June 1, 2006

Dr. W. D. Reece, Director
Nuclear Science Center
Texas Engineering Experimental Station
Texas A&M University
3575 TAMU
College Station, Texas 77843-3575

SUBJECT: TEXAS A&M UNIVERSITY—REQUEST FOR ADDITIONAL INFORMATION RE: HIGH-ENRICHED TO LOW-ENRICHED URANIUM CONVERSION FOR THE TEXAS A&M UNIVERSITY NUCLEAR SCIENCE CENTER REACTOR (TAC NO. MC9449)

Dear Dr. Reece:

We are continuing our review of your request for high-enriched uranium (HEU) to low-enriched uranium (LEU) fuel conversion for the Texas A&M University Nuclear Science Center Reactor which you submitted on December 29, 2005. During our review of your request, questions have arisen for which we require additional information and clarification. Please provide responses to the enclosed request for additional information within 30 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 Alexander Adams at (301) 415-1127 or myself at (301) 415-1128.

Sincerely,

/RA/

Marvin M. Mendonca, Senior Project Manager
Research and Test Reactors Branch
Division of Policy and Rulemaking
Associate Director for Risk Assessment & New Projects
Office of Nuclear Reactor Regulation

Docket No. 50-128

Enclosure:
As stated

cc:
See next page

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REQUEST FOR ADDITIONAL INFORMATION
TEXAS A&M UNIVERSITY NUCLEAR SCIENCE CENTER REACTOR
DOCKET NO. 50-128

1. License conditions. Please propose and justify license possession limits for the new low-enriched uranium (LEU) fuel if they are different than your current approved possession limits. Will any additional changes be needed to the facility license to allow for conversion from high-enriched uranium (HEU) to LEU fuel?

2. Section 4.1. What were the bases for validating the neutronic and thermal-hydraulic codes against the Puerto Rico Nuclear Center (PRNC) reactor instead of the Texas A&M reactor? While comparing the results of calculated parameters against measured parameters for the PRNC would serve to validate the use of the codes in general and the ability to develop inputs for the codes, it does not provide validation of the specific input model for the Texas A&M reactor. Provide an assessment of the effects of the design differences between the PRNC and TAMU TRIGA and demonstrate that the differences notwithstanding, the performance of the PRNC FLIP core effectively represents the performance expected of the TAMU FLIP core. Please provide a discussion of the steps taken to ensure the validity of the Texas A&M reactor model and code inputs.

3. Section 4.5.6. No references, or information on its validity, are given for the BURP code. Please provide such in order to help establish confidence in its veracity.

4. Sections 4.5.1 and 4.5.3. For the PRNC TRIGA core the MCNP5 model calculated criticality with 62 fuel elements in the core whereas the actual criticality was with 59 fuel elements. A calculation of the unrodded PRNC core provided a total reactivity of $6.26 compared to a measured value of $7.12. In light of the fact that the TAMU calculational model under-predicts core reactivity significantly, provide verification that the shutdown margin is sufficient.

5. Section 4.5.3. Only integral control rod worths and no differential worths are provided. How is the maximum reactivity insertion rate, when control rods are removed, determined and integrated into the safety analysis?

6. Section 4.5.4. Two of the conditions for analyzing shutdown margin are identical. Should one of them be “The highest worth non-secured experiment in its most reactive state.”?

7. Section 4.5.5. The calculation of β_{eff} utililizes a formula that is based on a core with ^{235}U. What is the origin of this formula and what is its error, in particular when applied to an LEU core?

8. Section 4.5.5. The numbers quoted for the prompt temperature coefficient on page 33 are inconsistent with those given on Figure 4.14. Please discuss.

9. Section 4.5.6. The conversion SAR states that the placement of fresh fuel into the center of a high burnup core raises concerns for excessive power peaking and that shuffling lower burnup fuel from the perimeter of the core to the core center and adding fresh fuel to the core perimeter addresses this concern. How will this movement be controlled? Should a TS requirement be added? Also, it is possible that thermocouple failures in an instrumented fuel element (IFE) could require replacement of an IFE. Because IFEs tend

to be placed in the center of the core, there may not be a low burnup IFE at the perimeter of the core to move to the center. Discuss how IFE replacement will be accomplished without raising a concern about power peaking.

