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July 31, 2012

U.S. Nuclear Regulatory Commission
Document Control Desk
Washington, DC 20555

Reference: U.S. Geological Survey TRIGA Reactor (GSTR), Docket 50-274, License R-113, Request for Additional Information (RAI) dated September 29, 2010

Subject: Response to Question 21 of the Referenced RAI

Mr. Wertz:

Question:

21. GSTR TS Section 14.2.2, "Limiting Safety System Setting," states that the limiting safety system setting shall be a steady state thermal power of 1.1 MW when there are at least 100 fuel elements in the core (including fuel-followed control rods) and a steady state thermal power of 0.1 MW if there are less than 100 fuel elements in the core and any of the core fuel elements are aluminum-clad. Please explain or clarify the following observations:

    21.1 Please explain whether the statement should read "or any of the core fuel elements are aluminum-clad."

    21.2 The LSSS discusses "steady state" power whereas the subject of the LSSS is the limiting power to be used for automatic protective circuits. Please explain.

    21.3 License Amendment 4 (January 1988) eliminated the allowance to exceed licensed power for purposes of testing SCRAM circuits. The safety analysis presented in the GSTR SAR provides no basis for an LSSS above 1.0 MW.

Response:

Preliminary results of the neutronic/thermal hydraulic analyses show that the most limiting core, with aluminum-clad fuel in the F and G rings, will not exceed any safety limits if at least 110 fuel elements are present in the core. The GSTR currently operates with about 123 fuel elements in the core and there is no reasonable expectation that this will decrease by any significant amount. The original proposed limit of 0.1 MW when the core has <100 fuel elements in the core seems to be confusing and causing significant additional analyses, so we will be changing

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our submission to require that the GSTR core always have at least 110 fuel elements in the core, for any operation. The safety analyses will be performed for a limiting core configuration of 110 fuel elements and a maximum analyzed power of 1.1 MW. The details of this submission cannot be finalized until the neutronic/thermal hydraulic analyses are finished. This change should eliminate the RAI questions 21.1 through 21.3.

Neutronic/thermal-hydraulic analysis:

The most recent update (mid-July, 2012) for the neutronic/thermal hydraulic analyses is provided as an attachment to this document. This update infers that the full-power model analyses may be completed in August. In a recent verbal discussion with the CSM principal investigator, it was felt that answers to all existing RAI questions could be provided to the NRC by the end of August. Accordingly, we do not expect to need another extension on our RAI response deadline at this time.

Sincerely,

Tim DeBey

Tim DeBey

USGS Reactor Supervisor

I declare under penalty of perjury that the foregoing is true and correct.
Executed on 7/31/12

Attachment

Copy to:

Betty Adrian, Reactor Administrator, MS 975
USGS Reactor Operations Committe

Safety Analysis Support for the USGS Research Reactor
Battelle Energy Alliance Award #00114253 (CSM # 400305)
June 2012 Progress Report - Revised
Nicolas Shugart and Jeffrey King

Work this June focused on the RELAP model and re-defining the GSTR limiting core. The RELAP model is very sensitive to the gap thickness between the fuel and cladding. The model uses a RELAP defined material for the cladding gas, which provides a very conservative temperature rise across the gap. Decreasing the size of the gap lowers the fuel temperature in the model, and adjusting the gap thickness to match the model's temperature to experimental data from the GSTR corrects the gap material bias. The thermocouples available at the GSTR have a temperature uncertainty of at least ±30 K, which makes an accurate validation difficult. Alternative methods of validation the RELAP model are under consideration.

The first first version of the RELAP model used the published gap thicknesses (~0.5 mm) as a worst-case scenario, and provides very conservative temperature approximations. Analyzing the limiting core under these conditions predicts fuel temperatures in excess of 1000 K for the hot-rod of the GSTR limiting core. Further analysis of the literature produced by OSU and other TRIGAs using similar RELAP models indicates that a much smaller gap (0.1 mm) accurately characterizes TRIGA fuel.

With a 0.1 mm gap, the predicted fuel temperatures for the limiting core still exceed the established limits, so the identification of a new limiting core is underway based on three criteria: an excess reactivity limit of $7.00, a minimum fuel rod number (to be determined), and filling both the B and C rings with fresh 12 wt% uranium fuel. To further define the new limiting core, fuel outside of the B and C-Rings would be old 8.5 wt% uranium fuel (at various stages of burnup), to promote a peaked core. These criteria lead to two possible limiting cores, a 110-element and a 105-element core. While both of these options maintain a high power factor in the hot-rod, the extra elements decrease the rod power to ~20 kW (compared to ~27 kW for the previous limiting core containing 80 fuel elements). This should allow the hot rod to function safely during normal operations. The GSTR staff has no strong preference on which limiting core to use, which prompted the analysis to focus on the 110-element core, which has a slightly lower rod power, and therefore a lower chance of fuel damage.

Part of the new limiting core analysis will included an examination of the dependence of the reactivity feedback coefficients on core configuration. These analyses will be completed in July, and the limiting core will be ready for the final stage of the re-licensing analysis: the transient analysis using the PARET code.