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For the attention of **Mr. BOYLE**

Montigny-le-Bretonneux, 1st February 2016

O/Ref.: CEX-15-00117104-004

Subject: **TN-BGC 1 package**

Application for American validation of the French certificate of approval F/313/B(U)F-96 (Jbb) for the package consisting of the TN-BGC1 packaging loaded with contents n°11 or n°26.

References:

<1> TN-BGC1 French Certificate of Approval No. F/313/B(U)F-96 (Jbb);

<2> Application for the validation of certificate of Approval No. F/313/B(U)F-96 (Jbb), ref. CEX-15-00117104-001 of June 25th, 2015;

<3> Request for additional information for revalidation of model No. TN-BGC1 (French competent authority certificate of approval No. F/313/B(U)F-96 Rev. Jbb), Docket No. 71-3034, TAC No. L25037 of December 16th, 2015;

<4> Criticality code validation for TN-BGC1 - contents 11a, 11b, 11c and 11g, ref. TN-BGC1-0600 rev. 1 of January 29th, 2016;

<5> Criticality analysis for TN-BGC1- contents 11a, 11b, 11c and 11g, ref. TN-BGC1-0601 rev.2 of January 29th, 2016;

<6> Answers to the Request for Additional Information Docket No. 71-3034, TAC No. L25037 of December 16th 2015, ref. CEX-15-00117104-003 of December 21st, 2015.

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Dear Mr. Boyle,

Following our application letter in reference <2> for the validation in United States of America of French certificate of approval in reference <1>, American Competent Authority issued the Request for Additional Information in reference <3> on December 16th 2015.

For the exception of questions 2 and 3 of the Criticality Review, answers to the questions raised in this letter were provided on December 21st, 2015 in the letter in reference <6>.

You will find in Appendix 1 the answers to questions 2 and 3 of the Criticality Review of the letter in reference <3>.

To support these answers, you will find enclosed the criticality calculation notes in reference <4> and <5>. Please, be aware that these notes correspond to the revision of the notes provided with the application letter in reference <2>.

Please note that, as mentioned in Appendix 2, all questions of the Request for Additional Information in reference <3> have now been treated.

For your information, the transport of LEU from the Y12 facility (USA) to CERCA facility (France) mentioned in the application letter in reference <2> is still tentatively scheduled for the beginning of second quarter of 2016.

As a consequence, we respectfully request the validation certificate to be issued no later than February 29th 2016.

Should you need any further information, please do not hesitate to contact us.

Gregory GALLAIS
Design Manager
Reactor Engineering Unit

Encl.:

- Criticality code validation for TN-BGC1 - contents 11a, 11b, 11c and 11g, ref. TN-BGC1-0600 rev. 1 of January 29th 2016;
- Criticality analysis for TN-BGC1- contents 11a, 11b, 11c and 11g ref. TN-BGC1-0601 rev.2 of January 29th 2016.
- 2 CD-Roms, each containing the following documents:
    a. Criticality code validation for TN-BGC1 - contents 11a, 11b, 11c and 11g, ref. TN-BGC1-0600 rev. 1 of January 29th 2016;
    b. Criticality analysis for TN-BGC1- contents 11a, 11b, 11c and 11g ref. TN-BGC1-0601 rev.2 of January 29th 2016.

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APPENDIX 1
Answers to the Request for Additional Information for revalidation of model No. TN-BGC1 (French competent authority certificate of approval No. F/313/B(U)F\96 Rev. Jbb) Docket No. 71-3034, TAC No. L25037

CRITICALITY REVIEW

2. Provide criticality safety calculations for the uranium oxides (UO_2, UO_3, U_3O_8); uranium tetrafluoride (UF_4); uranium nitrides (UN, U_2N_3, UN_2); uranium carbides (UC, UC_2 and U_2C_3); and uranium alloyed with aluminum (Al), molybdenum (Mo), silicon (Si); and zirconium (Zr) and USL values for each type of the requested contents.

In its application letter, dated July 9, 2015, the applicant requested approval of the TN-BGC 1 package for "the transport and storage of fissile material in very varied forms such as ingots of plutonium or metallic uranium, powders consisting of plutonium oxide or highly enriched uranium, and liquids such as uranyl nitrate." The applicant further clarified that, in addition to metallic uranium in powder form, the requested contents also include uranium oxides (UO_2, UO_3, U_3O_8), uranium tetrafluoride (UF_4), uranium nitrides (UN, U_2N_3, UN_2,), uranium carbides (UC, UC_2 and U_2C_3) and uranium alloyed with aluminum (Al), molybdenum (Mo), silicon (Si), and zirconium (Zr). However, the criticality safety analyses provided in TN-BGC1-0601, dated June 16th, 2015, only address pure uranium metal. The applicant needs to provide criticality safety analyses for the TN-BGC1 package containing uranium oxide (UO_2, UO_3, U_3O_8) powders, uranium tetrafluoride (UF_4), uranium nitrides (UN, U_2N_3, UN_2,), uranium carbides (UC, UC_2 and U_2C_3) and uranium alloyed with aluminum (Al), molybdenum (Mo), silicon (Si), and zirconium (Zr).

The staff needs this information to determine the TN-BGC1 package with requested contents meets the regulatory requirements of para. 673 to 683 of the IAEA TS-R-1, 2009 edition.

