GE Nuclear Energy

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July 1, 1998

Mr. Cass R. Chappell
Package Certification Section
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Dear Mr. Chappell:

Subject: Revision to Application to Reinstate the Provision for Loose Fuel Rods to be Shipped in the RA-3 Packaging

References:
(1) NRC Certificate of Compliance (COC) USA/4986/AF Docket Number 71-4986
(2) COC 4986, Revision 35, 4/2/98
(3) RA-3 Package Application Submittals Dated 6/5/98 and 6/25/98

GE's Nuclear Energy Production facility in Wilmington, N.C. hereby submits the attached revised pages to the above referenced applications for Sections 7L and 8L, which are identical. These pages supplement the previous submittals.

Pages 1 and 22-27 replace those pages previously submitted in both the proprietary and non-proprietary versions. None of the information on these pages is proprietary.

Changes on the pages have been identified with an asterisk (*) in the right hand margin and the revision date of 7/1/98 is shown on each page. Attachment 1 is an explanation of changes by page.

Ten (10) copies of this revised application are being provided for your use.

Please contact Rick Foleck on (910) 675-6299 or me on (910) 675-5950 if you have any questions or would like to discuss this matter further.

Sincerely,

GE NUCLEAR ENERGY

Scott P. Murray
Manager
Facility Licensing

/zb
attachments

cc: SPM-98-021

Explanation of Changes by Page

Page 1	Changed the N value to 8 and the TI to 6.3.
Pages 22, 23, 24 and 25	Starting with case ra10 - s6, we renumbered the cases and provided additional information to describe optimal fuel rod pitch.
Page 26	Replotted Figure 5c and limited the maximum allowed to 2N = 16.
Page 27	Corrected reference from Criticality Index to Transportation Index and reflected the revised number of maximum packages per shipment.

CRITICALITY SAFETY EVALUATION
RA-3 FUEL BUNDLE CONTENTS

1. GENERAL DESCRIPTION

The RA-3 transport package consists of a wooden outer container surrounding a carbon steel inner container holding one or two fuel bundles. A fuel bundle may be either a nuclear fuel assembly or an accumulation of loose fuel rods. Loose fuel rods may be transported in accumulations of no more than 20 rods per bundle which may be held together by metal bands or other equivalent fasteners. Accumulations of more than 20 fuel rods per bundle must be shipped within 5 inch Schedule 40 304L stainless steel product containers as described in the following sections in this evaluation.

In this evaluation there is no requirement to fill the empty space in either the channel assembly or the product container, but quality requirements may dictate filling the empty space. It is important that anything used to fill the empty space is not a more effective moderator than water. The preferred method for filling the empty space is to use empty sealed rods.

The maximum pellet enrichment in loose rods covered by this evaluation is 5.00 wt % U-235. The RA-3 shipping container with loose rods is a Type A fissile package with the following restrictions:

Product container	not required	required	
Maximum number of fuel rods per bundle	20	> 20	
Allowable number of packages, N	infinite	8	*
Transport Index	0.0	6.3	*

Table 5. Results for array calculations (continued)

