AREVA

December 4, 2009
REL:09:056

U. S. Nuclear Regulatory Commission
Director, Office of Nuclear Material
Safety and Safeguards
Attn: Document Control Desk
Washington, D.C. 20555-0001

Gentlemen:

Subject: **CLARIFICATONS TO AREVA'S RESPONSES TO NRC'S REQUEST FOR ADDITIONAL INFORMATION (RAI) RELATED TO THE AREVA NP INC. SUPERCRITICAL CO2 SYSTEM LICENSE AMENDMENT (TAC L32689)**

Reference 1: Letter, RE Link to NRC Document Control Desk, "Amended Responses to Request for Additional Information Regarding the Review of the AREVA NP Inc., Fuel Fabrication Facility Supercritical CO_2 License Amendment Application; License No. SNM-1227, Docket No. 70-1257 (TAC L32689) July 13, 2009

In Reference 1, AREVA NP Inc. provided responses to NRC's RAI questions regarding a license amendment application for a uranium recovery process using Supercritical CO_2.

During a conference call between AREVA and the NRC on August 20, 2009, AREVA agreed to clarify responses to RAI questions 5.b and 7 related to nuclear criticality safety (NCS).

Attached to this letter are the clarifications AREVA agreed to provide.

Please contact me on 509-375-8409 if you have questions or need additional assistance regarding this response.

Very truly yours,

R. E. Link, Manager
Environmental, Health, Safety & Licensing

/mah

Enclosures

cc: Mr. Rafael Rodriguez,
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NMSS01

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Attachment I

RAI 5b.

Relative to RAI response to NCS question 5.b, AREVA agreed to model the transport of fissile material in the subject area. Figure 3 shows the locations of material "in-transit" that have been modeled using KENO.Va.

Computer Model Description

The computer model analyzes the neutron interaction of the equipment in the supercritical carbon dioxide (CO_2) extraction system in the UO_2 Building room 131. The following equipment components were included in the neutron interaction sensitivity study:

1. Buckets on the in-feed preparation stack.
2. Tumbler on in-feed preparation stack.
3. In-feed preparation stack.
4. Extractor vessels and associated baskets.
5. Process vessels.
6. 55 gallon waste drum.
7. Other materials in transit through the area.

There are two additional extractor baskets in the model, one on each side of the extractor vessel array, which represent the loading and unloading placement where interaction with other equipment will be at its highest. The 55 gallon waste drum is placed at the end of the process line and is where the baskets will be emptied after processing. The entire system is enclosed within 30 cm thick concrete walls, floor, and ceiling. The analysis on interspersed moderation ranges from a light H_2O density of 0.001 g/cc to a full H_2O density of 1 g/cc.

The base model of the supercritical carbon dioxide (CO_2) extraction system is illustrated below in Figure 1. Figure 3 shows the addition of in transit materials.

