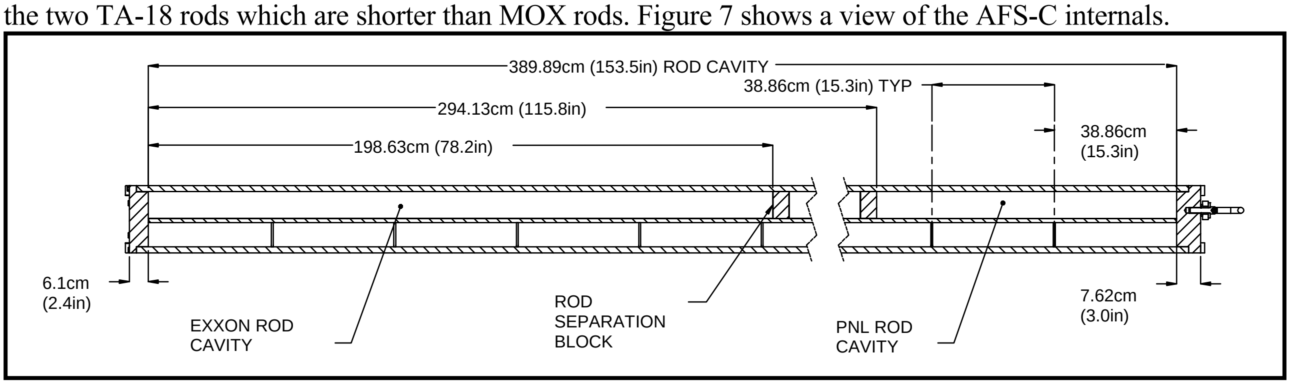

Figure 7. Cross Section of AFS-C showing rod separation block

Criticality and Thermal Issues

A majority of the analytical work for the amendment focused on criticality and thermal issues. Because the contents in the amendment included fuel rods unattached to a fuel assembly, scenarios were developed in which the number and position of the fuel rods were optimized for criticality purposes. In reality, the rod containers and dunnage rods would prevent the criticality scenarios envisioned, although the analysis approach utilized was conservative.

The thermal loading was limited to the thermal loading requirements provided in the original SAR. While the original SAR used three-dimensional thermal modeling, the thermal analyses in the appendices utilized a more simplified one-dimensional approach, using the results of the original analysis as a boundary condition. For AFS-C rod box, different thermal limits were developed for the Exxon and PNL rod compartments, although the total thermal load is within the limits of the original SAR. The additional contents were shown to be acceptable.

CONCLUSION

The successful amendment of the MOX Fresh Fuel Package gives this package more flexibility to conduct transports for the MOX Fresh Fuel Facility and allows for greater use for other users including the Department of Energy. By having a suite of generic rod boxes approved by the Nuclear Regulatory Commission, it is now possible to evaluate other payloads for the MFFP which can fit within the confines of these components. New amendments for these additional payloads would be required but the hardware is now available for transport, providing all the appropriate NRC 10 CFR Part 71 requirements are approved by the NRC.

REFERENCE

1. Title 10, Code of Federal Regulations, Part 71, Packaging and Transportation of Radioactive Material, Final Rule, 1-26-04.