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Mr. Marvin M. Mendonca, Senior Project Manager
Non-Power Reactors and Decommissioning Project Directorate
Division of Operating Reactor Support
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, D. C. 20555

Dear Mr. Mendonca:

This is our response to the request received January 25, 1994 from you for additional information concerning the conversion of the GTRR from High to Low-enriched uranium fuel.

Question 1:

In your January 21, 1993 cover letter, you proposed to possess, but not use, up to 5.1 Kg of HEU (93 percent enrichment) until it can be removed from your facility. Provide planned inventories and associated proposed license limits for possession of irradiated HEU fuel, and provide similar inventories and limits for unirradiated HEU fuel, as applicable. Requirements for unirradiated HEU fuel limits is provided in the attached order. Also, provide your plans for removal of all HEU fuel from your facility.

Answer:

Currently our total U^{235} inventory is 4550 grams. We have in the core 17 fuel elements. Eight elements have been irradiated and are in storage. The 17 fuel elements in the core and the eight elements in storage have all been irradiated to approximately the same fluence. In addition, we have one element that has never been irradiated and two partial elements with 10 plates each for experimental purposes. (A normal element has 16 plates of fuel.) The limit for HEU on hand should not exceed 4550 grams of U^{235}.

The plan for the inventory of HEU we currently have after we convert, is to store it in the storage pool and not use it until we are able to ship it to DOE. The plan for shipping the HEU to DOE requires that we have a licensed cask, a DOE place to ship it to, and a license from NRC to ship. Furthermore, we will write a procedure for preparing the fuel for shipment from the Neely Nuclear Research Center and obtain approval for this procedure from the Nuclear Safeguards Committee.

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Our license limit for U^{235} is currently 13.5 Kg of U^{235} (See License Amendment #6). After conversion to LEU we do not foresee that our inventory of LEU will exceed 25 elements. The amount of U^{235} in one LEU element is 225 grams. Consequently, we do not anticipate our LEU inventory to exceed 25 x 225 = 5625 grams of U^{235}. However, to be safe, we recommend that our limit on LEU fuel on hand be limited to two complete cores, i.e., 2 cores x $\frac{\text{19 elements}}{\text{core}}$ x $\frac{\text{225 grams } U^{235}}{\text{element}}$ = 8850 grams.

Question #2:

Section 5.4 of Attachment 1 of the application for conversion, dated January 21, 1993, states that a 14 element core will be analyzed for thermal-hydraulic safety margins because it is the minimum-sized core to be used at the Georgia Tech Research Reactor (GTRR). This implies that the safety margins for the 14 element core would envelope those for larger sized cores. Larger sized cores would be the norm for routine reactor operations and are allowed. Therefore, provide verification that all larger sized cores, which are allowed by your license and technical specifications, are not more limiting. Include assessment for total flow conditions, onset of flow instability, onset of nucleate boiling, and departure from nuclear boiling (e.g., Tables 9 and 10, and Figure 10 of the referenced attachment).

Answer:

The calculations in Tables 9 and 10 of referenced attachment have been repeated for a 17 element core. The calculations were performed by Dr. William Woodruff of Argonne National Laboratory. The results are attached. Note that by going from 17- to 14-element core the flow rate is decreased by 18% and the power per element is also decreased by 18%. The power peaking factor is slightly higher for the 17 element core because of the asymmetry of the core (see Fig. 6 of referenced attachment). The difference is, however, very small and within the uncertainty associated with the calculation. For a nineteen element core, we have symmetry again and the decrease in power per element is the same as the decrease in flow rate per element. Consequently, the onset of flow instability and/or departure from nucleate boiling are virtually the same for 14, 17 or 19 elements core (see attached data).

Question #3:

Section 8.4.2 of the 1967 GTRR Safety Analysis Report discusses a postulated fuel-loading accident scenario. This postulated accident, although very unlikely, was not considered for the LEU fuel conversion. Discuss the bases for not including this scenario in the conversion application. Include comparisons of the safety margin to loss of fuel integrity or associated parameters for the proposed LEU fuel for the accident scenario.