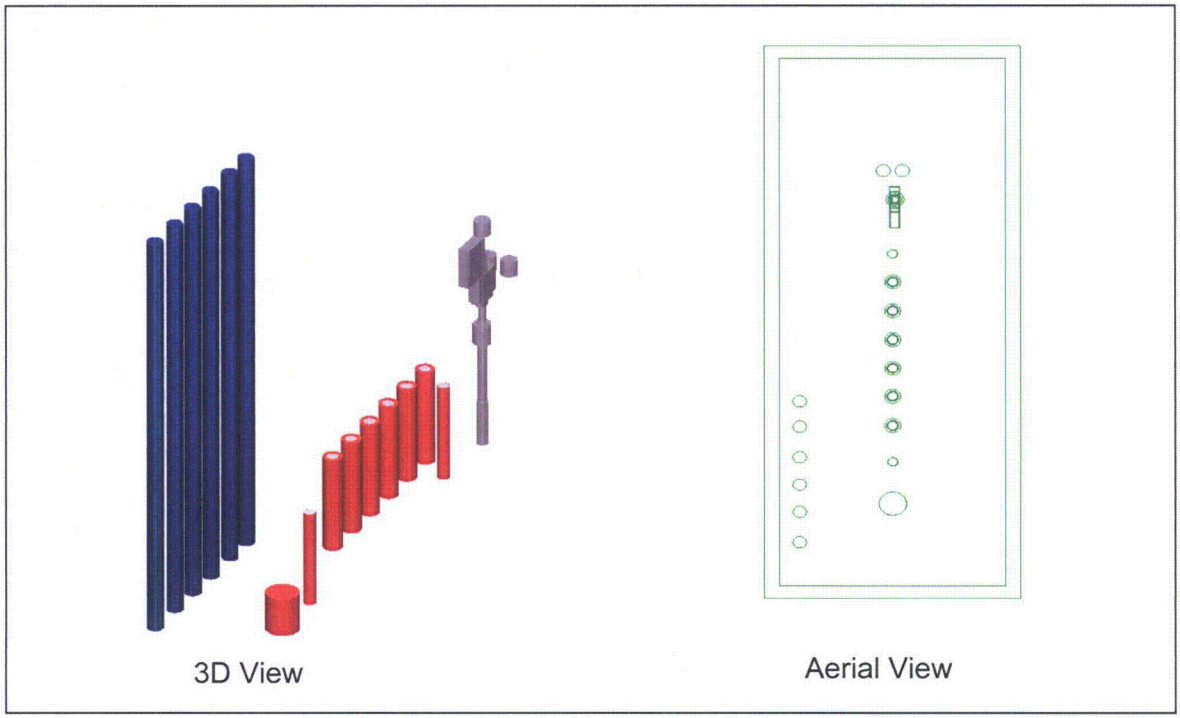

Figure 1 – Room Equipment Interaction Model

The room interaction model sensitivity study includes a variation of the interspersed moderator (H_2O) density between the equipment containing U-bearing materials. The calculations assume that the process vessels are filled with a UNH solution containing 1200 gU/l. The extractor vessels and baskets, are modeled as filled with water saturated, 2.3 g/cc UO_2 (the most reactive mixture). The buckets on the elevator, in-feed system, and the tumbler are modeled with 4 g/cc UO_2 with 10 wt% H_2O. The 55 gallon waste drum is filled with a water saturated UO_2 density of 0.10 g/cc.

The results for these cases are shown graphically in Figure 2 which shows that k_{eff} increases as interspersed moderator increases but remains less than 0.95.

