July 1, 2009

Mr. Richard Boyle, Chief
Radioactive Materials Branch
Office of Hazardous Materials
Technology
U.S. Department of Transportation
400 Seventh Street, S.W.
Washington, DC 20590

SUBJECT: REQUEST FOR ADDITIONAL INFORMATION FOR REVIEW OF THE MODEL NO. NCS 45 PACKAGE

Dear Mr. Boyle:

This refers to your request dated January 22, 2009, for a recommendation concerning the revalidation of the Model No. NCS 45 package, German Certificate of Approval No. D/4347/B(U)F-96, Revision 0. Enclosed are requests for additional information needed to continue the review for revalidation of the NCS 45. Our established schedule provides a Certificate of Compliance issuance date of November 20, 2009, for the NCS 45 package. We request that you provide this information by September 21, 2009, or earlier if possible. Inform us at your earliest convenience, but no later than September 7, 2009, if you are not able to provide the information by that date. To assist us in re-scheduling your review, you should include a new proposed submittal date and the reasons for the delay.

Please reference Docket No. 71-3084 in future correspondence related to this request. The staff is available to meet to discuss your proposed responses. If you have any questions regarding this matter, I may be contacted at (301) 492-3294 or you may contact Chris Staab of my staff at (301) 492-3321.

Sincerely,

/RA/

Eric Benner, Chief
Licensing Branch
Division of Spent Fuel Storage and Transportation
Office of Nuclear Material Safety
and Safeguards

Docket No. 71-3084
TAC No. L24301

Enclosure: Request for Additional Information

Mr. Richard Boyle, Chief
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Office of Hazardous Materials
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U.S. Department of Transportation
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Department of Transportation

Docket No. 71-3084

Request for Additional Information

Model No. NCS 45 Package

By letter dated January 22, 2009, the Department of Transportation submitted a request to the U.S. Nuclear Regulatory Commission to provide a recommendation concerning the revalidation of the Model No. NCS 45 package, German Certificate of Approval No. D/4347/B(U)F-96, Revision 0. This Request for Additional Information (RAI) identifies information needed by the U.S. Nuclear Regulatory Commission (NRC) staff in connection with its review of the application. Each individual RAI describes information needed by the staff for it to complete its review of the application to determine whether the applicant has demonstrated compliance with regulatory requirements.

General Information

1-1 Revise Table 4 and Table 5 for the General Specifications for Contents 1 and 5 contained within the Design Examination Certificate to be consistent with similar tables contained within the German Certificate of Approval and the tables located in the General Information Section.

The specifications in Table 4 state the maximum decay heat for content 1 with cask cavity flooded with air, without a closed container is 750 Watts. However, both the German Certificate of Approval and General Information Section state the maximum decay heat for Content 1 with cask cavity flooded with air, with a closed container is 750 Watts.

Table 4 does not state the maximum decay heat for a cask cavity flooded with Helium, with a closed container. Both the Certificate of Approval and General Information Section provide the maximum decay heat for this case as 2500 Watts. Without a closed container, the maximum decay heat is 3000 Watts.

Similar inconsistencies exist between Table 5 and the Certificate of Approval. The applicant should review the Design Examination Certificate, Certificate of Approval, General Information Tables, and other tables throughout the Safety Analysis Report (SAR) and revise the tables to resolve existing inconsistencies as appropriate.

This information is needed to determine compliance with TS-R-1 Regulation 807(a).

1-2 The applicant should make clear the containment description and maximum mass of the packaging provided in the German Certificate of Approval and the containment description and maximum mass of the packaging provided in the Description of Packaging section of the SAR. Currently, the containment descriptions do not match.

The containment description provided in the SAR states the containment consists of the “flange of the bottom lid” and the “discharge lid plug with belonging inner seal,” whereas the containment description provided in the Certificate of Approval states the containment consists of the “flange of the bottom plug” and the “push plug lid with

belonging inner seal." Other portions of the SAR refer to the "bottom lid" and "bottom plug" and the "discharge lid plug" and "push plug lid" as distinctly different components. Based on these inconsistencies, the containment boundary is unclear. The applicant should ensure the containment boundary is clearly defined throughout the SAR, containment analysis, and Certificate of Approval and that the containment boundary is consistently defined throughout these documents.

