CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIAL PACKAGES

1. a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE		PAGE
9330	13	71-9330	USA/9330/AF-96	1	OF	7

2.. PREAMBLE

a. This certificate is issued to certify that the package (packaging and contents) described in Item 5 below meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, “Packaging and Transportation of Radioactive Material.”

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO *(Name and Address)*

U.S. Department of Energy
Washington, DC 20585

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION

Safety Analysis Report, Advanced Test Reactor Fresh Fuel Shipping Container, ATR FFSC, Revision No. 14, dated May 2017, as supplemented.

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model No.: ATR FFSC

(2) Description

An insulated stainless steel package for the transport of unirradiated research reactor fuel, including intact fuel elements or fuel plates. The packaging consists of (1) a body, (2) a closure lid, and (3) inner packaging internals. The approximate dimensions and weights of the package are:

Overall package outer width and height	8 inches
Overall package length	73 inches
Cavity diameter	5-3/4 inches
Cavity length	68 inches
Packaging weight (without internals)	240 pounds
Maximum package weight (including internals and contents)	290 pounds

The body is composed of two thin-walled, stainless steel shells. The outer shell is a square tube with an 8-inch cross section, a 73-inch length, and a 3/16 inch wall thickness. The inner shell is a round tube with a 6-inch diameter and a 0.120-inch wall thickness. The inner tube is wrapped with ceramic fiber thermal insulation, overlaid with a stainless steel sheet. At the bottom end, the shells are welded to a 0.88-inch thick stainless steel base plate. At the top end (closure end), the shells are welded to a 1.5-inch thick stainless steel flange.

5.(a)(2) Description (Continued)

The closure is composed of circular stainless steel plates with ceramic fiber insulation. The closure engages the top end flange by way of four bayonets that are rotated and secured by two spring pins. The closure is equipped with a handle, which may be removed during transport. The closure does not have a gasket or seal.

The package internals consist of either a Fuel Handling Enclosure (FHE) for intact Advanced Test Reactor (ATR), Massachusetts Institute of Technology (MIT), University of Missouri Research Reactor (MURR), Conversion Of Belgian Reactor 2 – an Alternative (COBRA fuel-both HEU and LEU), or Rhode Island Nuclear Science Center (RINSC) fuel elements and Small Quantity Payloads, or a Loose Fuel Plate Basket for ATR fuel plates. The RINSC, MIT, MURR, COBRA, and Small Quantity Payload FHE use ball lock pins and end spacers to lock closed while the ATR FHE uses a spring plunger.

(3) Drawings

The packaging is constructed and assembled in accordance with the following Areva Federal Services LLC. or Packaging Technology, Inc., Drawing Nos.:

60501-10, Sheets 1-5, Rev. 3	ATR Fresh Fuel Shipping Container SAR Drawing
60501-20, Rev. 1	ATR Loose Plate Basket Assembly
60501-30, Rev. 1	ATR Fuel Handling Enclosure
60501-40, Rev. 0	MIT Fuel Handling Enclosure
60501-50, Rev. 0	MURR Fuel Handling Enclosure
60501-60, Rev. 0	RINSC Fuel Handling Enclosure
60501-70, Rev. 0	Small Quantity Payload Fuel Handling Enclosure
60501-90, Rev. 0	COBRA Fuel Handling Enclosure

(b) Contents

(1) Type and form of material

Unirradiated Mark IV, V, VI, and VII ATR fuel elements. The Mark IV fuel material is composed of U_3O_8 while the Mark V, VI, and VII ATR fuel material is composed of uranium aluminide (UAl_x). The uranium is enriched to a maximum 94 weight percent U-235; the maximum U-234 content is 1.2 weight percent; and the maximum U-236 content is 0.7 weight percent. Intact ATR fuel elements contain 19 curved fuel plates fitted within aluminum side plates, and the maximum channel thickness between fuel plates is 0.087 inch. The fuel meat thickness is a nominal 0.02 inch for all 19 plates, and the fuel meat width ranges from approximately 1.5 inches to 3.44 inches. The nominal active fuel length is approximately 48 inches. The maximum mass of U-235 per intact ATR fuel element is 1200 grams. The ATR fuel element must be contained within the ATR Fuel Handling Enclosure, as specified in 5.(a)(3).

