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

January 10, 2019

Framatome Inc.
Mr. Timothy J. Tate
2101 Horn Rapids Road
Richland, WA 99354

SUBJECT: REVISION NO. 11 OF CERTIFICATE OF COMPLIANCE NO. 9319, FOR THE MODEL NOS. MAP-12 AND MAP-13 TRANSPORTATION PACKAGES

Dear Mr. Tate:

As requested by your letter dated December 12, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No.ML18347A410), enclosed is Certificate of Compliance No. 9319, Revision No. 11, for the Model Nos. MAP-12 and MAP-13 packages. Changes made to the enclosed certificate are indicated by vertical lines in the margin. The staff's safety evaluation report is also enclosed.

The approval constitutes authority to use the package for shipment of radioactive material and for the package to be shipped in accordance with the provisions of Title 49 of the *Code of Federal Regulations* (49 CFR) 173.471. Those on the attached list have been registered as users of the package under the general license provisions of 10 CFR 71.17 or 49 CFR 173.471.

If you have any questions regarding this certificate, please contact me or Pierre Saverot of my staff at (301) 415-7505.

Sincerely,

/RA/

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

Enclosure 3 transmitted herewith contains Official Use Only - Security-Related Information. When separated from Enclosure 3, this document is uncontrolled.

Docket No. 71-9319
EPID No. L-2018-LRM-0091

Enclosures:
1. Certificate of Compliance No. 9319, Rev. No. 11
2. Safety Evaluation Report
3. Registered Users

cc w/encls 1 & 2: R. Boyle, DOT
J. Shuler, DOE c/o L.F. Gelder
Registered Users

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DISTRIBUTION:
DSFM r/f NMSS r/f R. Powell, RI B. Bonser, RII M. Kunowski, RIII J.Katanic, RIV

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71-9319.R11.doc

Closes EPID No. L-2018-LRM-0091

ADAMS PKG: ML19011A011 Ltr&SER: ML19011A013
Encl. 1: ML19011A012 Encl. 3: ML19011A014

OFC	DSFM	DSFM	DSFM	DSFM	DSFM
NAME	PSaverot	SFigueroa	DBarto	DDunn	DTang
DATE	12/31/2018	01/10/2019	01/03/2019	01/03/2019	01/10/2019
OFC	DSFM	DSFM	DSFM	DSFM	DSFM
NAME	JChang	CBajwa	MRahimi	TTate	JMcKirgan
DATE	01/09/2019	01/10/2019	01/08/2019	01/10/2019	01/10/2019

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SAFETY EVALUATION REPORT
Docket No. 71-9319
Model Nos. MAP-12 and MAP-13
Certificate of Compliance No. 9319
Revision No. 11

SUMMARY

By letter dated December 12, 2018 (Agencywide Documents Access and Management System (ADAMS) Accession No. ML18347A410), Framatome Inc., (or the applicant) requested an amendment to Certificate of Compliance (CoC) No. 9319 for the MAP packaging to include a new Accident Tolerant Fuel (ATF) design with a thin chromium coating applied to the fuel cladding.

The application was supplemented on January 9, 2019 in response to staff's requests for clarification regarding the structural evaluation and the need for additional data for the materials and thermal evaluations.

The staff reviewed the application and its supplement, as discussed below, and determined that the changes do not affect the ability of the package to meet the requirements of Title 10 of the *Code of Federal Regulations* (10 CFR) Part 71. The certificate has been updated to Revision No. 11.

EVALUATION

The applicant requested an amendment to the Model No. MAP package to transport fresh accident tolerant fuel (ATF) lead test assemblies (LTAs). These ATF LTAs consist of modified pressurized water reactor (PWR) fuel assemblies, currently approved in the CoC, as described in condition 5.(b)(3)(i). The requested modification to these assemblies consists of a chromium coating, with a nominal thickness of 15 micrometers (μm), along the length of the exterior of the zirconium alloy cladding of each fuel rod.