The calculation note TN-BGC1-0601 Rev. 1 dated June, 16th 2015 has been revised to incorporate additional analyses including uranium oxide (UO_2, UO_3, U_3O_8), uranium tetrafluoride (UF_4) and uranium alloyed with aluminum (Al), molybdenum (Mo), silicon (Si), zirconium (Zr). A copy of the revised document, in reference <5>, is enclosed.

Note that, as mentioned in letter <6>, uranium nitride and uranium carbide are not needed until 2018 and may be prohibited in the validation.

Appendix D of the calculation note in reference <5> provides the criticality safety calculations where the fissile metallic uranium is replaced with either UO_2 or UF_4 or U-Al or U-Mo or U-Si or U-Zr fissile materials in order to demonstrate that metallic uranium form is bounding. Content 11a and Content 11g have been selected for this purpose:

- Content 11a is the most reactive configuration with 100 wt.% U-235 enrichment, moderated with CH_2 and payload limit of 1.70 kg U;
- Content 11g for mid-range enrichment with 20 wt.% U-235 enrichment, moderated with water and payload limit of 40 kg U.

The Upper Safety Limit, USL, is determined using 279 critical experiments encompassing uranium metal, uranium oxide, uranium tetrafluorides and uranium alloys (aluminum). The USL applicable to the criticality analysis is 0.9370 corresponding to the minimum USL value

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for the moderator to fuel ratio, EALF, mean free path, average number of fission neutrons and enrichment parameters. A similarity study consisting of comparing the neutronic characteristics such as EALF, mean free path and average number of fission neutrons indicates that the package loaded with the eligible contents including uranium metal, uranium oxide, uranium tetrafluoride and uranium alloys is neutronically similar therefore a single USL can be applied.

This additional analysis demonstrates that metallic uranium is the bounding uranium form and the maximum allowable contents determined with metallic uranium form in Table 10-22 are valid for the uranium forms requested including uranium oxide (UO_2, UO_3, U_3O_8), uranium tetrafluoride (UF_4) and uranium alloyed with aluminum (Al), molybdenum (Mo), silicon (Si), zirconium (Zr).

3. Provide justification that the selected critical benchmark experiments are appropriate for the criticality safety calculations for the requested contents or provide additional benchmark for the powder form uranium oxides (UO_2, UO_3, U_3O_8), uranium tetrafluoride (UF_4), uranium nitrides (UN, U_2N_3, UN_2), uranium carbides (UC, UC_2 and U_2C_3) and uranium alloyed with aluminum (Al), molybdenum (Mo), silicon (Si), and zirconium (Zr) and corresponding USL for each of the contents.

In TN-BGC1-0600, dated June 11, 2015, the applicant provided code benchmarking analyses for the SCALE 6.0 computer code used for the TN-BGC1 criticality safety analyses. However, it appears that all selected critical experiments are associated with uranium metal, and that none of the selected critical experiments apply to the other content forms. As such, it is not clear how the selected critical experiments are applicable to the requested contents. The applicant needs to either justify that the selected critical experiments are appropriate for the criticality analyses of the requested contents or revise its code benchmark analyses to include critical experiments that are applicable to all requested contents.

The staff also notes that the upper safety limit (USL) values provided by the applicant are a function of enrichment, energy of average lethargy causing fission (EALF), hydrogen to fissile material (H/X) ratio, mean free path (MFP), and neutron fission yield for metallic uranium only. However, the applicant did not provide USL values for each content or a bounding USL value for all requested contents. The applicant needs to provide USL values for all of these parameters for each type of requested content or a bounding value for all of requested contents.

The staff needs this information to determine the TN-BGC1 package with the requested contents meets the regulatory requirements of para. 673 to 683 of the IAEA TS-R-1, 2009 edition.

The calculation note TN-BGC1-0600 Rev. 0 dated June, 11th 2015 has been revised to incorporate additional benchmarking analysis. A copy of the revised document, in reference <4>, is enclosed.

The selected critical experiments, 279 critical experiments, from Database for the International Criticality Safety Benchmark Evaluation Project (DICE) include metallic uranium, uranium oxides, uranium fluorides and uranium alloys as fissile medium; polyethylene and water as moderator; and, water, stainless steel and polyethylene as reflector.

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The critical experiments are subdivided into four categories as fast, intermediate, thermal and mixed spectra systems, depending upon the energy range of where the majority of the fission occurs. The trending analysis is performed and the USL functions have been developed for enrichment, EALF, moderator to fuel ratio, mean free path and neutron fission parameters. The above answer to question #2 of Criticality review provides additional information on USL determination.

Note that, as mentioned in letter <6>, uranium nitride and uranium carbide are not needed until 2018 and may be prohibited in the validation.

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APPENDIX 2
Follow up of answers to the Request for Additional Information
Docket No. 71-3034, TAC No. L25037

Reference of RAI	Reference of TNI letter
Criticality Review	
RAI - 1	CEX-15-00117104-003
RAI - 2	CEX-15-00117104-004
RAI - 3	CEX-15-00117104-004
RAI - 4	CEX-15-00117104-003
Material Review	
RAI - 1a	CEX-15-00117104-003
RAI - 1b	CEX-15-00117104-003
RAI - 1c	CEX-15-00117104-003
RAI - 1d	CEX-15-00117104-003
RAI - 2	CEX-15-00117104-003
RAI - 3	CEX-15-00117104-003
Containment Review	
RAI - 1	CEX-15-00117104-003