5.(b)(1) Type and Form of Material (continued)

Unirradiated ATR U-Mo fuel elements. The ATR U-Mo fuel element consists of a mixture of high-enriched uranium aluminide (UAl_x) fuel plates and low-enriched uranium and molybdenum alloy (U-Mo) fuel plates, with a maximum mass of U-235 per U-Mo fuel element of 1,240 grams. The ATR U-Mo fuel element contains 19 curved plates fitted within aluminum side plates; plates 1 through 4, and 16 through 18, contain high-enriched UAl_x fuel; plates 5 through 15 contain low-enriched U-Mo fuel; and plate 19 is an aluminum alloy plate. The maximum channel thickness between fuel plates is 0.087 inch. For the high-enriched UAl_x fuel plates, the uranium is enriched to a maximum 94 weight percent U-235; the maximum U-234 content is 1.2 weight percent; and the maximum U-236 content is 0.7 weight percent. For the low-enriched U-Mo fuel plates, the molybdenum content is a nominal 10 weight percent; the uranium is enriched to a maximum 20 weight percent U-235; the maximum U-234 content is 0.26 weight percent; and the maximum U-236 content is 0.46 weight percent. For the high-enriched UAl_x fuel plates, the fuel meat thickness is a nominal 0.02 inch; the fuel meat width ranges from approximately 1.5 inches to 3.44 inches; and the nominal active fuel length is approximately 48 inches. For the low-enriched U-Mo fuel plates, the fuel meat thickness is a nominal 0.013 inch, with a nominal 0.001 inch thick zirconium interlayer present between the fuel meat and the aluminum cladding layer; the fuel meat width ranges from approximately 2.25 inches to 3.28 inches; and the nominal active fuel length is approximately 48 inches. The ATR U-Mo fuel element must be contained within the ATR Fuel Handling Enclosure, as specified in 5.(a)(3).

Unirradiated MIT fuel element. The MIT fuel material is composed of uranium aluminide (UAl_x). The uranium is enriched to a maximum of 94 weight percent U-235; the maximum U-234 content is 1.2 weight percent; and the maximum U-236 content is 0.7 weight percent. Each MIT fuel element contains 15 flat fuel plates fitted within aluminum side plates and the maximum channel thickness between fuel plates is 0.090 inch. The fuel meat thickness is a nominal 0.03 inch for all 15 plates and the fuel meat width ranges from approximately 1.98 inches to 2.17 inches. The nominal active fuel length is 22.375 inches. The maximum mass of U-235 per intact MIT fuel element is 515 grams. The MIT fuel element must be contained within the MIT Fuel Handling Enclosure, as specified in 5.(a)(3).

Unirradiated MURR fuel element. The MURR fuel material is composed of uranium aluminide (UAl_x). The uranium is enriched to a maximum of 94 weight percent U-235; the maximum U-234 content is 1.2 weight percent; and the maximum U-236 content is 0.7 weight percent. Each MURR fuel element contains 24 curved fuel plates fitted within aluminum side plates and the maximum channel thickness between fuel plates is 0.090 inch. The fuel meat thickness is a nominal 0.02 inch for all 24 plates and the fuel meat width ranges from approximately 1.71 inches to 5.72 inches. The nominal active fuel length is 24 inches. The maximum mass of U-235 per intact MURR fuel element is 785 grams. The MURR fuel element must be contained within the MURR Fuel Handling Enclosure, as specified in 5.(a)(3).