Also, the maximum packaging mass described in the certificate and SAR is different by up to 2,000 kilograms.

This information is needed to determine compliance with TS-R-1 Regulation 807(b).

Structural

2-1 Staff was unable to locate any language addressing these following paragraphs. Provide staff with location of this information in the licensing documentation, or, provide an explanation illustrating why these provisions do not need to be addressed.

(a) 713 - All specimens shall be inspected before testing in order to identify and record faults or damage including the following: (a) divergence from the *design*; (b) defects in manufacture; (c) corrosion or other deterioration; and (d) distortion of features

(b) 720 - The time interval between the conclusion of the water spray test and the succeeding test: *For details see TS-R-1.*

(c) 732 - Water leakage test for packages containing fissile material. Test must occur after mechanical tests (727) and thermal test (728).

(d) 733 - Water leakage test for packages containing fissile material. Submerged under a head of water of 0.9 m for eight hours

(e) 737 - Impact test: The specimen shall be subject to an impact on a target at a velocity of not less than 90 m/s, at such an orientation as to suffer maximum damage. The target shall be as defined in paragraph 717, except that the target surface may be at any orientation as long as the surface is normal to the specimen path.

This information is necessary to determine compliance with TS-R-1.

2-2 Clarify the two wood types used in the shock absorbers.

SAR Section 3.6 states that the shock absorber is made of balsa and spruce wood. Figure 3 of SAR B-TA-3991-Rev. 2, page 15 and Table 2, page 18 indicates the shock absorbers are made of balsa and pine.

This information is required to meet TS-R-1 Regulation 656.

2-3 Provide a copy of the reference for the wood properties in Figures 6 and 7 (SAR B-TA-3991-Rev. 2).

These graphs are not in the wood reference (Niemz) provided.

This information is required to meet TS-R-1 Regulation 656.

2-4 Provide copies of the reference pages for the specific energy of deformation and compressive stress of balsa and spruce in Table 4-3 of SAR NCS 0017, Rev. 4.

The spruce longitudinal and balsa longitudinal deformation energies at 25ºC agree with the Materials Data Sheet but the other information entries are either incorrect or were not found in the wood reference provided (Niemz).

This information is required to meet TS-R-1 Regulation 656.

2-5 Provide a copy of the reference pages for the Young's Modulus for the plaster. Provide verification of the plaster density of 1890 g/cc.

The ASTM data sheet (provided by the applicant) lists the density at 2060 g/cc or about 8% higher than the value above. It is expected that the thermal properties of the insulating material will be dependent on the density of the material.

This information is required to meet TS-R-1 Regulations 501(b) and 655.

2-6 Provide a copy of the reference supporting the limiting temperatures for the thermal insulation (Table 5-1 of SAR NSC 0017 Rev 3), and all values given for the thermal insulation in Tables 5-5 and 5-6 of SAR NSC 0017, Rev. 3.

No references were provided to support the thermal characteristics of the insulator. Incorrect thermal properties will result in incorrect determination of the temperature of the components.

This information is required to meet TS-R-1 Regulations 501(b) and 655.

2-7 Provide support for the "time yield limit" given for tungsten in Table 4-9 of SAR NCS 0017, Rev. 4.

The tables in the Guruswamy reference do not support the values given in Table 4-9. These values are used in Section 4.2.4.3.1 to calculate heat effects.

This information is required to meet TS-R-1 Regulation 651(b).

2-8 Clarify why the physical property values for a particular material are different for different components?

The values for physical properties listed in Table 4-48 of SAR NCS 0017, Rev. 4, are internally inconsistent, and do not agree with the values given in Tables 4-5 thru 4-11.

This information is required to meet TS-R-1 Regulation 501(b).

2-9 Provide references or justification for the specific heat capacities in SAR Table 5.5.1.3. Provide justification for the density of helium that appears to be a factor of 2 to low.