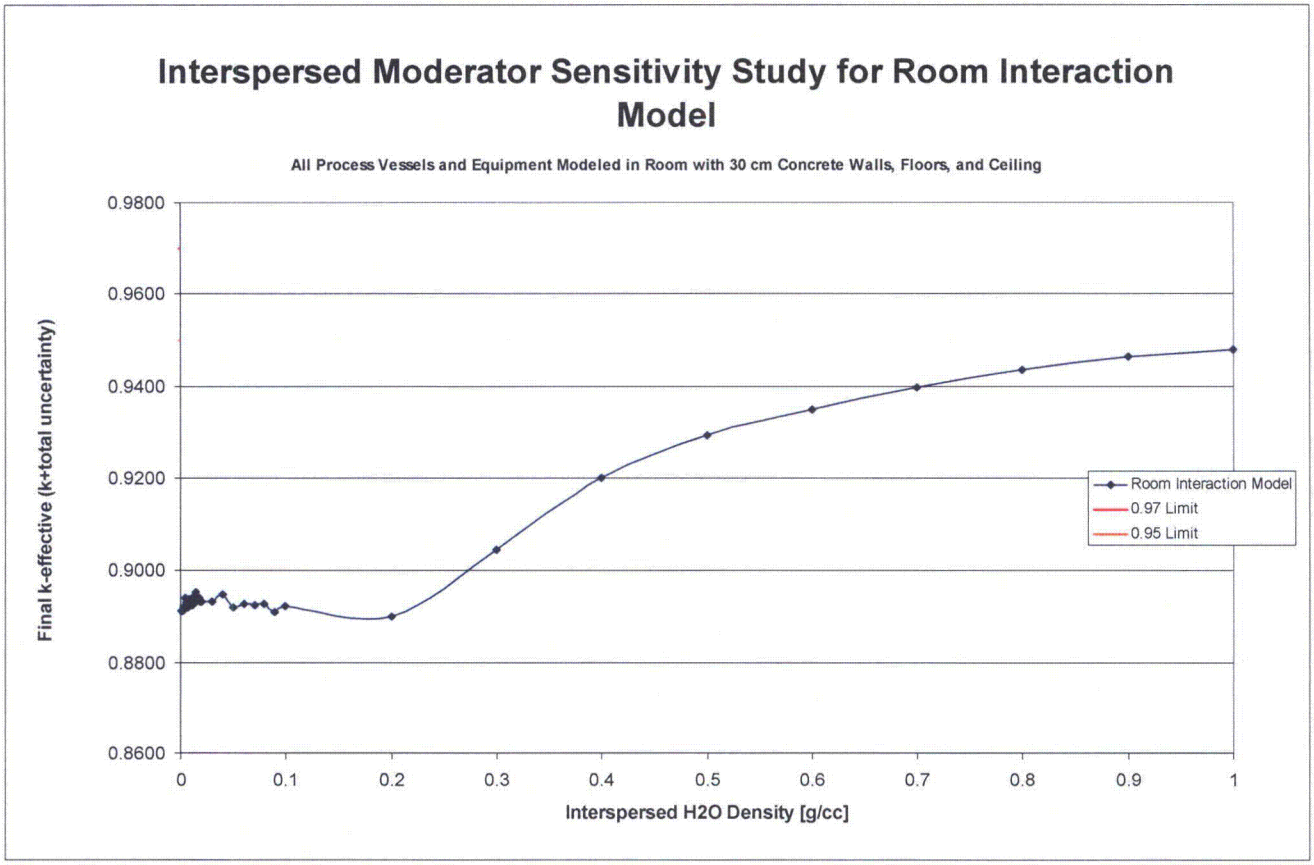

Figure 2- Interspersed Moderator Sensitivity Study for Room Interaction Model

The next study evaluates the impact of various containers in transit in various locations of the process room. These containers include: 55-gallon drums of waste, 55-gallon drums of UNH, 45-Gallon powder drums, and a pallet of four buckets containing UO_2 powder in transit.

The locations of the drums and buckets are shown in **Figure 3**. The first drum location is directly over the top of a waste drum at the end of the extraction system. The rest of the drum and bucket locations are directly over the floor next to the equipment as depicted.

The interaction model considers an interspersed moderator content of 0.001 g/cc and 1.00 g/cc H_2O density for each container at each location. The 55-gallon waste drums are modeled as containing a mixture of UO_2 (0.10 g/cc) saturated with water. The 55-gallon drums of UNH are modeled as containing UNH solution with a U concentration of 140 g U/l (Maximum allowed U concentration in solution drums. Normal concentrations are less than 75 g U/l). The 45 gallon powder drums with boron inserts are modeled as containing 2.3 g/cc.UO_2 powder saturated with water (optimal moderation). The pallet of four buckets is modeled with each bucket filled full with 2.3 g/cc UO_2 powder with 7 wt% H_2O (represents a 3 times overbatch of mass and more than a 3 times overbatch of water in each container).

Table 1 shows that for all cases k_{eff} is not significantly different when compared to the values shown in Figure 2. The variation of k_{eff} with different in transit material locations is less than ± 0.0094. This variance is within the total uncertainty of 0.0113 added to k_{eff} calculations attained using SCALE and supports the conclusion that movement of these containers does not pose a concern with regards to interaction on the supercritical CO_2 equipment.