ral0-s4	Damaged package,	10 x 15 x 1	1.02236 ± 0.00177	
ral0-s4a	finite array,	8 x 12 x 1	0.99758 ± 0.00162	
ral0-s4b	full water reflection,	6 x 9 x 1	0.95600 ± 0.00164	
ral0-s4c	optimum moderation,	5 x 7 x 1	0.91137 ± 0.00162	
ral0-s4d	w/ product container,	4 x 8 x 1	0.90418 ± 0.00176	
ral0-s4e	fuel rod pitch 1.277 cm,	4 x 6 x 1	0.86651 ± 0.00161	
ral0-s4f	no. fuel rods 76	4 x 5 x 1	0.84094 ± 0.00199	
ral0-s5	Damaged package,	10 x 15 x 1	1.04891 ± 0.00155	
ral0-s5a	finite array,	8 x 12 x 1	1.02520 ± 0.00164	
ral0-s5b	full water reflection,	6 x 9 x 1	0.97702 ± 0.00157	
ral0-s5c	optimum moderation,	5 x 7 x 1	0.93548 ± 0.00159	
ral0-s5d	w/ product container,	4 x 8 x 1	0.93070 ± 0.00162	
ral0-s5e	fuel rod pitch 1.327 cm,	4 x 6 x 1	0.89639 ± 0.00182	
ral0-s5f	no. fuel rods 73	4 x 5 x 1	0.87062 ± 0.00199	
ral0-s6	Damaged package,	10 x 15 x 1	1.07766 ± 0.00193	*
ral0-s6a	finite array,	8 x 12 x 1	1.05544 ± 0.00230	*
ral0-s6b	full water reflection,	6 x 9 x 1	1.00542 ± 0.00213	*
ral0-s6c	optimum moderation,	5 x 7 x 1	0.96973 ± 0.00211	*
ral0-s6d	w/ product container,	4 x 8 x 1	0.95861 ± 0.00268	*
ral0-s6e	fuel rod pitch 1.477 cm,	4 x 6 x 1	0.92410 ± 0.00261	*
ral0-s6f	no. fuel rods 61	4 x 5 x 1	0.89870 ± 0.00211	*
ral0-s6g		4 x 4 x 1	0.81720 ± 0.00234	*
ral0-s7	Damaged package,	10 x 15 x 1	1.08508 ± 0.00147	*
ral0-s7a	finite array,	8 x 12 x 1	1.06262 ± 0.00146	*
ral0-s7b	full water reflection,	6 x 9 x 1	1.02191 ± 0.00167	*
ral0-s7c	optimum moderation,	5 x 7 x 1	0.98169 ± 0.00162	*
ral0-s7d	w/ product container,	4 x 8 x 1	0.96797 ± 0.00161	*
ral0-s7e	fuel rod pitch 1.577 cm,	4 x 6 x 1	0.93445 ± 0.00174	*
ral0-s7f	no. fuel rods 55	4 x 5 x 1	0.91320 ± 0.00159	*
ral0-s7g		4 x 4 x 1	0.86419 ± 0.00248	*

Table 5. Results for array calculations (continued)

ra10-s9d	Damaged package,	4 x 8 x 1	0.99276 ± 0.00156	*
ra10-s9e	finite array,	4 x 6 x 1	0.96207 ± 0.00165	*
ra10-s9f	full water reflection,	4 x 5 x 1	0.93751 ± 0.00168	*
ra10-s9g	optimum moderation,	4 x 4 x 1	0.89227 ± 0.00243	*
	w/ product container,			*
	fuel rod pitch 1.650m,			*
	no. fuel rods 55			*
ra10s10d	Damaged package,	4 x 8 x 1	0.94894 ± 0.00243	*
ra10s10e	finite array,	4 x 6 x 1	0.94468 ± 0.00242	*
ra10s10f	full water reflection,	4 x 5 x 1	0.92416 ± 0.00218	*
ra10s10g	optimum moderation,	4 x 4 x 1	0.88831 ± 0.00255	*
	w/ product container,			*
	fuel rod pitch 1.700 cm,			*
	no. fuel rods 53			*
ra10s11	Damaged package,	10 x 15 x 1	1.01056 ± 0.00202	*
ra10s11a	finite array,	8 x 12 x 1	0.99237 ± 0.00205	*
ra10s11b	full water reflection,	6 x 9 x 1	0.91668 ± 0.00192	*
ra10s11c	optimum moderation,	5 x 7 x 1	0.91459 ± 0.00213	*
ra10s11d	w/ product container,	4 x 8 x 1	0.90652 ± 0.00245	*
ra10s11e	fuel rod pitch 1.827 cm,	4 x 6 x 1	0.88407 ± 0.00229	*
ra10s11f	no. fuel rods 37	4 x 5 x 1	0.86219 ± 0.00214	*
ra10s11g		4 x 4 x 1	0.88659 ± 0.00228	*
ra10s12	Damaged package,	10 x 15 x 1	0.97282 ± 0.00225	*
ra10s12a	finite array,	8 x 12 x 1	0.95380 ± 0.00228	*
ra10s12b	full water reflection,	6 x 9 x 1	0.91668 ± 0.00192	*
ra10s12c	optimum moderation,	5 x 7 x 1	0.88515 ± 0.00225	*
ra10s12d	w/ product container,	4 x 8 x 1	0.87633 ± 0.00251	*
ra10s12e	fuel rod pitch 2.077 cm,	4 x 6 x 1	0.85097 ± 0.00253	*
ra10s12f	no. fuel rods 30	4 x 5 x 1	0.83855 ± 0.00223	*
ra10s12g		4 x 4 x 1	0.79650 ± 0.00212	*