5.(b)(1) Type and Form of Material (continued)

Small Quantity Payloads (RINSC fuel elements, GRR-1 fuel elements, ATR Full-size plate In Flux Trap Position (AFIP) elements, U-Mo foils, Design Demonstration Elements (DDEs) and similar test elements, MIT, COBRA or MURR loose fuel element plates, and FUTURE-HFIR loose plates) where the maximum mass of U-235 is 400 grams and maximum U-235 enrichment is 94 weight percent. Aluminum plates, shapes, and sheets, miscellaneous steel or aluminum fasteners, and cellulosic material such as cardboard may be used as dunnage to fill gaps between the small quantity payloads and the small quantity FHE. Loose plates may be separated by kraft paper and taped or wire tied together. Dunnage shall be used to limit motion of the small quanity payload within the FHE to ¼” or less. 1/8” neoprene strips may be used between the small quantity FHE and small quantity payloads and/or between the optional aluminum dunnage and the small quantity payload. The 1/8” neoprene strips shall not be stacked in more than two layers between the small quantity payload and any interior face of the small quantity FHE.

Unirradiated RINSC fuel element. The RINSC fuel material is composed of uranium silicide (U_3Si_2) dispersed in aluminum powder. The uranium is enriched to a maximum of 20 weight percent U-235; the maximum U- 234 content is 0.5 weight percent; and the maximum U-236 content is 1.0 weight percent. Each RINSC fuel element contains 22 flat fuel plates fitted within aluminum alloy side plates and the maximum channel thickness between fuel plates is 0.096 inch. The fuel meat thickness is a nominal 0.02 inch for all 22 plates. The maximum mass of U-235 per intact RINSC fuel element is 283 grams. The RINSC fuel element must be contained within the RINSC Fuel Handling Enclosure, as specified in 5.(a)(3).

Unirradiated GRR-1 fuel element. The GRR-1 fuel material is composed of uranium silicide (U_3Si_2) dispersed in aluminum powder. The uranium is enriched to a maximum of 20 weight percent U-235. Each GRR-1 fuel element contains 18 flat plates fitted within aluminum alloy side plates and the maximum channel thickness between fuel plates is 0.124 inch. The fuel meat thickness is a nominal 0.02 inch for all 18 plates. The maximum mass of U-235 per intact GRR-1 fuel element is 223 grams. The GRR-1 fuel element must be contained within the Small Quantity Payload Fuel Handling Enclosure, as specified in 5.(a)(3).

AFIP fuel element. The AFIP fuel element is composed of uranium molybdenum alloy in an aluminum-silicon matrix or uranium molybdenum alloy coated with a thin zirconium interlayer. The uranium is enriched to approximately 20 weight percent U-235. Each AFIP element contains 4 curved fuel plates fitted within 6061 aluminum side plates. The maximum mass of U-235 AFIP element is 365 grams. Loose plates from an AFIP fuel element are also permitted. The AFIP fuel element must be contained within the Small Quantity Payload Fuel Handling Enclosure, as specified in 5.(a)(3).

COBRA fuel element. The COBRA HEU fuel element is composed of uranium aluminide (UAl_x) dispersed in aluminum powder, with the uranium enriched to a maximum of 94 weight percent U-235. The COBRA LEU fuel element is composed of uranium silicide (U_3Si_2) dispersed in aluminum powder, with the uranium enriched to a maximum of 20 weight percent U-235. The maximum mass of U-235 is 410.3 grams in the HEU configuration or

5.(b)(1) Type and Form of Material (continued)

435.8 grams in the LEU configuration. The COBRA fuel element weighs a maximum of 20 lb, is bagged, and must be contained within the COBRA Fuel Handling Enclosure, as specified in 5.(a)(3).

U-Mo Foils. The U-Mo foils are composed of uranium molybdenum alloy in an aluminum-silicon matrix or uranium molybdenum alloy and may contain a zirconium coating. The uranium is enriched to a maximum of 94 weight percent U-235. The maximum mass of U-235 is 160 grams. More than one U-Mo foil type may be transported at a time. The U-Mo foils must be contained within the Small Quantity Payload Fuel Handling Enclosure, as specified in 5.(a)(3). This category includes FUTURE-HFIR Mono loose plates.

