February 20, 2008

Dr. Donald Wall, Director
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Washington State University
PO Box 641300
Pullman, WA 99164-1300

SUBJECT: WASHINGTON STATE UNIVERSITY – REQUEST FOR ADDITIONAL INFORMATION RE: AMENDMENT REQUEST FOR CONVERSION FROM HIGH-ENRICHED URANIUM TO LOW-ENRICHED URANIUM FUEL (TAC NO. MD6570)

Dear Dr. Wall:

We are continuing our review of your amendment request for Amended Facility Operating License No. R-76 for the Washington State University Modified TRIGA Reactor which you submitted on August 15, 2007, as supplemented on December 14, 2007, and January 15, 2008. During our review of your amendment request, questions have arisen for which we require additional information and clarification. Please provide responses to the enclosed request for additional information within 50 days of the date of this letter. In accordance with 10 CFR 50.30(b), your response must be executed in a signed original under oath or affirmation. Following receipt of the additional information, we will continue our evaluation of your amendment request.

If you have any questions regarding this review, please contact me at (301) 415-1127.

Sincerely,

/RA/

Alexander Adams, Jr., Senior Project Manager
Research and Test Reactors Branch A
Division of Policy and Rulemaking
Office of Nuclear Reactor Regulation

Docket No. 50-27

Enclosure:
As stated

cc w/enclosure:
See next page

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Test, Research, and Training
Reactor Newsletter
University of Florida
202 Nuclear Sciences Center
Gainesville, FL 32611

REQUEST FOR ADDITIONAL INFORMATION
WASHINGTON STATE UNIVERSITY MODIFIED TRIGA REACTOR
DOCKET NO. 50-27

The purpose of the following questions is to ensure a complete application under 10 CFR 50.64.

1. General comment. Please confirm consistency between the safety analysis report text and table numbering because it appears that errors may exist in the text. For example, on page 52 Table 19A is referenced. It appears that it should be Table 20 and Table 20A on page 54 should be labeled Table 20. On page 55 it appears that the reference to Table 19A should be Table 21 as should the reference to Table 20 on page 56.

2. Section 1.1. Why is the transient rod being replaced as part of the conversion?

3. Tables 2 and 3. The fuel is referred to as ZrH rather than ZrH_x. Please clarify.

4. Table 2. Please provide engineering diagrams and specifications for the fuel. Please describe the quality assurance process for production of the fuel.

5. Table 2 and Section 4.5.5. Please clarify if the coolant void coefficient of reactivity is positive or negative.

6. Table 2 and Section 4.5.10. Table 2 has a calculated maximum pulsed reactivity insertion of $2.02 for mixed core 34A while the historical pulsing data has reactivity additions of $2.15. Please explain.

7. Section 4. Is the neutronic analysis done with both graphite/water and water-only reflectors since the Technical Specifications (TSs) allow both designs? Does the presentation in the safety analysis report (SAR) represent the most limiting case? If not, please discuss.

8. Section 4.2.6 and Table 5. Why are the burnup days for the fuel rods calculated? The SAR states that the U-235 in the mass inventory report is used. Please clarify which report this is. In this report, what methodology is used to determine the mass inventory and what is the accuracy of the values used?

9. Table 9. The individual calculated rod worths differ from the measured values by 28% for Blade 4 and 111% for Blade 5. Please explain these differences? What are the estimated uncertainties for the measurements of the rod worths?

10. Section 4.5.1. The calculated reactivity with all of the control rods fully withdrawn is $6.31 and with them inserted it is -$6.91. The measured reactivity for the condition with the rods fully withdrawn was quoted as being $6.65. The text on pages 35 and 36 states that these values are for water reflection only. Is the graphite reflector usually removed, or was only the benchmarking measurement made with the graphite removed? Alternatively should this read the water/graphite reflector instead of water reflector?

