December 9, 2009

MEMORANDUM TO: Eric Benner, Acting Deputy Director
Licensing and Inspection Directorate
Division of Spent Fuel Storage and Transportation, NMSS

FROM: Pierre Saverot, Project Manager **/RA/**
Licensing Branch
Division of Spent Fuel Storage and Transportation, NMSS

SUBJECT: SUMMARY OF DECEMBER 2, 2009, MEETING WITH AREVA NP REGARDING THE GLOBAL SHIPPING CONTAINER

Background

AREVA NP (AREVA) is designing a new fresh fuel transportation package to support the EPR reactors' fleet (USA, Europe, China, other countries). Drop tests and thermal tests are now scheduled to be performed in June 2010 (versus a February 2010 date announced at the April 21, 2009, meeting with NRC). Analysis of the results will take two months, followed by the decision to manufacture a series of containers in August 2010. A license application will be submitted to the French Authorities at the end of 2010, while the Model No. FCC-NG package application is planned for submittal to the NRC in late Spring 2011. AREVA will thus manufacture "at risk" during staff's review of the Model No. FCC-NG package application.

Discussion

Materials and Structural Issues

The package design includes four types of materials, i.e., stainless steel, balsa wood, BORA resin, and rubber seals. A cable wire damping system has now replaced the rubber bearings planned in the original design. Staff noted that components "important to safety" have quality-related specifications for procurement, and explained that (i) all "important to safety" materials shall be properly defined and characterized, and (ii) the representativeness of materials used for the prototypes shall be demonstrated because the use of "generic" materials is likely to be contested during the application's review. Staff said that the cable wires shall be considered important to safety and properly captured in the licensing drawings if they serve any energy absorbing mechanical safety function in a slap down configuration.

AREVA confirmed that the T-frame is continuous in its axial direction. Staff noted that findings in recently approved packages, e.g., the "Traveller" package, would be helpful in identifying commonly encountered technical issues and said that sufficient details shall be addressed in the application, e.g., the lattice expansion failure mode in view of the criticality safety evaluation. In addition, staff said that key test results, e.g., records, observations, and photos may need to be submitted to (i) support the applicant's case in

making bounding assumptions for criticality analysis, and (ii) help staff in determining compliance with regulations.

AREVA mentioned that the maximum crushing strength of the balsa wood at - 40ºC is equal to the minimum crushing strength of the poplar tree at + 20ºC, and proposed to replace the balsa wood of the impact limiters by poplar wood for the test prototypes. Staff stated that such a concept is “interesting” but questioned the need for such a change which might “work against” the applicant’s objectives because the demonstration of the performance of the impact limiters during the end-drop, secondary impact, is crucial for this type of package. Staff referred again AREVA to recently approved packages for such a demonstration.

AREVA proposed to use a fuel assembly mock-up (265 rods) with half of the rods with their lower insert and half of the rods without their lower insert. Staff disagreed with this approach for a number of reasons, including the following: (i) the focus shall be on rod buckling, not stress performance, (ii) inserts configuration might change the fuel assembly behavior and its structural performance may be sensitive to some constraints and boundary conditions provided by the grid spacers, and (iii) there will likely be a tendency for non-uniform lattice expansion and the interpretation of the results will be difficult.

The EPR fuel assemblies may have a strengthening grid spacer near the bottom end-fitting. AREVA proposed not to put the strengthening spacer on the fuel assembly mock-up to be dropped in the vertical position, while there will be one for drops in the horizontal position. Staff noted that pre-test design calculations for performance verification will be needed for determining this test option. AREVA informed staff that M5 is the cladding of choice for the EPR fuel rods but that Zircalloy-4 (Zr4) may also be used. Staff then stated that these claddings have different material strengths (Zr4 with a higher yield strength is less ductile than M5) and that the cladding material with the largest potential for plastic deformation during end drops needs to be captured in the test program.

AREVA indicated that RCCAs will be shipped with the fuel (for security and economic reasons) and that the drop tests will include RCCAs. Staff noted that potential structural interactions between the RCCA and the fuel assembly during the drop tests need to be considered for a number of reasons, including: (i) the types of structural damage modes, resulting from accident conditions, may be affected by the presence of the RCCAs, and (ii) the need to properly represent the distribution of the mass of the fuel rods. AREVA also indicated that the ballast (used to simulate one of the two fuel assemblies to be held in the fuel cavity for the test) will be a tube, and staff asked if its flexural rigidity is similar to that of the fuel assembly mock-up, and if spatial distribution will be considered.

AREVA claimed that the sequence of the drop tests had no impact on the internal arrangement of the damaged state and that it could apply for a Part 71 license without following the sequence specified in the regulations. Staff unequivocally disagreed with such an approach and said that the test sequence specified in the regulations is not subject to interpretation. In addition, staff noted that the presence or absence of an air

gap resulting from the drop test, which could be very important for the package thermal performance, may significantly be affected by the test sequence.

Regarding the drop test program, the staff said that the applicant needs to plan also for a corner drop when the secondary impact is considered for evaluating the most damaging drop orientation. AREVA answered that written arguments will be prepared and that there is currently no plan for performing a corner drop test. AREVA also indicated that a drop angle of 20º was determined by LS-DYNA calculations to maximize the G load and the energy dissipated at the second impact in the slap down drop test. Staff said that such calculations must be submitted with the license application. AREVA mentioned that it was initially planning a 1 meter drop test onto a punch bar with a 40º angle followed by an impact onto the package door - T- frame closure area, and that the French Competent Authority (ASN) had said that the 40º angle was too large. Staff reminded AREVA that (i) the application should clearly explain how the secondary impacts are handled and how the most damaging configuration is being evaluated, (ii) accelerometers should be installed for the drop tests to aid in the interpretation of the results, and (iii) it was the applicant's responsibility to make the case that the most damaging drop orientation was also applicable and resulted into the most damaging packaging condition for the thermal test that follows the drop tests.