The specific heat capacity of the zirconium heat zones appears to be more than a factor of 3 too high. No references are given for the specific heat capacity of the balsa wood shock absorber, or the plenum cladding tubes. Correct values are required in order to calculate the temperatures of the components.

This information is required to meet TS-R-1 Regulation 501(b).

2-10 Explain why oxidation of fuel pellets and pellet scrap (Content 1.3) that are not required to be in a welded container but can be in an air atmosphere does not create a containment safety issue.

This information is required to meet TS-R-1 Regulations 507, 613, and 642.

2-11 Provide materials of construction, designs, and drawings, for the welded cans

Many of the contents are required to be placed in welded cans because their burnup is too high, or they are uncontained by themselves (debris), or are considered damaged rods with cladding breaches. No materials, of construction, design, code specifications, or a description of these cans are provided in the SAR. This information is needed to determine if the cans will perform their intended function.

This information is required to meet TS-R-1 Regulations 651(a) and 807(b).

2-12 Justify why welded canning of fuel should not be required for fuel with burnup above 45 GWd/MTU instead of above 62 GWd/MTU.

No definition is given for high burnup fuel. At burnups above 45 GWd/MTU the properties of the fuel and cladding start to change rapidly. Some of these changes, especially hydrogen absorption in the cladding, may have adverse affects on the ability of the fuel cladding to act as a containment barrier.

This information is required to meet TS-R-1 Regulation 651(a).

Containment

3-1 Correct or further explain the necessary Helium purity discussed in Section 6.3.6 of the Test Instruction No. PA-02-06, Rev. 3.

A value of 4.6 for Helium purity is given as necessary purity for the Helium used as a test gas for the Helium leakage test. It is not clear to the staff what the 4.6 value represents,

whether it is a percentage or other measure of purity. Clarification of this value would provide the staff with the needed assurance of the proper Helium purity.

This information is needed to determine compliance with TS-R-1 Regulation 501(b).

Shielding

4-1 Please provide an English copy of drawing SK020503-7 found in Attachment 10.3.

The boundary dimensions for the vehicle and dose rate distance from the axis pertaining to Figure 7-10, 7-13, and 7-14 need to be established.

This information is required to meet TS-R-1 Regulations 807(b), 531, and 532.

4-2 Explain why variable active source volumes are considered in Tables 7-31 and 7-34.

It is not stated elsewhere in the Safety Analysis Report that the Applicant will use less than the entire cask length volume to serve as the active fuel volume. The relevance of the different source heights needs to be explained.

This information is required to meet TS-R-1 Regulations 501(b), 531, and 532.

4-3 Describe the mechanism used to fix the fuel rods in place when positioned in guide tubes or in cask internal volume for transport.

Fuel rods placed in guide tubes may shift during transport without a mechanism to fix their location. A shift in fuel rod position will change the dose rate distribution along the cask. This information is needed to determine whether the dose rate distribution along the cask will remain within the allowable limit.

This information is required to meet TS-R-1 Regulations 531, 532, and 651(a).

4-4 Describe the mechanism used to fix pellets and pellet scraps not in welded cans in place during transport.

Table 1.3: Specification for Content 1.3, in the Certificate of Approval lists “Pellets and pellet scraps in not welded cans.” Pellets and pellet scraps not contained in welded cans will shift during transport. Contents shifting position will change the dose rate distribution along the cask. This information is needed to determine whether the dose rate distribution along the cask will remain within the allowable limit.

This information is required to meet TS-R-1 Regulations 531, 532, and 651(a).

4-5 Clarify the fissile material cross section, mass of fissile material before irradiation, and the permissible heavy metal mass allowed as found in Tables 1.5 and 1.5a in the Certificate of Approval.

Tables 1.5 and 1.5a in the Certificate of Approval contain differing values than Table 10: Specific data for Content 1.5, in Section 3.5 of the SAR.

This information is required to meet TS-R-1 Regulations 501(b), 502(a), and 807(a).

4-6 Verify the neutron radiation correction factor for the axial extension of the source, 2 m distance equation found in Table 2 of the Certificate of Approval.