DDEs and similar test elements. The DDEs and similar test elements are composed of uranium molybdenum alloy in an aluminum-silicon matrix or uranium molybdenum alloy. The uranium is enriched to a maximum of 94 weight percent U-235. The maximum mass of U-235 is 365 grams. Loose plates from a DDE or similar test element are also permitted. The DDEs or similar test elements must be contained within the Small Quantity Payload Fuel Handling Enclosure, as specified in 5.(a)(3).

MIT and MURR loose fuel element plates. MIT and MURR loose plates may either be flat or curved and may be banded or wire-tied in a bundle. The MIT and MURR loose plate payload is limited to 400 grams of U-235. The approximate mass of U-235 of each MIT fuel plate is 34.3 grams.

The approximate mass of U-235 per each MURR fuel plate is 19 to 46 grams. A mixture of MIT and MURR fuel plates may be shipped together. The fuel plates must be contained within the Small Quantity Payload Fuel Handling Enclosure, as specified in 5.(a)(3).

Mark IV, V, VI, and VII ATR loose fuel plates: ATR loose plates may either be flat or curved and may be banded or wire-tied in a bundle. The ATR loose plate payload is limited to 600 grams of U-235. Additional aluminum plates may be used as dunnage to fill gaps between the fuel plates and the basket payload cavity. The fuel plates must be contained within the ATR Loose Fuel Plate Basket, as specified in 5.(a)(3).

COBRA loose fuel element plates: COBRA loose plates may either be flat or rolled to the geometry required for assembly into the fuel element and may be taped or wire-tied together. The U-235 content per COBRA loose plate is variable and may be HEU or LEU, but the total payload is limited to 400 grams of U-235. COBRA loose plates are transported as Small Quantity Payloads. This category includes FUTURE-HFIR IFE-ALT1, FUTURE-HFIR IFE THIN, and FUTURE-HFIR OFE THICK loose plates.

(2) Maximum quantity of material per package

The maximum total weight of contents and internals, including dunnage and other secondary packaging, is 50 lbs. Radioactive contents are not to exceed a Type A quantity.

For intact ATR, ATR U-Mo, MURR, RINSC, COBRA, and MIT fuel elements: One fuel element.

For ATR loose fuel plates: A maximum of 600 grams U-235.

For Small Quantity Payloads: A maximum of 400 grams U-235.

(c) Criticality Safety Index (CSI):

For ATR, ATR U-Mo, MURR, MIT fuel elements or ATR loose fuel plates:	4.0
For Small Quantity Payloads:	25
For COBRA fuel elements:	4.0

6. Fuel elements and fuel plates may be bagged or wrapped in polyethylene. The maximum weight of the polyethylene wrap and tape shall not exceed 100 grams per package. The maximum weight of neoprene plus cellulosic material shall not exceed 4 kg per package.

7. Types of small quantity payloads cannot be mixed in a single Fuel Handling Enclosure.

8. Air transport of fuel elements or loose plates is authorized.

9. In addition to the requirements of 10 CFR 71 Subpart G:

   (a) The package must be loaded and prepared for shipment in accordance with the Package Operations in Section 7 of the application.

   (b) The package must be tested and maintained in accordance with the Acceptance Tests and Maintenance Program in Section 8 of the application.

10. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR 71.17.

11. Revision No. 12 of this certificate may be used until March 31, 2020.

12. Expiration date: May 31, 2024.

REFERENCES

Safety Analysis Report, Advanced Test Reactor Fresh Fuel Container (ATR FFSC), Revision 14, dated May 2017.

Amendment Request Letter, J. Shuler, U.S. Department of Energy to J. McKirgan, U.S. Nuclear Regulatory Commission, dated February 20, 2019.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

John McKirgan

John McKirgan, Chief
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Date: 4/18/19

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SAFETY EVALUATION REPORT

Docket No. 71-9330
Model No. ATR-FFSC Package
Certificate of Compliance No. 9330
Revision No. 13

SUMMARY

By letter dated February 20, 2019 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML19052A428), the Department of Energy (DOE or the applicant) requested an amendment of the Certificate of Compliance (CoC) No. 9330 for the Model No. ATR-FFSC package.