Thermal Issues

Thermal tests will be performed for the NRC license application, while AREVA will perform finite element calculations for its French license. Staff indicated that the applicant shall use an emissivity of 0.9 and the correct temperature of 1475º F. Staff advised AREVA to (i) run thermal simulations to capture transients and perform a detailed post-fire analysis, (ii) record the post-fire temperatures for 24 hours minimum, and (iii) evaluate the thermal stresses in the components of the package.

Criticality Issues

During the first pre-application meeting, staff had clearly stated that it does not accept code to code comparisons and that complete benchmarking information is needed for all codes. Staff had expressed concerns over the CRISTAL benchmarking results versus IHECSBE experiments and also said at the time that the applicant must either justify that there is no gap or assume, per 10 CFR 71.55(b), a flooded gap and take no credit for the cladding as containment boundary.

AREVA mentioned that the qualification tests for the BORA resin will include a 9 m drop test, followed by the pin test and a damage assessment, but that the thermal test will be performed with a reduced length container with an "identical" damage. AREVA indicated the following assumptions for the criticality calculation results (K_{eff} = 0.925, including 2 σ): degradation of the BORA resin (poison burned out), a penalty of 25% on the boron content, and a fully flooded gap between the pellets and the cladding. Regarding the credit for boron content in the BORA resin, the staff explained that a 75% credit is for Normal Conditions of Transport and that the 25% reduction is used to account for the non-uniformity of the boron distribution in the poison material. Staff stated that (i) the common practice is to assume that all boron is gone under Hypothetical Accident

Conditions (HAC), (ii) if AREVA claims a 75% credit, this needs to be demonstrated after the thermal test, (iii) the thermal test shall positively show that boron is still present and retains its shape, and (iv) any assumption, e.g., a 25% burned thickness of the outer layer of the BORA resin, shall be justified for this particular compound, i.e., staff cannot accept a result obtained with the FS-69 neutron absorber material for a BORA resin. However, the 25% reduction in boron content still applies because it is used to account for manufacturing defects rather than for HAC damages to the neutron absorber materials. Staff further stated that rod slipping, bird caging, fuel rod expansion and manufacturer's tolerances are not included in the margin of safety for the k_{eff} and thus need to be evaluated. AREVA said that, for HAC conditions, the section of the fuel assembly is expanded to the section of the maximum package cavity (219 mm) on 1/3 of its length and remains nominal on the remaining length. Staff answered that it will have to think about such a novel approach but that the applicant must, in all cases, justify any assumption and prove that the configuration gives the maximum k_{eff}.

AREVA presented some results of criticality calculations with either a moderation ratio between 2 and 3 or by using an EALF parameter less than 0.4 (USL1=0.941, USL2=0.978 in the first case; and USL1=0.942 and USL2=0.980 in the second case) and said that an USL of 0.941 was chosen for the safety criticality evaluation. Staff did mention that the applicant must present data with the proper enrichment range (from 2% to 5%) or justify why low enrichment ranges are not included in the calculations particularly for shipments of first fuel loads. Staff also said that an USL2 of 0.982, as presented on one of the slides, is very high.

Staff fundamentally disagreed with the applicant's approach for benchmarking the criticality analysis codes (a cross section generation code and a package criticality analysis code). Staff stated that (i) the purpose of a super cell is to generate a cross section, (ii) the package geometric effect to flux distribution has to be considered for flux-weighted cross sections, (iii) the applicant's approach of using a one dimensional (1-D) code to obtain a cross section and use a 3-D Monte Carlo code for k_{eff} calculation looses all meaning for the Monte Carlo code, and (iv) a 3-D code becomes now meaningless because the input is a 1-D result. Staff stated multiple times that one would never be able to benchmark a cross section generation code against critical experiments (IHECSBE). In view of the fundamental differences expressed during this part of the discussion, staff said that the applicant's approach should be reconsidered and that AREVA should request additional pre-application meetings or conference calls over the next 16 months to obtain clear guidance and enhance the likelihood of a high quality application.

The enclosures are the agenda, the list of meeting attendees, and a copy of the slides AREVA presented at the meeting. The staff did not make any regulatory commitments at the meeting.

Docket No. 71-9351
TAC No. L24331

Enclosures: As listed

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Distribution: SFST, NRC Attendees

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OFC	SFST	E	SFST	C	SFST			
NAME	PSaverot		MDeBose		SBaggett			
DATE	12/6/2009		12/08/2009		12/09/2009			

C=Without attachment/enclosure E=With attachment/enclosure N=No copy **OFFICIAL RECORD COPY**

Agenda

Meeting between AREVA NP and the
Nuclear Regulatory Commission
December 2, 2009
9:00 a.m. – 1:00 p.m.

- Opening Comments
- Presentation of the Project: timeframe, needs, requirements
- Description of the Container
- Review of Design Changes since the April 21, 2009, Meeting with NRC
- Proposed Test Plan – Justification of Each Drop
- Progress Status of the Cristal Code Validations
- Safety Case with Flooded Gap
- Closing Comments and Conclusions

Meeting Between AREVA NP and the
Nuclear Regulatory Commission
December 2, 2009
Meeting Attendees

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