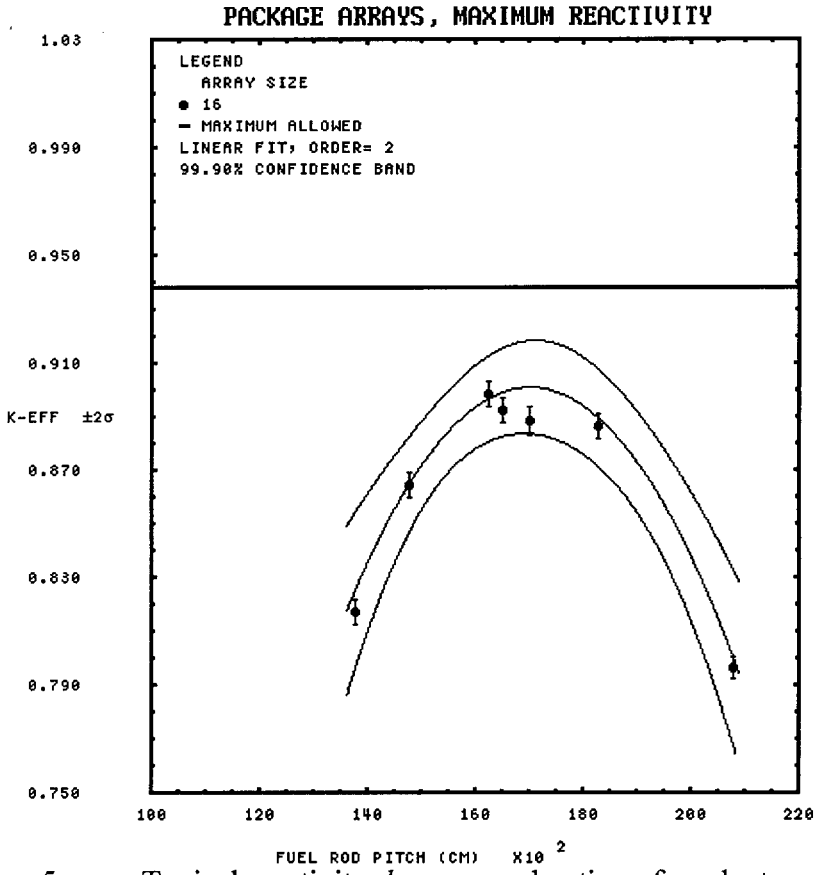

Figure 5a Typical reactivity, k_{eff}, vs moderation of product container for package array (4 x 4 x 1)

The k_{eff} results may be plotted for a specific array size to determine the optimum fuel rod pitch. Figure 5a displays a the relationship between k_{eff} and moderation typical for the package array with the product container. The optimum moderation occurs in at a fuel rod pitch 1.5 cm to 1.8 cm for any array size. This is consistent with the most reactive condition for a single package with the product container and typical of k_{eff} calculations or infinite fuel rod lattices.

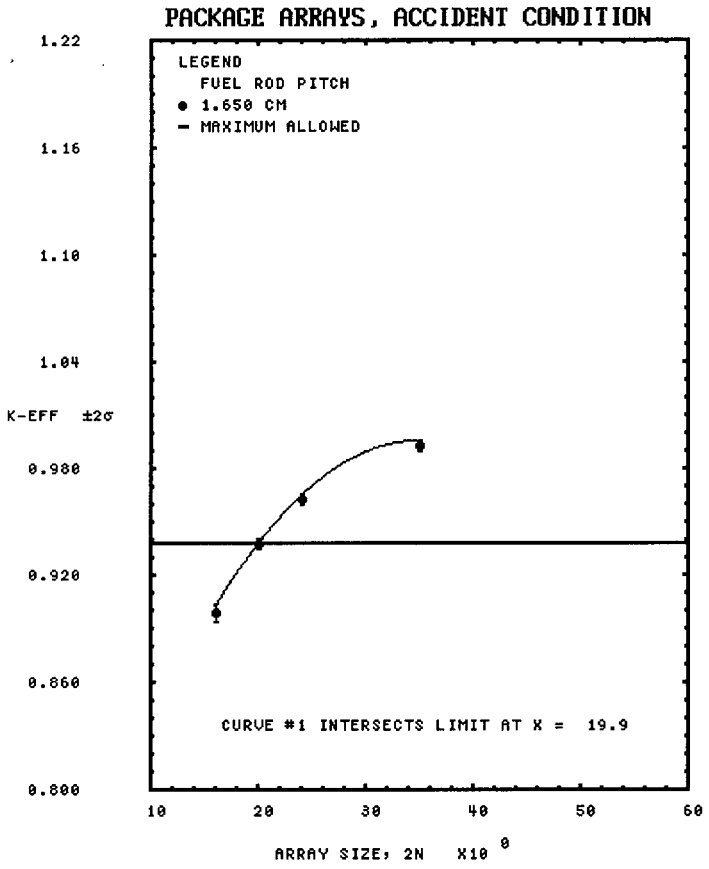

Figure 5b Typical reactivity, k_{eff}, vs array size for a product container moderation (fuel rod pitch 1.650 , 55 fuel rods)

The k_{eff} results for each array size are plotted to determine a maximum allowed value for 2N for a range of fuel rod pitches. Figure 5b displays a typical relationship between k_{eff} and array size for specific fuel rod pitch. The maximum allowed number of damaged packages, 2N , is about 20 for optimum moderation of the product container that occurs at a fuel rod pitch of 1.650 cm.