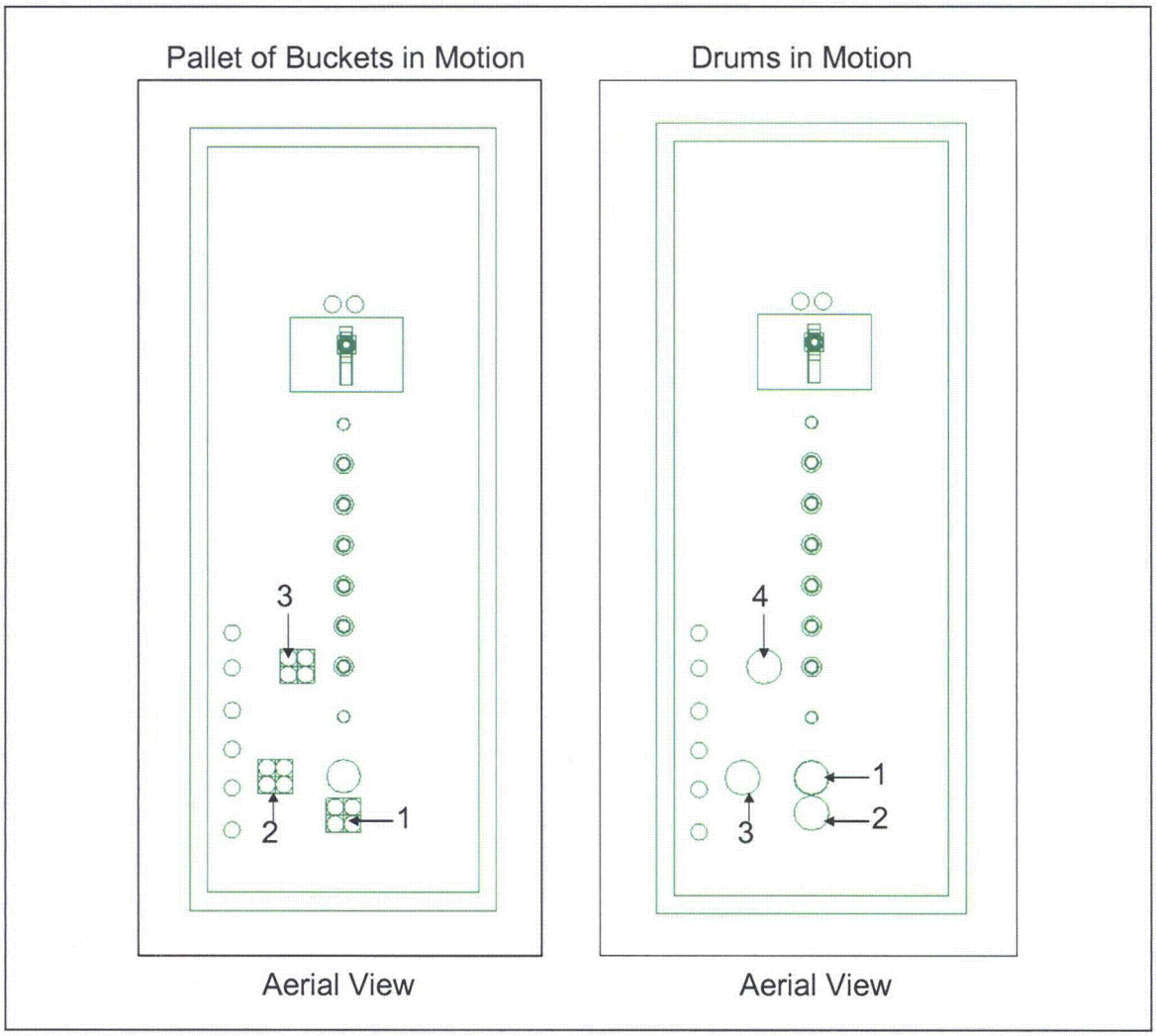

Figure 3 – Drums and Buckets in Motion Interaction Sensitivity Study

Table 1

File Location: \NCSA 186\V1\NRC RAI for CO2\RAI Results\1	Description: Interspersed Moderator Sensitivity Study for Room Model
File Location: \NCSA 186\V1\NRC RAI for CO2\RAI Results\2	Description: Sensitivity Study effects on k-effective for Fissile Material in Motion

Description: Interspersed Moderation Comparison and Sensitivity Study effects on k-effective for drums of waste, UNH, 45- gallon powder, and a pallet with 4 buckets in motion for Room Interaction Model