10. Sections 4.5.9 and 4.5.11. The conversion SAR discusses the desirability of placing the IFE at certain locations within the core. It does not appear that a conclusion is reached. What are the proposed locations of IFEs in the LEU core and why are these locations used?

11. Section 4.6. This section discusses the addition of an electro-mechanical interlock on the transient rod to limit reactivity additions. How does this differ from the system required by existing TS 3.1.2.a, which appears to be a mechanical system? If the electronic interlock is a new feature, discuss the need for a TS LCO requirement with an associated surveillance requirement.

12. Section 4.7.2. Provide a discussion on the verification and validation of the STAT code for thermal-hydraulic conditions applicable to the PRNC and the TAMU reactors.

13. Section 4.7.2. There were four fuel elements associated with each coolant channel modeled by STAT. Were all fuel elements in each problem assumed to have the same rod power? By symmetry each fuel element is bounded by four coolant channels. How was the maximum powered channel determined?

14. Section 4.7.2. There are at least three different channel flow areas in the TRIGA core and each is associated with different bundle geometry, the four-element bundle, the three-element bundle (with fuel-followed control rod), and the three-element bundle with guide tube (for regulating rod or transient rod). Did the flow area used in the STAT analysis take into account the location of the fuel element in the core? Was a limiting flow area used in the analysis?

15. Section 4.7.2. Provide justification for ignoring diversion of coolant to neighboring flow channels.

16. Section 4.7.2. Provide the units and reference for the boiling heat transfer correlation in Section 4.7.2 of the SAR. Is the correlation for pool boiling or flow boiling? If it is for flow boiling, provide justification for not using a pool boiling correlation that is more applicable to natural convection cooling.

17. Section 4.7.2. The single-phase heat transfer correlation shown in Section 4.7.2 is for turbulent forced flow. Provide justification for using a forced convection heat transfer correlation in a problem dominated by natural convection.

18. Section 4.7.2. Confirm that the flow is in the turbulent regime and not in the transition or laminar flow regime such that a turbulent friction factor and heat transfer correlation are applicable.

19. Section 4.7.2. Demonstrate that both the McAdams and the Bernath correlation are applicable to natural convection boiling and the predicted CHF is conservative as compared with the one using a pool boiling CHF correlation.

20. Section 4.7.3. In a transient, such as in pulsed operation, the rate of energy generation in the fuel rod is not equal to the rate of heat transfer to the coolant. How is the coupling between the TAC2D calculation and the thermal-hydraulic calculation (coolant flow rate, coolant temperature, and surface heat transfer coefficient) handled in a transient?

21. Section 4.8. Calculations were performed for the LEU core at a power level of 1 MW. However, TS 3.1.1 allows the reactor to be operated at power levels up to 1.3 MW. The TS does not appear to have a constraint on the amount of time the reactor can be operated at this power level. Please provide steady-state thermal-hydraulic calculation results for a 1.3 MW power level.

22. Section 4.8.3. It is noted on page 39 of the SAR that based on the under prediction of the reactivity loss with increasing power it is suggested that the actual average core temperature is under predicted by 30-60EC at 1.0 and 1.4 MW for the PRNC core. This assertion appears to contradict the good agreement between the measured and predicted temperature for the instrumented fuel element. Quantify the uncertainty in the predicted peak fuel temperature if the predicted average fuel temperature is attributed to have an error in the range of 30-60EC.

23. Section 4.8.4. In the TAMU LEU (30/20) core, the peak power density does not occur in the fuel element with the maximum rod power. Which rod has the peak fuel temperature and the MDNBR, the rod with the maximum rod power or the rod with the peak power density? Is the fuel element in position 4D3 the one experiencing the peak power density at 1.0 MW steady state and in a pulse operation?

24. The references in Section 13 of the SAR need to be corrected. What are referred to in the text as References 13, 14, 15, and 16 should be References 2, 13, 14, and 15, respectively. In addition there is an unknown Reference 8-3 cited in the text.

25. Section 13.3. The conversion SAR discusses the safety margin to account for accuracy of fuel temperature measurements and overshoot in reactor power resulting from a reactor transient during steady state mode operation. However, there does not appear to be any justification for this statement. Please show that sufficient safety margin exists.