The applicant claimed that the structural safety analysis for the MAP-12/13 package was unaffected by the ATF fuel features, since the ATF assembly weight was within the limits of the previously approved contents and the overall design of the ATF fuel assemblies was also consistent with the previously authorized contents. In the safety analysis referenced as "FS1-0038397-1.0, MAP PWR Fuel Shipping Package –USA/9319/B(U)F-96," the basis for demonstrating cladding integrity, during both normal conditions of transport (NCT) and hypothetical accident conditions (HAC) drops, was based on physical drop testing which determined that the cladding integrity was preserved. The staff concurred with this overall assessment. However, the staff noted that, as described in the amendment request, the package drop testing was performed using a fuel assembly with fuel rods seated on the bottom nozzle. Seated rods were characteristic of all Framatome PWR fuel designs at the time of the original package approval. This seated fuel rod-to bottom nozzle interface configuration deviates from the gapped fuel rod condition and is unanalyzed for the ATF assemblies to be shipped.

In response to staff's questions on this unanalyzed condition, both during the pre-application conference call and during the review, Framatome provided a fuel assembly 30-ft end drop evaluation to show that the design-basis testing condition of seated rods bounds the gapped rod condition. As a comparison analysis, the evaluation used a representative finite element analysis (FEA) model, which had been benchmarked for fuel assembly vertical seismic and loss of coolant accident condition loadings. Framatome explained that (i) the 3-beam lumped parameter model included guide tubes, fuel rods, and instrument tube, (ii) gap elements defined the top and bottom nozzle gaps for the fuel rods and the gap between the bottom nozzle and the ground, and (iii) slider spring elements represented the frictional interface between the spacer grids and the fuel rods. The applicant performed two comparison analyses by simulating a hard-drop and then the impact limiter-protected drop scenarios. The analyses were used to demonstrate that the fuel rod end impact load, associated with a secondary or delayed impact of the gapped rod condition, was bounded by that with the direct impact of seated rod condition.

In the 30-ft hard-drop simulation for which a fuel assembly is dropped onto a rigid surface, the applicant analyzed three fuel rod gaps, 0", 0.12", and 2", with varying friction slip loads between the spacer grid and the fuel rod. The analysis demonstrated that the zero-gap condition produces the highest rod impact load. For the maximum gap of 2", where the friction has the longest path to dissipate energy, the fuel rod experienced the most reduction in impact load. For the impact limiter-protected fuel assembly drop analysis, the applicant modified the hard-drop FEA model by inserting a slider-spring element between the bottom nozzle and the ground to represent the effects of the container impact limiter in series. The analysis demonstrated that, for a zero-gap, the full grid spacer-to rod friction case produced the highest impact load compared with the gapped fuel rod conditions. This result is consistent with the observation that, for the gapped fuel rod configuration, the impact limiter also helps in dissipating the kinetic energy of the fuel assembly, further reducing the fuel rod impact loads compared with the seated fuel rod configuration. The staff reviewed the FEA simulation of a representative fuel assembly undergoing a 30-ft bottom end drop. The analysis considered both hard-drop and impact limiter-protected drop scenarios. The analysis compared fuel rod impact loads for seated and gapped fuel rod-to-nozzle interface configurations, which confirmed that a fuel rod impact load with seated configuration would be bounding. On this basis, the staff has reasonable assurance to conclude that the drop testing for the original package approval with seated fuel rods also applies to the ATF fuel assembly with gapped fuel rods in meeting the structural performance requirements of 10 CFR 71.73

The applicant clarified that sintered pellets of uranium oxides mixed with various additives included in the application had been previously approved by the staff. The staff reviewed the CoC and confirmed that the fuel chemistry was approved in Revision No. 10 of the CoC.

The staff reviewed the cladding integrity structural-materials assessment with respect to the effect of adding chromium-coating to the cladding material mechanical strength and fracture toughness. Although the applicant provided limited information with respect to the effect of the coating process on the mechanical properties of the cladding, the staff's conclusion on reasonable assurance compliance with 10 CFR Part 71 regulations did not rely on the material mechanical properties discussed in this assessment. The staff does not also make any judgement on the adequacy of the material mechanical properties in the structural assessment for transport of any lead test assemblies or batch assemblies. While the staff's conclusions did not rely on the testing results for the coated cladding provided by the applicant, the staff notes that the applicant showed that the coating process results in a minimal amount of hydrogen uptake in the cladding: the hydrogen uptake is well below values that are detrimental to the base cladding material. The applicant also showed that the mechanical properties of the cladding are not significantly affected by the coating process.