	Filename	Container Type	Location	IM Density of H2O [g/cc]	BEST KEFF	SIGMA	Uncertainty	Final k-effective	Difference from Original
Original Room Results	room1_0.001_.in	NA	NA	0.001	0.8799	0.0006	0.0113	0.8912	
	room1_1_.in	NA	NA	1.000	0.9366	0.0004	0.0113	0.9479	
Fissile Material in Motion Interaction Results	b1rm_0.001_.in	Buckets	1	0.001	0.8803	0.0005	0.0113	0.8916	0.0004
	b1rm_1_.in	Buckets	1	1.000	0.9377	0.0005	0.0113	0.9490	0.0011
	b2rm_0.001_.in	Buckets	2	0.001	0.8808	0.0005	0.0113	0.8921	0.0009
	b2rm_1_.in	Buckets	2	1.000	0.9376	0.0005	0.0113	0.9489	0.0010
	b3rm_0.001_.in	Buckets	3	0.001	0.8809	0.0006	0.0113	0.8922	0.0010
	b3rm_1_.in	Buckets	3	1.000	0.9365	0.0005	0.0113	0.9478	0.0001
	d1rm_0.001_.in	Waste Drum	1	0.001	0.8805	0.0006	0.0113	0.8918	0.0006
	d1rm_1_.in	Waste Drum	1	1.000	0.9364	0.0005	0.0113	0.9477	0.0002
	d2rm_0.001_.in	Waste Drum	2	0.001	0.8800	0.0006	0.0113	0.8913	0.0001
	d2rm_1_.in	Waste Drum	2	1.000	0.9369	0.0005	0.0113	0.9482	0.0003
	d3rm_0.001_.in	Waste Drum	3	0.001	0.8800	0.0005	0.0113	0.8913	0.0001
	d3rm_1_.in	Waste Drum	3	1.000	0.9360	0.0005	0.0113	0.9473	0.0006
	d4rm_0.001_.in	Waste Drum	4	0.001	0.8803	0.0006	0.0113	0.8916	0.0004
	d4rm_1_.in	Waste Drum	4	1.000	0.9364	0.0005	0.0113	0.9477	0.0002
	UNHd1rm_0.001_.in	UNH Drum	1	0.001	0.8801	0.0005	0.0113	0.8914	0.0002
	UNHd1rm_1_.in	UNH Drum	1	1.000	0.9375	0.0005	0.0113	0.9488	0.0009
	UNHd2rm_0.001_.in	UNH Drum	2	0.001	0.8805	0.0004	0.0113	0.8918	0.0006
	UNHd2rm_1_.in	UNH Drum	2	1.000	0.9365	0.0005	0.0113	0.9478	0.0001
	UNHd3rm_0.001_.in	UNH Drum	3	0.001	0.8807	0.0005	0.0113	0.8920	0.0008
	UNHd3rm_1_.in	UNH Drum	3	1.000	0.9373	0.0005	0.0113	0.9486	0.0007
	UNHd4rm_0.001_.in	UNH Drum	4	0.001	0.8809	0.0005	0.0113	0.8922	0.0010
	UNHd4rm_1_.in	UNH Drum	4	1.000	0.9364	0.0005	0.0113	0.9477	0.0002
	45d1rm_0.001_.in	45 Gallon Powder Drum	1	0.001	0.8846	0.0006	0.0113	0.8959	0.0047
	45d1rm_1_.in	45 Gallon Powder Drum	1	1.000	0.9362	0.0005	0.0113	0.9475	0.0004
	45d2rm_0.001_.in	45 Gallon Powder Drum	2	0.001	0.8893	0.0006	0.0113	0.9006	0.0094
	45d2rm_1_.in	45 Gallon Powder Drum	2	1.000	0.9363	0.0005	0.0113	0.9476	0.0003
	45d3rm_0.001_.in	45 Gallon Powder Drum	3	0.001	0.8881	0.0006	0.0113	0.8994	0.0082
	45d3rm_1_.in	45 Gallon Powder Drum	3	1.000	0.9373	0.0004	0.0113	0.9486	0.0007
	45d4rm_0.001_.in	45 Gallon Powder Drum	4	0.001	0.8885	0.0006	0.0113	0.8998	0.0086
	45d4rm_1_.in	45 Gallon Powder Drum	4	1.000	0.9362	0.0005	0.0113	0.9475	0.0004

RAI 7.

Relative to RAI response to NCS question 7, AREVA agreed to model the material in the feed preparation equipment as heterogeneous material. AREVA further agreed to demonstrate how IROFS 6910 and 6911 are independently capable of keeping the process adequately subcritical.