The applicant requested a simple content amendment necessary to transport experimental loose fuel plates to be irradiated in Belgium as part of DOE's Office of Materials Management and Minimization program. The applicant requested that the CoC be amended based on the letter request and in lieu of a revision to the Safety Analysis Report (SAR).

The submittal was evaluated against the regulatory standards in Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71, including the general standards for all packages, standards for fissile material packages, and performance standards under normal conditions of transport and hypothetical accident conditions.

The certificate has been amended based on the statements and representations in the application. The staff agrees that the changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

EVALUATION

In the effort to convert the High Flux Isotope Reactor (HFIR) research reactor from using highly enriched uranium (HEU) fuel to low enriched uranium (LEU) fuel, several experimental loose fuel plates were designed to aid in this process. The amendment proposes including the following four plates:

Fuel Plate Name	**Bounded in CoC by**
FUTURE-HFIR Mono	U-Mo foils
FUTURE-HFIR U_3Si_2 Curved Profile (IFE-ALT1)	COBRA loose fuel
FUTURE-HFIR U_3Si_2 (IFE) THIN	COBRA loose fuel
FUTURE-HFIR U_3Si_2 (OFE) THICK	COBRA loose fuel

The four FUTURE-HFIR plates have a construction similar to the other loose plates already authorized by the CoC, having a central fuel region completely surrounded by aluminum alloy cladding. The Small Quantity payload, described in Section 1.2.2.4 of the ATR FFSC SAR, Revision 14, consists of a class of research and development plate-type fuels with U-235 as the fissile isotope (i.e., no U-233 or plutonium), with a bounding U-235 loading up to 400 g, and U-235 enrichment up to 94%. Fuel types that fall into the small quantity payload category include RINSC fuel elements, AFIP elements, U-Mo foils, DDEs, MIT loose fuel element plates, MURR loose fuel element plates, and Cobra loose fuel element plates. Shipments of the four plates proposed in this amendment are being included in the definition of the Small Quantity payload.

To demonstrate that the four loose fuel plate types may be shipped in the ATR FFSC package under the Small Quantity payload category (defined in the CoC), the applicant provided tables comparing key physical and nucleonic characteristics of the four plates to payload descriptions currently authorized in Section 5.(b)(1) of the NRC CoC, Revision 12.

FUTURE-HFIR Mono

The FUTURE-HFIR Mono fuel type is bounded by the U-Mo foils loose plate subcategory. Details of that comparison are in Table 1 below.

Table 1: Comparison of FUTURE-HFIR Mono Fuel Type to Currently Authorized Payload Descriptions

Fuel Designation	Fuel alloy & matrix	Enrichment	Mass U-235
FUTURE-HFIR Mono	U-Mo, U-10Mo matrix, zirconium coating	≤ 20%	22.58 g maximum per plate
CoC, revision 12, Section 5.(b)(1), paragraph 10	...uranium molybdenum alloy in an aluminum-silicon matrix or uranium molybdenum alloy and may contain a zirconium coating.	≤ 94%	160 g maximum in this category

FUTURE-HFIR IFE-ALT1, FUTURE-HFIR IFE THIN, and FUTURE-HFIR OFE THICK

The other three fuel types (FUTURE-HFIR IFE-ALT1, FUTURE-HFIR IFE THIN, and FUTURE-HFIR OFE THICK) are bounded by the COBRA loose fuel element subcategory.

