Second Request For Additional Information For Review Of The Certificate Of Compliance No. 9372 (TN-B1)

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Agenda

Time	Topic(s)
11:00 AM – 11:15 AM	Introductions (Non-Proprietary)
11:15 AM – 11:45 AM	Structural RAI's Review (Non-Proprietary)
11:45 AM - 12:00 PM	Thermal RAI 3-2 Review (Non-Proprietary)
12:00 PM – 12:20 PM	Criticality RAI 6-1 Review (Non-Proprietary)
12:20 PM – 12:25 PM	Break
12:25 PM – 1:00 PM	Thermal RAI 3-1 Review (Proprietary)

Introductions

Structural RAI’s

RAI 2-1

Provide technical discussions on how the fuel was modeled and more importantly how the fuel mass was incorporated into the fuel rod model in the finite element (FE) analysis, and provide the FE analysis results.

In the response to the RAI 2.1, the applicant indicated that the cladding was modeled using shell elements in its LS-DYNA FE analysis. However, there is no discussion about how the fuel was modeled and how the fuel mass was incorporated into the fuel rod model. The applicant must address this, because if 100% of the fuel mass was not included in the fuel rod model, the FE analysis results would be very unconservative.

This information is needed to determine compliance with 10 CFR 71.41(a), and 71.73(c)(1).

RAI 2-1 Response

N° FS1-0015328	Rev. 2.0	Structural Analyses of the AREVA ATRIUM-11 LTA Fuel Assembly in the RAJ-II Container during Normal and Accident Transport Conditions [redacted]
[redacted]	Page 10/88	

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[redacted]

5.0 ASSUMPTIONS

5.1 Assumptions

The following assumptions are made in the present analysis.

- The Atrium-11 LTA fuel bundle is packaged inside the inner container of the TN-B1/RAJ-II shipping container. The total weight of the Atrium-11 LTA fuel bundle is essentially equal to that of Atrium-10. The other cavity of the TN-B1/RAJ-II inner container is occupied with a dummy weight that has the same weight as Atrium-11 LTA fuel bundle.
- Actual ATRIUM 11 LTA fuel shipments may be done in the TN-B1/RAJ-II shipping container with a single element in each shipping container and a ballast (fuel channel, cage assembly with tie plates) having the equivalent peripheral envelope with no fissionable material in the other side of the container. The ballast will may have the weight of the ATRIUM element. Appendix B evaluates the reduction in weight of ballast compared to a full weight element or ballast and its acceptability.
- The fuel pellets are not modeled in the present analysis. However, the weights of the fuel pellets are added to the cladding tubes.
- In the dynamic simulation, the side surfaces of the inside container is assumed to be elastic. This is conservative given the side surfaces of the inner container are made of Ethafoam material and a steel sheet liner.
- In the present analysis, individual fuel bundle without the container is directly dropped at a velocity equals to 527.5 in/sec (corresponds to a height of 30 ft). It results in conservative estimate of the

Discussion of how pellet weight was incorporated into model

RAI 2-2

- **Highlights of AREVA response to RAI 2-2**
  - **Testing shows the weld and heat affected zone (HAZ) are strongest part of rod**
  - **Strain in HAZ is less that 1%**
  - **At the weld, the plastic strain of the cladding is at its minimum**
  - **Significant margin to failure exists**

RAI 2-3

Revise Chapter 8 of the application to incorporate the fuel rod acceptance and qualification tests for the ATRIUM-11 fuel rods and end caps.

In response to RAI 2-4, the applicant revised the description of the containment boundary in Section 4.1.1 of the application by describing qualification and acceptance tests for the ATRIUM 11 fuel rod and end caps. The applicant is asked to incorporate these tests into Chapter 8 of the application, which the staff can incorporate as a Certificate of Compliance condition.

This information is required to ensure compliance with 10 CFR 71.33(a).

RAI 2-3 Response

Section 8.2.2 Leakage Tests will be changed to read as follows:

“Containment is provided by the fuel rod for Type B shipments. The fuel rods are manufactured under a Quality Assurance Program meeting the requirements of 10 CFR 71 Subpart H. Welds of the fuel rod end caps to the cladding are conducted under a qualified process and verified for integrity by such means as X-ray inspection, ultrasonic testing, or process control. For 11x11 fuel rods, the integrity of the closure welds for the fuel rods are periodically assessed using burst testing. This testing is considered successful if the ultimate hoop strength at room temperature obtained is equal or greater than the minimum ultimate strength established from temperature, longitudinal tensile tests for the same lot. Each loaded fuel rod (of any design) is leak tested after fabrication to assure that the rod is leak tight (<1x 10-7 atm-cc/s). Neither the inner or outer container is credited with providing leak protection. Therefore, no leak test of the packaging is required.”

Thermal RAI's

RAI 3-1

- **This RAI will be discussed during the propreitary session**

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RAI 3-2

Provide additional information that justifies the statement included in Section 7 of calculation package FS1-0024572, which states: "testing resulted in no failure of the cladding as verified by leak tests." Likewise, justify the conclusion in Sections 7 and 8 of calculation package FS1-0024572 that the GNF-J CTU 2J certification unit resulted in no failure of the simulated fuel assembly cladding after hypothetical accident condition tests.