Under normal conditions the feed material consists of various solid oxides with less than 25% U. The material density is generally less than 1.5 g/cc except for ashclinkers. Lab analysis of numerous clinkers determined the average clinker density to be 1.58 g/cc with a standard deviation of 0.56. Both IROFS 6910 and 6911 are intact during normal conditions. This means that the normal feed batch of 16 containers of feed material will contain less than 15.8 kg U (45% of a minimum critical mass assuming optimum moderation and spherical geometry). In addition to this mass control, the feed preparation equipment is limited to two 5-gallon feed containers (each limited to a net weight of 18 kg) being processed at a time. An additional limit on material hold-up in the feed preparation equipment of 7 kg of feed material is also imposed. Under these normal conditions k_{eff} is much less than 0.90 as shown in Figure 4.

During abnormal conditions, it is possible that one of these two IROFS will fail or will be unavailable to perform the required safety function.

If IROFS 6911 (process hold-up limit of 7 kg net weight) fails or is not available, IROFS 6910 prevents accidental nuclear criticality by limiting the batch of feed material in the feed preparation equipment to 15.8 kg U (45% of a minimum critical mass assuming optimum moderation and full water reflection). A double batch of this feed material will remain less than 90% of a minimum critical mass of U.

It is noted that a clean out of material is required between process batches to ensure that minimal material hold up occurs. This requirement is completely independent of IROFS 6911.

If IROFS 6910 (process batch limited to 15.8 kg U) fails or is not available, IROFS 6911 prevents accidental nuclear criticality by preventing the input of the next two 5-gallon containers (each containing less than 18 kg net weight) into the feed preparation equipment if the material hold up is more than 7 kg net weight. The maximum k_{eff} obtained, if only IROFS 6910 is credited, is less than 0.95 as shown in Figure 5.

The following conservatisms are depicted in Figures 4, and 5.

- For normal conditions, the fuel lump is assumed to be UO_2 at 2.3 g/cc (25.88% TD for U_3O_8, see Figure 4.) The lab determined the mean density of clinkers to be 1.58 g/cc.
- For abnormal conditions, the fuel lump is assumed to be UO_2 at 6.0 g/cc (67.5% TD for U_3O_8 or mean density +8σ, see Figure 5).
- The chemical form of the U in the feed incinerator ash will be U_3O_8 or UO_3 even if the incinerator feed were sintered UO_2 Pellets or ADU.
- The feed material is assumed to simultaneously posses the hygroscopic properties of CaO and the nuclear properties of UO_2.
- If all of the feed material is 43 kg (18+18+7) of dry CaO, it could adsorb a maximum of 12.255 kg water from room air. The total mass of UO_2 + H_2O in Figures 4,and 5 is 56 kg. Note that conservatively the adsorption is considered to occur inside the feed preparation equipment after the 18 kg net wt. per container check.

- If both feed containers are powder or pellets, the maximum water available in the hold up will be less than a minimum mass of water for criticality (also note that 7 kg of liquid water as the hold up is not possible as liquid water would run out of the system onto the floor during normal ash discharge).

- If the minimum critical mass of water is present in the system (~18.5 kg,) then the allowable mass loading remaining for UO_2 (37.5 kg) is less than a minimum critical mass (~40 kg UO_2) and as shown in Figure 5, k_{eff} is less than 0.95 assuming all of the material is in the most reactive equipment piece.

As discussed on the telephone on August 20, 2009, the potential for water addition into the feed preparation equipment from firefighting is rendered highly unlikely by IROFS 4502 and 4503, which are used facility wide to prevent large fires. The potential for water addition into this equipment from roof or pipe leaks is prevented by IROFS 1614, roof and pipe integrity. These IROFS assure that unacceptable additions of moderator will not be added to the equipment if IROFS 6910 fails or is unavailable.