Answer:

In order for any fuel element to be added to the GTRR when the reactor is critical or nearly critical, the upper shield plug and the lower shield plug must be removed individually and separately. The reactor must have been checked out, and the control rods must have been withdrawn to criticality position before one can add anything. This is never done at the GTRR. It is simply not credible. What we analyzed is a scenario in which a step reactivity of 1.5% $\delta k/k$ is inserted. The magnitude of the step (i.e. 1.5% $\delta k/k$) was set equal to the sum of the magnitudes of all the static reactivity worths of all the unsecured experiments which are allowed under our Technical Specifications. The purpose of the analysis was to show that there is a sufficient margin of safety between the maximum allowable reactivity worth and the maximum step reactivity insertion that can be tolerated without fuel damage, assuming failure of reactor scram systems.

Under the above scenario, the analysis showed that fuel melting would not occur until the step reactivity is greater than 2.2% $\delta k/k$. The margin of at least 0.7% $\delta k/k$ (2.2-1.5) above the maximum allowed reactivity for a single experiment is sufficient to ensure that the facility is safe even under the very unlikely conditions that a maximum step reactivity is inserted and the scram system failed to function.

We appreciate the opportunity to respond to the questions you raised. Should you have additional questions, please let me know.

Sincerely,

R.A. Karam

R.A. Karam, Ph.D., Director
Neely Nuclear Research Center

RAK/ccg

cc: Gary W. Poehlein

A Comparison of 14 and 17 Element Cores

The following tables provide a comparison of GTRR cores with 14 and 17 elements:

Table 1: Reactor Power Limits for a Maximum Inlet Temperature of 123°F Based on DNB and FI.

Reactor Coolant Flowrate, gpm	GTRR-HEU	ANL-LEU 14	ANL-LEU 17
	Reactor Power Level (MW) for DNB		
760	5.5	5.3	4.9
1625	11.5	10.8	10.7
	Reactor Power Level (MW) for FI		
760	5.3	5.0	4.7
1625	10.6	10.6	10.4

Table 2: Thermal-hydraulic Data with a Minimum Coolant Flow of 1625 gpm and a Maximum Inlet Temperature of 123°F.

	GTRR-HEU	ANL-LEU 14	ANL-LEU 17
Coolant Velocity, m/s	2.44	2.61	2.15
Friction Pressure Drop, kPa	10.9	15.0	10.5
Power/Plate, kW	21.2	18.8	15.5
Outlet Temperature of Hottest Channel, °F	157	156	157
Peak Clad Surface Temperature, °F	219	224	224
Minimum DNBR	2.29	2.17	2.14
Limiting Power Based on Min. DNBR, MW	11.5	10.8	10.7
Flow Instability Ratio (FIR)	2.12	2.11	2.07
Limiting Power Based on FIR, MW	10.6	10.6	10.4

These tables correspond to expanded versions of Tables 9 and 10 in the reference document. The

17 element LEU core can be compared to the 14 element LEU core. The flowrate is decreased by about 18% while the power/element is also decreased by about 18% in going from 14 to 17 elements. The peaking factors for the two cores are slightly different with 1.58 for the 14 element core (see Fig. 8 of reference document) and with 1.62 for the 17 element core (see Fig. 9 of the reference document). Since the 17 element core is no longer symmetric, the power is slightly skewed and hence the higher peaking factor. The 17 element core at 1625 gpm using the same peaking factor as that for the 14 element case gives limiting powers of 11.0 MW based on DNBR (2.19) and 10.6 MW based on FIR (2.13) or values that are slightly higher than those for the 14 element core. The limiting values shown in Tables 1 and 2 are not significantly different for the two cases, and a 17 element core raises no new safety issues.

Reference:

J. E. Matos, S. C. Mo and W. L. Woodruff, "Analysis for Conversion of the Georgia Tech Research Reactor from HEU to LEU Fuel," Sept. 1992