The information presented in the SAR does not appear to be consistent with the statements in FS1-0024572. For example, SAR Section 2.12.1.3 stated that the CTU 1 and CTU 2 certification units were helium leak tested after the drop tests and that results from the CTU 2 tests indicated a helium leakage rate of 5.5E-6 atm-cc/s. In addition, there was no mention of helium leakage rate testing in SAR Section 2.12.2 for the corresponding GNF-J certification tests.

This information is required to ensure compliance with 10 CFR 71.51(a)(2) and 71.73.

RAI 3-2

- **Section 1.2.2 "Containment System**

1.2.2. ***Containment System***

The containment system components are identified above in Section 1.2.1 and accompanying figures. The primary containment boundary of this package is the fuel rod cladding as shown in example *Figure 1-6 Example Fuel Rod (Primary Containment)*. The fuel rod is completed by loading the uranium dioxide pellets into a zirconium alloy cladding tube. The tubes are pressurized with helium and zirconium end plugs are welded to the tube which effectively seals and contains the radioactive material. Welds of the fuel rods are verified for integrity by such means as X-ray inspection, ultrasonic testing, or process control. A representative nominal internal pressure of fuel rods at room temperature conditions is 1.1 MPa (160 psia) (absolute pressure). The TN-B1 package cannot be opened unintentionally. Both the OC and IC lids are attached to their respective bodies with socket-headed cap screws. There are twenty-four bolts holding the outer lid in place. There are no other openings in the outer container. The inner container has ten bolts holding the main lid in place and four bolts holding the end closure in place. Thus, the requirements of 10 CFR 71.43(c) are satisfied.

Figure 1-6 Example Fuel Rod (Primary Containment)

RAI 3-2 (Continued)

4.4. CONTAINMENT UNDER FOR HYPOTHETICAL ACCIDENT CONDITIONS (TYPE B PACKAGES)

The sintered pellet form of the radioactive material and the integrity of the fuel rod cladding are such that there will be no substantial release of radioactivity under the Hypothetical Accident Conditions. Before and after the accident condition testing the rods were helium leak tested demonstrating leak tightness. Similar fuel rods have been tested at temperatures and resulting pressures that will be seen by fuel shipped in the TN-B1.

10 CFR 71.51 requires that no escape of other radioactive material exceeding a total amount A_2 in 1 week, and no external radiation dose rate exceeding 10 mSv/h (1 rem/h) at 1 m (40 in) from the external surface of the package. The following qualitative assessment demonstrates that the performance requirement of 10 CFR 71.51(a)(2) will be satisfied.

RAI 3-2 (Continued)

Table 1-4 shows the calculated A_2 for the mixture of the maximum radionuclide content in the package is 0.17 Ci. The total radioactivity in the package using the maximum isotopic values is7.7 Ci. The mass of UO_2 equivalent to an activity of 7.7 Ci is 550 kg (275 kg UO_2/assembly x 2 assemblies) which yields a mass to activity ratio of 71.4kg UO_2/Ci. The mass equivalent A_2 is therefore 2.1 kg UO_2.

Following the drop test, fuel rods were leak tested and shown to have a very low leak rate of He at a rate of 5.5×10^{-6} cm^3/s. Over one week this is equal to 3.3 cm^3 (5.5E-6 cm^3/s x 6.05E5 s/wk = 3.3 cm^3). Conservatively assuming that the density of the radioactive material is 10g/cm^3 and using the A_2 mass above of 2,100 g of UO_2, the UO_2 would have a volume of 210 cm^3. This is much greater than the volume leaked. This calculation is extremely conservative since the UO_2 would predominantly stay in a ceramic form and not be available for dispersion.

Test fuel rods as described in Section 2.0 have been baked at 800°C for over 30 minutes and did not leak.

Additionally, the large mass, 2,100 g, of material required to exceed the A_2 would require a catastrophic failure of the rod, significant leak of the inner and outer container.

Dose rates are less than the 10mSv/hr under any condition because of the low specific activity and low abundance of gamma emitters in the fuel.

Based on this evaluation, it is demonstrated that the package meets the containment requirements of 10 CFR 71.51

RAI 3-2 (Continued)

- Although CTU-2 did show a leak rate of 5.5 x 10^{-6} atm-cc/s the cladding is not considered to having failed in that, although there was a leak from the cladding, the leak rate was well below regulatory requirements under HAC conditions.
- FS1-0024572
  - Section 7, the statement that “testing resulted in no failure of the cladding as verified by leak tests” is correct in that the cladding, as demonstrated in the SAR section 4, did not fail in its function as a containment boundary.
  - Section 8 which states “testing performed on a GNF-J CTU-2J resulted in no failure of the simulated fuel assembly cladding”, this statement is consistent with the results reported in in section 2.12.2.3 “Test Performance”, of the SAR. AREVA does not have any records from these tests which would indicate that a helium leak rate test was performed during that testing.

RAI 3-2 Summary

- The results of CTU1 and CTU-2 testing did not show any “failure” of the cladding because the testing did not show any failure in its function as a containment boundary.
- The SAR, along with other documents, does not contain any data regarding leak rate from the testing of GNF-J CTU-2J. The only data reported is that there was no failure of the simulated fuel assembly cladding.
- All leak rate data is a result of the testing on CTU-1 and CTU-2 as described in the SAR, both in the current revision and previous revisions, including those for the RAJ-II SARs upon which the TN-B1 SAR is derived from.

Criticality RAI

RAI 6-1

- **Open discussion on RAI and framatome response.**