The 2 m distance from the transport vehicle correction factor with respect to neutron radiation, found in Table 2 of the Certificate of Authority, is not the same as that found in Table 7-29 of the SAR.

This information is required to meet TS-R-1 Regulation 531 and 532.

4-7 Further explain the remark in Section 7.8.2 that states, "For the determination of these factors also other calculations were taken into account, which are for the time being not subject of the Safety Analysis Report," and explain how it impacts the differences between Equations in Table 7-20 and 7-21.

Details important to dose rate calculations should be provided in to the Safety Analysis Report.

This information is required to meet TS-R-1 Regulations 501(b), 531, and 532.

4-8 Describe how dose rate calculations are adjusted for older fuel that may be clad by stainless steel and how dose rates will remain within allowable limits and comment how permissible heavy metal mass, as found in Table 1.1a of the Certificate of Approval, will change when the cask contains fuel rods clad with stainless steel verses zircaloy.

As per Table 1 in the Certificate of Approval, the cladding tube materials allowable are stainless steel, zirconium alloys, and aluminum. The homogeneous fuel zone mixture modeled is with zircaloy cladding and SS304 guide tube. Cladding composed of stainless steel will have greater activity due to cobalt-60 activation products.

This information is required to meet TS-R-1 Regulations 501(b), 531, and 532.

4-9 Justify use of the source spectrum in Table 7-7 of the SAR for Uranium fuel with an enrichment of 4.5 wt% U-235 in Uranium, burn up of 60,000 MWt/tU, and a decay time of 365 days.

Table 1.5 of the Certificate of Approval allows for sources of more burn up, less cooling time, and lower enrichment than the source strength modeled. Modeling more conservative but allowed conditions will provide more conservative dose rates.

This information is required to meet TS-R-1 Regulations 501(b), 531, and 532.

4-10 Explain how figures are carried from Table 7-7 to Table 7-19.

The source strength for energy group 2.0 – 2.5 MeV, on Table 7-7, is found to be 1.77E+11 (1/s) and on Table 7-19 the normalized source strength it is found to be 1.77E+13. It is unclear how the Applicant obtains the figures in Table 7-19 from those found in Table 7-7.

This information is required to meet TS-R-1 Regulations 531 and 532.

4-11 Explain how the permissible heavy metal mass (kg) for undamaged fuel rods and canned fuel is derived.

It is unclear how the Applicant established the limits on the mass of the source term, as found in Table 1.1a of the Certificate of Approval, such that dose rates do not exceed the dose rate limit, based on the normalized source strengths, as found in Table 7-37, and package surface dose rates, as found in Table 7-31.

This information is required to meet TS-R-1 Regulations 501(b), 531, 532, and 807(a).

Criticality

5-1 Provide the supporting reference for the verification plan used to justify your use of SCALE 5.

Section 8.3.1 states "….according to [NUREG 1996] the verification of program systems SCALE 5 consists of installation verification and of functional verification." The reference mentioned (NUREG 1996) refers to the verification and validation of the earlier SCALE-4 version of the software.

This information is required to meet TS-R-1 Regulations 671(a), 677, and 679.

5-2 Provide more clarification for the methodology used in the proof for Content 1.2. Include justification for assuming a maximum 18 cm diameter based on the concentration of fissile material and water distribution.

Section 8.6.1.2 states a maximum fissile material diameter of 18 cm is assumed in the calculation. Table 8-8 shows the reactivity for combinations of fissile material per unit length and water fractions. Table 2-3 shows that the fissile material maximum cross section is 18 cm which could be interpreted as including smaller diameter cross sections. The fissile material and water fractions shown in Table 8-8 are only based on an 18 cm diameter. If varying cross sections up to 18 cm are allowed, then the optimum concentration of fissile material and water would be different. Justification is needed for the use of 18 cm diameter as bounding given that fissile material and water fraction per unit length are varied also.

This information is required to meet TS-R-1 Regulations 671(a), 677, and 679.

5-3 Provide more detail regarding the methodology used in the proof for Content 1.3. Include an example showing how the fissile material diameter and fissile material distribution per unit length were obtained using the results from Section 8.6.1.