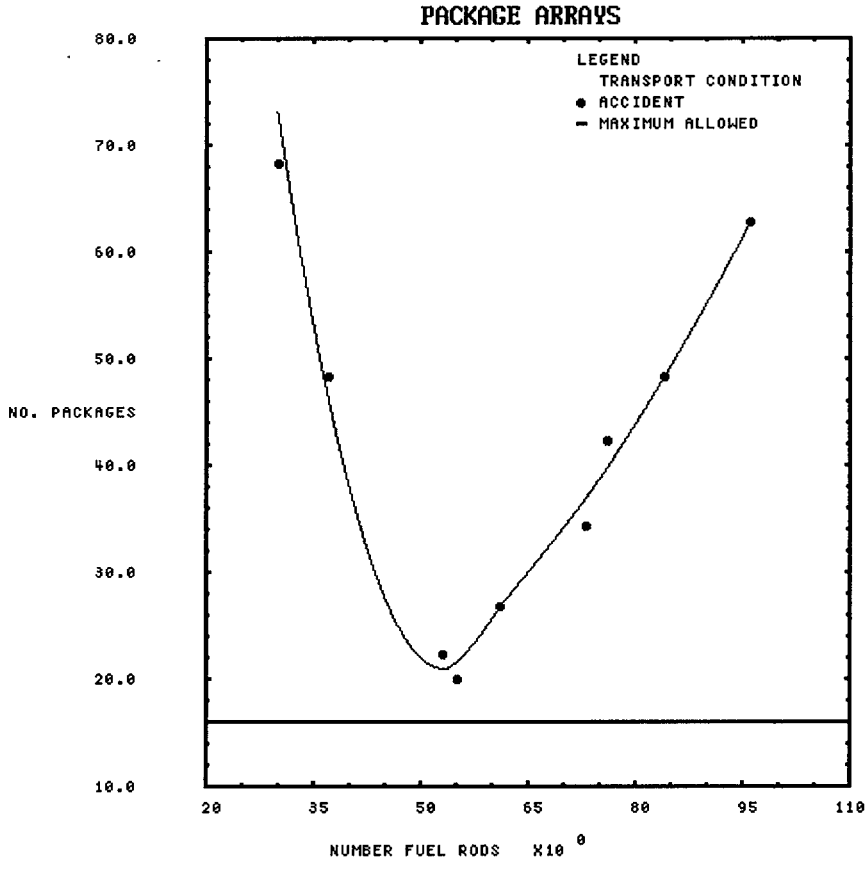

Figure 5c Maximum allowed number of damaged packages, 2N, with product container contents

Each value for 2N is plotted versus the number of fuel rods that corresponds to the value determined for a specific array size as shown in Figure 5b. This demonstrates that there is a maximum number of packages allowed for which the damaged array is subcritical independent of the number of fuel rods loaded in the product container. This maximum allowed value for 2N shall be no less than 16 as shown in Figure 5c.

6.3 TRANSPORTATION INDEX

The Transport Index (TI) for criticality control is determined by the number of packages that remain below the upper safety limit (USL). For normal conditions of transport, an infinite array of packages with either the rod bundle contents is subcritical. Therefore, the maximum allowed number of undamaged packages that may be in any arrangement is unlimited, and 5N is equal to infinity.

Under hypothetical accident conditions, an infinite number of packages with a bundle of 20 fuel rods loaded directly in the channel assembly is subcritical. Therefore, 2N is equal to infinity when the product container is not used. A maximum of only 16 damaged packages remain subcritical when the product container is used, and 2N is equal to 16 when the product container is used.

The transport index assigned to the RA-3 package with a rod bundle contents depends on the packaging used for the fuel rods. A TI = 0.0 may be assigned when the number of fuel rods is limited to 20 per side of the channel assembly for a total of 40 fuel rods per RA-3 package. However, a TI = 6.3 must be assigned when the product container is used, but there is no limit on the number of fuel rods loaded in the product container.