11. Section 4.5.1. Please define “STD.” Is it the same as “SFE?”

12. It appears as if the HEU core is analyzed assuming operation at constant power. Does this match the actual operating history? If not, what is the effect on key parameters of the constant power assumption?

13. Section 4.5.1. Should the reference to β_{eff} on page 35 be Section 4.5.5 rather than 4.4.5 as stated?

14. Section 4.5.3. On page 37 for the LEU core, to be consistent with the wording used for the HEU core, should the combined reactivity worth of all control elements be quoted as (6.37+7.44=) $13.81 and the $10.97 quoted be defined as the sum of individual worths?

15. Section 4.5.4. It says that calculated shutdown worth is the excess reactivity minus the worth of rods 1, 2, and 3. Shouldn't it be rods 1, 2, and 4?

16. Section 4.5.4. Explain why the shutdown margin calculation does not take into account the removal of the experiment with the maximum non-secured reactivity worth.

17. Section 4.5.4. Why are the shutdown margins quoted in Table 2 not consistent with the values stated on page 38?

18. Section 4.5.5. For the LEU core, using the stated values of $k_p = 1.04225$ and $k_t = 1.05019$, should β_{eff} be 0.0076 ± 0.0002 instead of 0.0075 ± 0.0002 as stated on page 39. Please explain.

19. Section 4.5.5. The discussion of the prompt temperature coefficient of reactivity (pages 40-44) appears to confuse reactor and fuel temperature. Is the coefficient obtained using the core average temperature (including water) or the fuel temperature? If the former, please explain why.

20. Table 14. The cold excess reactivity is given as $5.299 for the mixed HEU core, but on page 35 the excess reactivity is claimed to be $6.31. For the mixed LEU core the numbers are $4.959 (Table 15) and $6.37 (p. 36), respectively. Please explain.

21. Sections 4.5.9 and 12.6. What controls are in place with respect to loading new fuel into an existing core? Section 12.6 of the SAR discusses core locations with low peaking factors where new fuel should be introduced into the core. Should fuel additions be limited to these locations by TS? Provide a calculation to indicate the change in the peaking factor when fresh fuel is placed in an EOL core at the worst location or, if limited to the locations discussed in Section 12.6, those locations.

22. Section 4.5.10. Please provide a copy of Reference 8 in order for us to understand the modeling in BLOOST. Table 19 shows that BLOOST over predicts the energy release and it under predicts the temperature increase for small reactivity insertions. Please discuss.

23. Section 4.5.10. Does the analysis of pulsed operation assume that a gap of 0.2 mils will apply to the new core? If so, how would a larger gap affect the pulsing result including peak temperature?

24. Section 4.7.2. Provide justification for ignoring cross flow between neighboring flow channels.

25. Section 4.5.8/4.7.3/4.8.3. Does the peak power density (maximum local heat flux) at steady-state occur in the fuel element (rod) with the maximum rod power?

26. Section 4.7.3/4.8.3. Are changes in gap properties (e.g., oxidation at the fuel boundary, gas composition) over time taken into account when calculating fuel temperatures? If not, why not?

27. Section 4.7.3. Please provide a copy of Reference 10 in order for us to understand the modeling in TAC3D.

28. Section 4.8.1. The thermal hydraulic analysis was performed with an assumed water inlet temperature of 30 ºC. Based on this analysis, please propose a TS limiting condition on water temperature or explain why a limit on water temperature is not needed.

29. Section 4.8.3. Based on the values for kW/element and rod peaking factor, a simple calculation indicates a MDNBR at 1 MW of 2.50 rather than 2.45 as quoted. Please clarify.

30. Section 4.8.3. The SAR states that the location of the highest powered fuel element is D4NE and that this would be an ideal location of the IFE. What consideration has been given to locating the IFE in this location?

31. Section 4.9.1. The description of regions (in cm) of the thermal neutron flux across the reactor core does not appear to match the figures. Please discuss.