The height was varied in Section 8.6.1.3 as part of the methodology for the proof of Content 1.3. Furthermore it states that for every considered fissile material height, the diameter of fissile material cylinder is optimized. However, no data or calculation was found justifying the use of each fissile material concentration in Table 8-9 used to determine the optimum water fraction.

This information is required to meet TS-R-1 Regulations 671(a), 677, and 679.

5-4 Indicate whether the bounding fissile material and water concentration shown in Table 8-9 occurred at a diameter of 11.00 cm or a radius of 11.00 cm. Indicate whether the reactivity values in Table 8-9 correspond to the appropriate diameters.

The fissile material diameters are listed in Table 8-9 of the SAR. However, Section 8.6.1.3 states, in part, that the "maximum reactivity is reached for …..a diameter of fuel cylinder of 22 cm."

This information is required to meet TS-R-1 Regulations 671(a), 677, and 679.

5-5 Provide more detail concerning how the fissile material cylinder diameter at each height was optimized.

Section 8.6.1.3 states "….for every considered fissile material height the diameter of fissile material cylinder is optimized." However, the results in Table 8-9 only show the varying concentrations of fissile material and water fraction. Detail concerning how the optimum diameter at each of the cylindrical heights in Table 8-9 is not specified.

This information is required to meet TS-R-1 Regulation 671(a).

5-6 Provide more detail concerning how the bounding diameter was determined.

Section 8.6.1.4 states, in part, that the "Maximum reactivity is reached for …..a diameter of fuel cylinders of 22 cm." However, information detailing how the optimum diameter was determined was not found.

This information is required to meet TS-R-1 Regulations 671(a), 677, and 679.

5-7 Provide more detail regarding the placement of steel tubes containing fissile material used in the methodology for the proof of Content 1.5. In addition, provide the methodology for how the number of tubes filled in the model was obtained. Include drawings of analyzed rod configurations within the cavity.

The methodology in Section 8.6.1.5 describes the placement of steel tubes containing fissile material. However, the reviewer found the description hard to understand.

In addition, the model used for the proof is an infinite heterogeneous cylinder. Section 8.6.1.5 states that "….for a constant number of tubes reactivity increases with the increase of fissile material distribution. Reactivity reaches its maximum if the fuel completely fills the tubes. For a material distribution of 69.7 g/cm….46 tubes are nearly completely filled with fuel." However there is no information regarding the methodology used to determine how the number of tubes filled was calculated. In addition, more information needs to be provided regarding the correlation between fissile material distribution, the number of tubes modeled, and the reactivity.

This information is required to meet TS-R-1 Regulations 671(a), 677, and 679.

5-8 Provide clarification in Tables 6 and 7 of the Design Examination Certificate for footnote 1.

In Tables 6 and 7, footnote 1 makes reference to PWR surface contamination, but the footnote is attached to “BWR fuel rods” in the table.

This information is required to meet TS-R-1 Regulations 671(a), 677, and 679.

5-9 Provide clarification regarding whether the inner cavity of the package is dry for the package array models. In addition, indicate whether water density was varied between the array packages.

Section 8.5.4.1 states that “….the water gap between fuel cylinder and inner package wall is defined as void or is replaced by water of variable density.” However, Section 8.7 of the SAR states “that for the array of packages the dry package is assumed.”

This information is required to meet TS-R-1 Regulations 671(a), 681, and 682.

Operating Procedures, Acceptance Criteria, and Maintenance Tests

6-1 Include a requirement to inspect the trunnion threads for mechanical deviation or provide a technical justification for not including a trunnion thread inspection for mechanical deviation.

The application should include a trunnion thread inspection for mechanical deviation or should provide a technical justification for not requiring an inspection of trunnion threads for mechanical deviation. The inspection criteria should include a check for deformities such as nicks, marks, and deformities which could impair the function of the threads. Since the trunnions are used for handling the packaging, failure of the trunnions could result in a dropped load.

This information is needed to determine compliance with TS-R-1 Regulation 807.