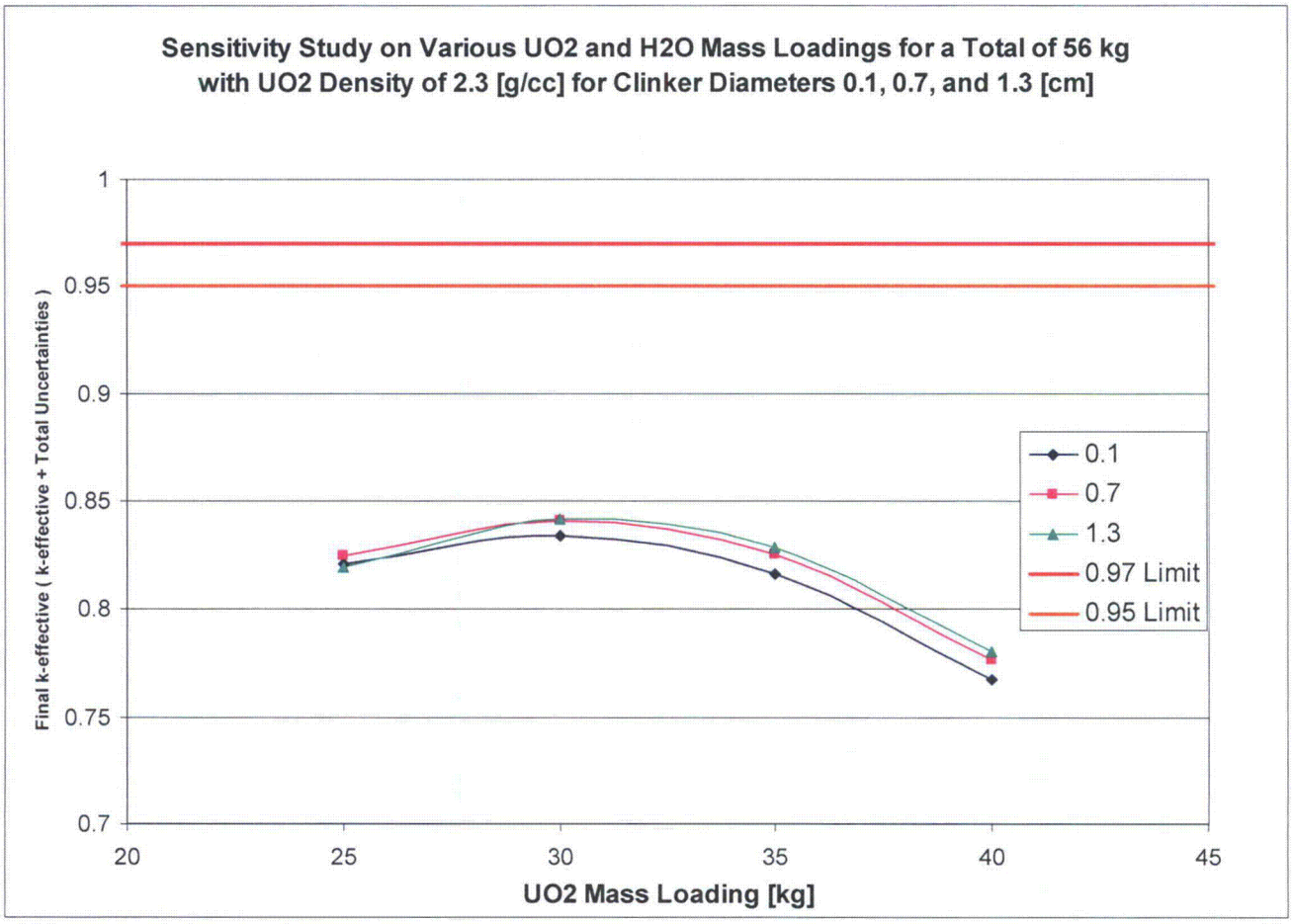
Sensitivity Study on Various UO2 and H2O Mass Loadings for a Total of 56 kg
with UO2 Density of 2.3 [g/cc] for Clinker Diameters 0.1, 0.7, and 1.3 [cm]
Final k-effective (k-effective + Total Uncertainties)
1
0.95
0.9
0.85
0.8
0.75
0.7
20
25
30
35
40
45
UO2 Mass Loading [kg]
0.1
0.7
1.3
0.97 Limit
0.95 Limit