26. The basis for Technical Specification 14.3.1.2, Pulse Mode Operation, discusses the effect on fuel of temperatures exceeding 874EC. In light of this fuel behavior, discuss whether a lower temperature should be the safety limit which currently is 1150EC for any conditions of operation.

27. Analysis of pulse operation shown in Sections 4.5.11 and 4.5.12 of the conversion SAR showed that peak fuel temperature occurred in core location 4D3, not an instrumented fuel element. Provide an uncertainty analysis for the prediction of the peak fuel temperature in the pulse mode of operation. The analysis should also account for uncertainties in calculated rod power and axial power profile. Do the uncertainties reduce the safety factor significantly?

28. TS 2.1. Does the peak fuel temperature in a reactivity pulse transient depend on the initial power level? If yes, was the analysis performed with a conservative initial power? The

proposed Technical Specification 14.3.2.2 has an interlock included that limits pulsing from any power greater than 1kW. How was this value obtained?

29. Section 13.5. A safety limit of 950EC is cited in NUREG-1282 when the clad temperature equals the fuel temperature. This is the likely condition for the air cooling of fuel stipulated for the LOCA event by TAMU. What is the fuel temperature limit used in the determination of the power/rod limit for the LOCA event? Explain if the fuel temperature limit for the LOCA is consistent with the technical basis for the safety limit of 1150EC.

30. Section 13.5. Explain the relation of the pulsing accident analyzed in Section 13.5 of the conversion SAR and the pulse operation for BOL and EOL conditions discussed in Sections 4.5.11 and 4.5.12 respectively. The accident analysis used a reactivity limit of $2.95 and a safety limit of 1150EC while the pulse operation limited the reactivity insertion to $2.1 and a technical basis that relies on a temperature limit of 830EC. In view of the LCO imposed on pulse operation explain the basis for using the 1150EC safety limit in a pulsing accident.

31. Section 13.5. In both the 2003 NSCR SAR submittal and the HEU/LEU fuel conversion submittal, a release fraction of $2.6\text{x}10^{-5}$ is used, based on a General Atomics experiment. Please provide the technical bases for how this release fraction was determined and why/how it is applicable to the NSCR. If analytical and experimental results are used, as they were in this section of the HEU/LEU fuel conversion document and in the 2003 SAR submittal, they should be cited by reference and adequate technical justification provided for the assumptions used in any analysis.

32. Section 13.5. In this section (analysis of the MHA) it is stated that in the TAMU SAR for re-licensing submitted to the NRC in 2003 (2003 SAR), an individual lingering in the Reactor Hall for one hour would receive a 49 Rem thyroid dose. It is then stated that “It might be better to indicate that workers in the Reactor Hall when the fuel element ruptures would promptly leave this hall in less than an estimated 5 minutes (not 1 hour), thus receiving a thyroid dose of 4.1 Rem.” On this basis, the HEU-LEU conversion SAR concludes that the prior analysis submitted in the 2003 SAR for one TRIGA FLIP fuel element bounds the results expected for the LEU (30/20) core.

    a. Provide a justification for changing the stay time for a worker in the Reactor Hall from 1 hour to 5 minutes.

    b. Since the fission product inventory for LEU fuel is different than for HEU fuel, please provide the technical basis and/or references for the radiological inventory used to calculate the doses in Table 13-1 of the 2003 SAR, as well as the technical justification or rationale for the assumptions and boundary conditions applied in the calculation of those doses. Discuss why the use of the HEU fuel analysis is valid for the LEU fuel or provide and justify a radiological inventory based on LEU fuel.

    c. For the LEU fuel, please provide the thyroid and whole body doses for an individual in the unrestricted area receiving the maximum dose, at the nearest permanent residence and to an individual remaining in the Reactor Hall. It can be in a format similar to that of Table 13-1 in the 2003 SAR submittal.

33. Please provide a copy of your proposed TS that contains change bars in the margin indicating areas of change. Also, for each proposed change in the TS, please provide a justification for requesting each specific change. To allow NRC to complete its initial review of your proposed TS changes, could you please submit this information as soon as possible.

34. TS 14.2.2 If removing the LSSS setting of 125% of 1 MW was intentional, why is it discussed in the Basis for this Technical Specification?

35. TS 14.3.1.2. If the $2.00 limit is still valid, why was it removed from the Technical Specification, and if it has been intentionally removed, why is it still discussed in the Basis?