Table 2: Comparison of the Other Three FUTURE-HFIR Fuel Types to Currently Authorized Payload Descriptions

Fuel Designation	Fuel alloy & matrix	Enrichment	Maximum Mass U-235
FUTURE-HFIR IFE-ALT1	U_3Si_2 – Aluminum dispersion	≤ 20%	19.00 g per plate
FUTURE-HFIR IFE THIN			9.07 g per plate
FUTURE-HFIR OFE THICK			24.77 g per plate
ATR FFSC CoC, rev 12 (Section 5.(b)(1))	Not directly specified. (COBRA LEU fuel is listed as U_3Si_2 dispersed in aluminum powder.)	… may be HEU or LEU	400 g in this category

Criticality Safety

The applicant request an amendment to the CoC for the Model No. ATR FFSC package to include additional loose fuel plate types in the list of allowable contents. Specifically, the applicant requested to modify condition 5.(b)(1) of the CoC to change:

1. The description of Small Quantity Payloads to include FUTURE-HFIR loose plates,
2. The description of U-Mo foils to include FUTURE-HFIR Mono loose plates, and
3. The description of COBRA loose fuel plates to include FUTURE-HFIR IFE-ALT1, FUTURE-HFIR IFE THIN, and FUTURE-HFIR OFE THICK loose plates.

The four FUTURE-HFIR contents are similar in construction to previously approved loose fuel plate contents (i.e., central fuel region clad in aluminum alloy). All new loose plate types must be transported as Small Quantity Payloads in the Small Quantity Payload Fuel Handling Enclosure, as shown in Drawing No. 60501-70, Rev. 0.

The FUTURE-HFIR Mono fuel plates consist of uranium enriched up to 20 weight percent in a uranium molybdenum alloy with a zirconium coating. This fuel type is bounded by the U-Mo foils category of contents currently listed under CoC condition 5.(b)(1), which limits enrichment to 94 weight percent and 160 grams total U-235.

The FUTURE-HFIR IFE-ALT1, FUTURE-HFIR IFE THIN, and FUTURE-HFIR OFE THICK fuel plates consist of uranium enriched up to 20 weight percent in a uranium silicide (U_3Si_2) and aluminum matrix. These fuel types are bounded by the COBRA loose fuel element plates category of contents currently listed under CoC condition 5.(b)(1), which limits high enriched or low enriched uranium contents to 400 grams total U-235.

The applicant previously evaluated U-Mo foil and COBRA loose fuel element plate categories assuming the fuel is high enriched (94 weight percent U-235), and conservatively representing the contents as an optimally-moderated, homogenized mixture of uranium and water. Since the FUTURE-HFIR Mono, FUTURE-HFIR IFE-ALT1, FUTURE-HFIR IFE THIN, and FUTURE-HFIR OFE THICK fuel plates all consist of uranium enriched up to 20 weight percent, the previous analysis bounds these contents, provided the U-235 mass limits in the CoC are met.

Based on the discussion above, the staff found the applicant’s proposed changes to the CoC, to include four new FUTURE-HFIR loose fuel plate contents, would not affect the ability of the Model No. ATR-FFSC package to meet the criticality safety requirements of 10 CFR Part 71.

Conclusion

Based on the statements and representations in the application, and the conditions listed in the CoC, the staff concludes that the design has been adequately described and evaluated, and will continue to meet the requirements of 10 CFR Part 71 with the transport of the FUTURE-HFIR plates.

CONDITIONS

The following changes are included in Revision No. 13 to Certificate of Compliance No. 9330:

Condition No. 5(b)(1) was revised in three places to include reference to the four FUTURE-HFIR plates. Reference was added to include:

1. the FUTURE-HFIR plates in the definition of Small Quantity Payloads,
2. the FUTURE-HFIR Mono loose plates in the description of the U-Mo Foils
3. the FUTURE-HFIR IFE-ALT1, FUTURE-HFIR IFE THIN, and FUTURE-HFIR OFE THICK loose plates in the description of the COBRA loose fuel element plates

Condition No. 11 authorizes the use of Revision No. 12 of this certificate for approximately one year.

In addition, the February 2019 application has been added to the references section of this certificate.

CONCLUSION

Based on the statements and representations in the application, and the conditions listed above, the staff concludes that the Model No. ATR-FFSC package design has been adequately described and evaluated and that these changes do not affect the ability of the package to meet the requirements of 10 CFR Part 71.

Issued with Certificate of Compliance No. 9330, Revision No. 13, for the Model No. ATR-FFSC.