32. Section 12.5. Please verify if updates are needed to your physical security plan. If changes are needed and you want them made as part of the conversion process, please submit your updated plan. If changes are needed and you do not want them to be made under conversion, please follow the regulations in 10 CFR 50.54(p). In this case, the changes would need to be in place before the order to convert the reactor is issued.

33. Section 13.3. The IFE contains three thermocouples at different locations. What impact will the choice of thermocouple have on the LSSS. This section states that at 1.3 MW, peak fuel temperature in the core is 520 ºC. Table 29 indicates a peak fuel temperature of 541 ºC. Please explain. The factors listed (items i-iv) to be taken into account when setting the LSSS are termed the “safety margin”. However, you discuss a peak core temperature of 950 ºC representing a safety margin of 200 ºC. Given this, do the factors really represent a safety margin?

34. Section 13.5.1. Please verify that the references in the text of this section correctly match the reference list in the SAR.

35. Section 13.5.1. The 2002 SAR has not been approved by NRC. Please submit a stand-alone evaluation for the MHA stating all assumptions and showing calculations. You give occupational doses based on 5-minute and 1-hour stay times. Please base your calculations on a realistic evacuation time based on drill performance.

36. Section 13.5.2. Please submit a stand-alone evaluation for the LOCA stating all assumptions and showing calculations. Also, please state what is the margin to clad yield strength with a power density of 22.9 kW/rod.

37. Section 13.5.3. Your proposed TS changes discuss limiting the reactivity value of the pulse rod in the pulsing mode by mechanical means or the rod extension physically shortened. Does this impact the accidental pulsing analysis? If so, how?

38. Section 14. Provide replacement TS pages with the changes to the TSs shown by change bars in the page margins. Separately, list each change requested to the TS along with a justification for the requested change. In Section 14.1 it appears that you have proposed numerous changes to this section of the TS that are not directly related to conversion. Please ensure that proposed changes to the TSs are related to conversion.

39. Section 14.2.1. It appears that you are proposing to change the safety limit for a standard TRIGA fuel rod from 1000 ºC to 1150 ºC. Please provide a justification for this change given that fuel under the current 1000 ºC limit will continue to be used in your reactor.

40. Section 14.2.2. Section 13.3 of the SAR evaluates the LSSS for two specific IFE locations. However, the TS allows the IFE to be located anywhere in the 30/20 fuel region. Please repeat the analysis for the worse case to show that the LSSS as proposed protects the safety limit.

41. Section 14.3.1. For TS 3.3, Pulse Mode Operation, it appears that you are proposing to eliminate the requirement to determine the maximum safe allowable reactivity insertion. Please justify elimination of the requirement.

42. Section 14.3.1. The TS "Maximum Excess Reactivity" states "The maximum reactivity in excess of cold, xenon-free critical shall not exceed 5.6% Δk/k ($8.00)". If β=0.0075, then it appears the worth is $7.47. Please clarify.

43. Section 14.3.2. It appears that you are proposing the addition of 2 high power level measuring channels. What is the relationship between the high power level channels and the linear and log power channels? How is this change related to conversion of the reactor?

44. Section 14.3.2. Why is the manual scram, pool level and interlock that prevents energizing the pulse circuit when the power is less than 1 kW not part of the safety channels that must be operable?

45. Section 14.5.2. To the extent that this TS repeats requirements given in the Core Configuration Limitation TS, you may remove the redundancy.

46. Appendix A. What action is taken if an acceptance criterion for a startup test is not met?

47. Appendix A.1.1. It is stated that criticality is expected with a loading of 58-68 fresh, 30/20 fuel elements. The acceptance criteria states that 1/M criticality is expected with 43-77 30/20 fuel elements and 24-32 partially burned standard fuel elements. Please explain the difference in these two statements.

48. Appendix A.1.4. The SAR implies that the regulating rod does not have scram capability. However, the acceptance criterion for shutdown margin only refers to the most reactive rod stuck out of the core. Please clarify.