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November 4, 2008

U.S. Nuclear Regulatory Commission
11555 Rockville Pike
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Attn: Document Control Desk

Subject: Request for Authorization for One-Time Shipment of Irradiated THAR Fuel Elements in a 42 MTR Basket in the NAC-LWT Cask

Docket No. 71-9225

Reference:
1. Safety Analysis Report (SAR) for the NAC Legal Weight Truck Cask, Revision 38, NAC International, November 2007
2. Model No. NAC-LWT Package, U.S. Nuclear Regulatory Commission (NRC) Certificate of Compliance (CoC) No. 9225, Revision 49, October 10, 2008

NAC International (NAC) hereby requests authorization for a one-time shipment of 40 irradiated THAR fuel elements (low enriched MTR flat plate elements) in a 42 MTR basket in the NAC-LWT cask from the Institute of Nuclear Energy Research (INER), Atomic Energy Council, Republic of China (ROC), to the Savannah River Site (SRS) in Aiken, South Carolina in the United States. The shipment will consist of two NAC-LWT casks (one containing the 40 THAR fuel elements) and will be performed in conjunction with a separate U.S. Department of Energy (DOE) spent nuclear fuel (SNF) shipment from Indonesia.

The planned THAR fuel shipment from INER to SRS will be a foreign research reactor (FRR) fuel shipment in support of the DOE's National Nuclear Security Administration FRR fuel acceptance program.

The planned shipment will be performed in accordance with all the applicable requirements of the Model No. NAC-LWT Package, U.S. Nuclear Regulatory Commission (NRC) Certificate of Compliance (CoC) No. 9225 (Reference 2). However, NRC authorization is being requested for shipping the 40 irradiated THAR fuel elements in the NAC-LWT cask due to the following particularities not specifically covered by Reference 2.

<u>Clad Thickness</u>

Per 5.(b)(1)(iv)(c) of Reference 2, the minimum clad thickness for LEU MTR fuel is ≥ 0.02 cm. Contrary to this requirement, the actual as-manufactured clad thickness of the THAR fuel elements is 0.005 cm. Authorization is requested to include the one-time shipment of MTR fuel with clad thickness of 0.005 cm.

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NAC's additional criticality analysis included a clad thickness of 0.001 cm, which envelopes the 0.005 cm clad thickness of the THAR fuel intended to be shipped.

Maximum ^{235}U per Plate Limit Exceeded

Per 5.(b)(1)(iv)(c) of Reference 2, the maximum ^{235}U per plate is ≤ 22 g. Contrary to this requirement, several of the THAR fuel plates contain slightly higher ^{235}U. Authorization is requested to include a one-time shipment of MTR fuel plates, each containing up to 24.5 g ^{235}U, without the loading restriction of 5.(b)(2)(iv)(f). NAC performed a specific criticality analysis for this configuration and concluded that safe transport of the THAR fuel assemblies does not require limiting loading to basket positions 4, 5, 6 and 7.

Reconstituted Fuel Assemblies

Post-irradiation, INER has disassembled the THAR fuel assemblies for examination purposes. The assemblies have been reconstituted in preparation for shipping. Attachment 1 (Argonne National Laboratory drawing RE-1-23655-C, Fuel Plate) depicts the as-manufactured fuel plate configuration. Attachment 2 contains a graphic representation of the INER reconstituted fuel assemblies. No modification has been made to the individual fuel plates. Authorization is requested to ship the reconstituted THAR fuel assemblies.

Epoxy Coating

MTR fuel elements are typically composed of fuel plates with a clad greater than 0.02 cm. The fuel meat (core material) for these plates is enclosed within a sealed/welded aluminum clad. Fuel plates may be composed of significantly thinner clad (e.g., 0.005 cm for THAR plates) with the ends coated by an epoxy resin versus an aluminum seal for the typical plate (see Attachment 1). The end coating of the plates, during in-core use, experiences significantly higher neutron flux than experienced in a cask environment (i.e., in-core power level >> cask power level, which is 30 watts per element for a uniform loading). No significant further radiolytic degradation, or release of gases, is expected during shipment based on the low cask-to-core fluence levels. Furthermore, the quantity of epoxy is listed as negligible within the DOE Appendix A information. An epoxy coating equivalent to the clad thickness of 0.005 cm produces a total nonvolatile coating with a mass of approximately 0.25 grams/element for the maximum 9-plate THAR elements (~0.6 grams for the 23-plate design basis element). As the NAC-LWT cask is vacuum dried and helium backfilled (~10 moles of helium), any hypothetical residual gas release from the paint will not have a significant effect on the safety function of the system (i.e., no significant buildup of flammable gas and less than one mole of oxidizing gases generated in the cask cavity).

Criticality Considerations:

MTR fuel elements may contain fuel clad thinner than the 0.02 cm used in previous baseline analysis described in Reference 1. Additionally, fuel elements may contain fissile material content up to 24.5 g ^{235}U per plate. Fuel elements were evaluated with the maximum 7.3 cm active fuel width previously included in Section 6.4.3.12 (maximum fuel width producing maximum reactivity results) of Reference 1. The baseline MTR fuel definition specified in Table 6.4.3-21 of Reference 1 was, therefore, revised to include the broadened fuel specification (a minimum active fuel height of 56 cm and a 0.7 cm fuel offset is retained from the previous evaluations).