Figure 4

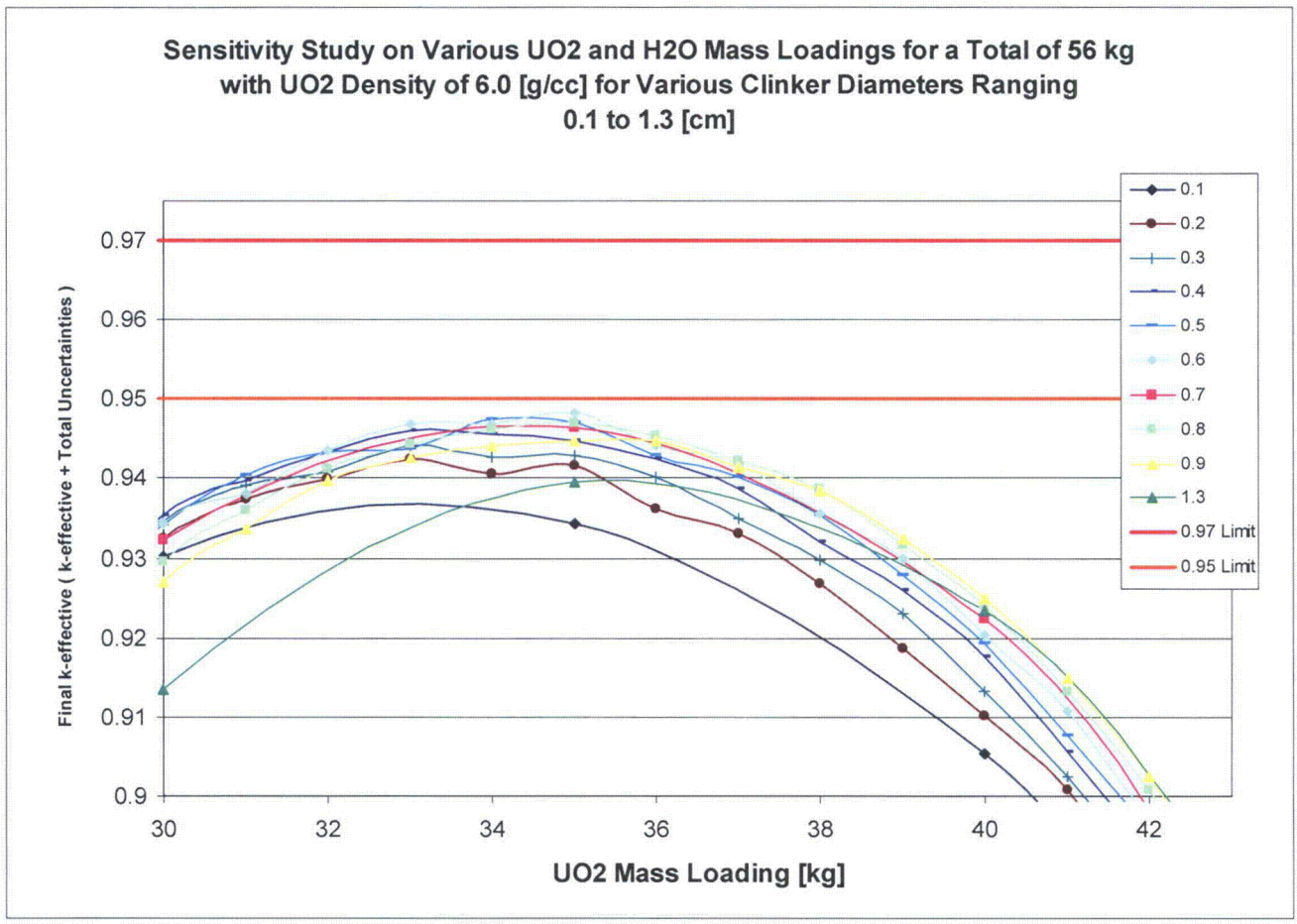
Sensitivity Study on Various UO2 and H2O Mass Loadings for a Total of 56 kg with UO2 Density of 6.0 [g/cc] for Various Clinker Diameters Ranging 0.1 to 1.3 [cm]
Final k-effective (k-effective + Total Uncertainties)
0.97
0.96
0.95
0.94
0.93
0.92
0.91
0.9
30
32
34
36
38
40
42
UO2 Mass Loading [kg]
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.3
0.97 Limit
0.95 Limit

Figure 5