The staff reviewed the applicant's justification that the thermal material properties of the cladding remain unchanged as a result of the applied coating. The staff considers the justification to be acceptable since: (1) the base cladding material remains unchanged from prior approvals, and (2) the maximum measured cladding temperature during the regulatory fire test is an order of magnitude lower than any credible eutectic melting temperature for the cladding material and the coating material.

The applicant stated in the application that the use of the chromium coating on the ATF fuel cladding had no impact on the thermal analysis because (a) chromium coating has no significant impact on the package heat removal performance under normal conditions of transport (NCT) and hypothetical accident conditions (HAC), (b) there is no melting eutectic and/or oxidation of the chromium coating under the HAC fire, and (c) the chromium coating does not affect the properties of zirconium alloy at the "cold" temperature condition required to be analyzed as part of the package evaluation (i.e., -40°F). The staff reviewed the application, and the supplemental information and references provided by the applicant at staff's request, and determined that:

(a) Chromium-coated cladding, with less than 0.2% increase in density, less than 0.5% increase in thermal resistance, and less than 1% increase in specific heat, has a minor change in the thermal conductance and, therefore, has no significant impact on the thermal evaluation, given that large margins to component temperature limits continue to exist under both NCT and HAC.

(b) Chromium coating exhibits temperatures of 1332°C for the melting eutectic and approximately 1300°C for oxidation, temperatures which are both higher than the HAC fire temperature of 800°C. Therefore, the chromium coating will likely not exhibit either a melting eutectic or an oxidation under the HAC fire.

(c) Chromium coating does not affect the ATF fuel cladding (zirconium alloy) at low temperatures (-40°F) as zirconium alloy does not have a zero ductility at -40°F.

Thus, the staff concludes that the MAP package continues to meet the thermal performance requirements of 10 CFR Part 71.

The applicant evaluated the Model No. MAP package with LTAs containing chromium coated rods using the HAC array model used for previously approved PWR fuel contents, as this was the bounding model for those contents. The applicant modified the HAC package model with the 15 Type 1A PWR fuel assembly, which is the bounding fuel assembly type based on the applicant's previously approved analysis. The applicant added varying thicknesses of chromium coating on each zirconium alloy-clad rod. The thickness of chromium was varied from 5 μm to 30 μm in increments of 5 μm. The results of the applicant's analysis, shown in Table 6-4b of the application, demonstrate that the fuel assembly reactivity multiplication factor, k_{eff} , decreases with an increasing chromium thickness. These results are expected, as PWR fuel assemblies are designed to be under-moderated, and the chromium coating displaces water in the fuel array, leading to a reduced k_{eff}. Since the chromium coating reduces the system k_{eff}, it is conservative to neglect the coating, and the previously evaluated most reactive package and array configuration remain the same.

The applicant used the SCALE 6.2.2 code system for all calculations involving chromium coated rods. The applicant used SCALE 4.4a for the previously approved MAP criticality calculations, which was validated as described in Section 6.8 of the application. While the applicant indicated a reference to a facility validation report for the use of SCALE 6.2.2, the applicant did not provide a validation analysis of SCALE 6.2.2 specific to the MAP package and the PWR fuel design evaluated in this amendment request. The staff believes that the applicant's criticality results are appropriate, however, for the following reasons: 1) the results are consistent with the expected behavior of the system with the proposed changes (i.e., the addition of the chromium coating displaces water and reduces system reactivity); and 2) the code is only used in this amendment to determine the direction of changes in the system reactivity, and is not used to evaluate the final most reactive system, which remains the same as in the previously evaluated application.

Based on the discussion above, the staff found the applicant's proposed changes to the CoC, with respect to transporting PWR fuel assemblies with chromium coated zirconium alloy-clad rods, would not affect the ability of the Model No. MAP package to meet the criticality safety requirements of 10 CFR Part 71.

CONDITIONS

The following changes were made to the certificate of compliance:

Item No. 3(b) identifies the application dated December 12, 2018, as supplemented.

Condition No. 5(b)(3)(i) includes a note on the chromium coated cladding.

Condition No. 9 has been renumbered Condition No. 10. Condition No. 9 now extends the previous revision of the certificate for approximately one year.

The expiration date of the certificate (Condition No. 10) was not modified.

The References section of the certificate was updated to include the application dated December 12, 2018, as supplemented on January 9, 2019.

CONCLUSION

Based on the statements and representations in the application, the staff finds 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. 9319, Revision No. 11,
On January 10, 2019.