Reactivity sensitivity of the LEU fuel definition was evaluated incrementally for each of the fuel specification changes. The model employed in these analyses is identical to the models developed for the Reference 1 Section 6.4.3.14 evaluations and includes a full 42-element payload. Basket and elements are placed at maximum reactivity configuration in all cases, with the system placed at optimum, maximum reactivity, moderator conditions – i.e., fully flooded cask cavity, void neutron shield and cask exterior.

The following table contains the results of these analyses demonstrating no significant change as a result of clad thickness (a slight positive trend has previously been identified as a result of reduced clad thickness). A significant reactivity rise is observed as active fuel width is increased, and a large jump in reactivity occurs with the fissile material content increase.

Additional LEU MTR Element Specification Studies

Enrichment [wt % ^{235}U]	Plate Thickness [cm]	Clad Thickness [cm]	Number of Fuel Plates	^{235}U per Plate [g]	Active Width [cm]	k_{eff}	Delta to Base [Δk]
94	0.115	0.02	23	18	6.6	0.9289	N/A
25	0.115	0.02	23	18	6.6	0.8856	N/A
25	0.115	0.001	23	18	6.6	0.8867	0.0011
25	0.115	0.001	23	18	7.3	0.9031	0.0175
25	0.115	0.001	23	24.5	7.3	0.9567	0.0711
25	0.15	0.001	23	24.5	7.3	0.9109	0.0254
25	0.2	0.001	23	24.5	7.3	0.8377	-0.0479

To offset the increase in reactivity, which results in above-limit system reactivity, the plate thickness is increased to 0.15 cm. As expected, the increased plate thickness decreases reactivity by displacing moderator in the fuel lattice (fuel elements are undermoderated at typical element pitch and at maximum pitch allowed by the basket).

Previous evaluations have demonstrated that removing fuel plates with a fixed plate geometry and fissile material mass reduces reactivity due to the removal of fissile material from the system. The fissile material reduction more than offsets the increased moderation in the maximum plate pitch array. With the significantly thicker fuel plates, this conclusion must be reevaluated, as removal of a plate provides significantly more moderator space for a fixed fissile material reduction.

As seen in the following table, the generic fuel definition fuel type (0.115 cm plate thickness) shows a rapid decrease in reactivity when fuel plates are removed from the system. The 0.15 cm LEU model shows a slight increase, $\Delta k < 0.003$, as fuel plates are removed, with reactivity remaining below the design basis HEU levels.

Number of Plates Study for 24.5 g ^{235}U per Plate Elements

No. Plates	HEU 0.115cm 18g ^{235}U	LEU 0.15cm 24.5g ^{235}U
23	0.9289	0.9109
22	0.9241	0.9133
21	0.9194	0.9146
20	0.9149	0.9137
19	0.9064	0.9132
18	0.8982	0.9110
17	--	0.9076
16	--	0.9012
15	--	0.8944
14	--	0.8877
13	--	0.8745

The additional allowed fuel configuration based on evaluations described herein is shown in the following table.

Additional MTR Element Specification (24.5 g ^{235}U plates)

Parameter	Value
Enrichment [wt % ^{235}U]	≤ 25
Plate thickness [cm]	≥ 0.15
Clad thickness [cm]	≥ 0.001
Number of fuel plates	≤ 23
^{235}U content per plate [g]	≤ 24.5
Active width [cm]	≤ 7.3
Active fuel height [cm]	≥ 56

It is planned that the THAR fuel shipment will be performed in the summer of 2009. To support the above schedule and any unanticipated delays, the authorization is requested to be valid until December 31, 2009. In order to support shipment planning activities and necessary interaction with the appropriate Foreign Competent Authorities, NAC requests the authorization to be issued by January 16, 2009.

If you have any comments or questions, please contact me on my direct line at 678-328-1274. All requested information will be provided in a prompt manner.

Sincerely,

Anthony L. Patko
Director, Licensing
Engineering

Attachments:

1. Argonne National Laboratory Drawing RE-1-23655-C, Fuel Plate
2. INER THAR Fuel, Reconstituted MTR Fuel Plate Assembly

Figure Withheld Under 10 CFR 2.390

NEXT ASSEMBLY	NO. REQUIRED
ARGONNE NATIONAL LABORATORY THIS DRAWING IS THE PROPERTY OF THE ARGONNE NATIONAL LABORATORY	
TITLE FUEL PLATE	
SCALE FULL	DRWG. NO. RE-1-23655-C

Figure Withheld Under 10 CFR 2.390

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ATTACHMENT 2
INER THAR FUEL,
RECONSTITUTED
MTR FUEL PLATE
ASSEMBLY

PROJECT	DRAWING	REV
INER THAR FUEL	ED20080132	0
SCALE -	WEIGHT -	SHEET 1 OF 1