GE Nuclear Energy

General Electric Company
P.O. Box 780, Wilmington, NC 28402
910 675 5000

July 21, 1998

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

Dear Mr. Chappell:

Subject: Application to Revise the Provision for Shipping Loose Fuel Rods Not in a Product Container and Minor Changes to the RA-3 Inner Drawing

Reference: (1) NRC Certificate of Compliance (COC) USA/4986/AF Docket Number 71-4986
(2) COC 4986, Revision 36, 7/2/98
(3) Supplements dated 6/5/98, 6/25/98 and 7/1/98

GE's Nuclear Energy Production facility in Wilmington, N.C. hereby submits a revision (1) for the shipment of loose rods not shipped in the product container, and (2) to the RA-3 inner container drawing.

General Electric has determined that portions of the information contained in this application are proprietary in nature. Therefore, pursuant to 10CFR2.790(b), the required affidavit, Attachment 1, requests that the information in this submittal designated as proprietary be withheld from public disclosure.

Attachment 2 contains the proprietary version of the criticality safety evaluation for shipping loose rods. A vertical line (I) in the right hand margin indicates where changes to the previously submitted criticality safety evaluations. Only the loose rods not in the product container are affected by the changes. This analysis replaces the previous ones in their entirety and should be placed in the section identified as 8L of the current consolidated application book.

This revision corrects errors in the calculation of the most reactive condition for fuel rod bundle contents (loose rods) when the product container is not used. The maximum allowed number of packages for this content was revised from an infinite array to a finite array size of 5 x 7. The maximum allowed number of packages was determined to be 35 and the transport index is revised from zero to 2.9. The number of fuel rods in each bundle was reduced from 20 to 15.

Ltr. Encl. 1
Change: LP 4 0

As a result of this revision, the discussion of the model for the fuel rod bundle contents without the product container was revised throughout the document. Calculations for this content were added and figures displaying the most reactive conditions were inserted. In addition, the tables of calculation results for both contents with and without the product container were revised to clarify the summary of calculations and results.

Typographical errors and grammatical errors were corrected throughout the document. Additional discussions have been inserted to explain the calculations and results.

All changes from the previous submittals are indicated with a vertical line (I) in the right hand margin of the criticality safety evaluation.

Attachment 3 contains the non-proprietary version of the criticality safety evaluation for shipping loose rods. The proprietary information in this attachment has been deleted and an asterisk (*) has been placed in the right hand column adjacent to where the information has been removed. A vertical line (I) in the right hand margin indicates where changes to the previously submitted criticality safety evaluations have been made. Only the loose rods, not in the product container, are affected by the changes. This analysis replaces the previous ones in their entirety and should be placed in the section identified as 7L of the current consolidated application book.

Attachment 4 is a detailed explanation of the changes made to the drawing for the RA-3 inner container. This drawing can be found in Attachment 6 and should be inserted as a replacement to the existing drawing in Section 3.0 of the consolidation application. Our criticality safety function has reviewed changes to this drawing and have determined that the changes do not affect the criticality safety evaluation.

Attachment 5 is a description of the changes being made in this submittal.

Attachment 6 are the replacement pages that should be inserted in the appropriate sections of the consolidation application book.

The following is suggested wording that may be used in the Conditions of the COC.

Under 5.(a)(3) Drawings. Change drawing 769E231 revision to Revision 8.

Under 5.(b)(2)(iii) Contents. Change the maximum number of fuel rods allowed to be positioned within one side of the channel of the inner container from 20 to 15.

Under 5.(c). Change the transport index "For the contents described in 5(b)(1)(v), and limited in 5(b)(2)(iii):" from 0.0 to 2.9.

This supplement application should be referenced under References on the last page of the COC.

Ten (10) copies of this application are being provided for your use. Two of these copies have had the proprietary information removed and are so marked.

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 98-026

Attachment 1

Affidavit of

Proprietary Information

GENERAL ELECTRIC COMPANY
(GE)

AFFIDAVIT

I, Charles M. Vaughan, being duly sworn, depose and state as follows:

(1) I am the Manager, Strategic Planning & Policies, at the GE Nuclear Energy Production facility in Wilmington, N.C., and have been delegated the function of reviewing the information described in paragraph 2 which is sought to be withheld, and have been authorized to apply for its withholding.

(2) The information sought to be withheld is contained in portions of the letter to revise the provisions for loose rods to be shipped in the RA Packaging dated July 21, 1998, to Mr. Cass R. Chappell (NRC) from Mr. Scott P. Murray (GE), and has been identified as "GE COMPANY PROPRIETARY INFORMATION". The information contains details supporting an application for revision of radioactive material packaging NRC Certificate of Compliance USA/4986/AF.

(3) In making this application for withholding of proprietary information of which it is the owner, GE relies upon the exemption from disclosure set forth in the Freedom of Information act ("FOIA"), 5 USC Sec. 552(b)(4), and the Trade Secrets Act, 18 USC Sec. 1905, and NRC regulations 10 CFR 9.17(a)(4) and 2.790(a)(4) for "trade secrets and commercial or financial information obtained from a person and privileged or confidential" (Exemption 4). The material for which exemption from disclosure is here sought is all "confidential commercial information", and some portions also qualify under the narrower definition of "trade secret", within the meanings assigned to those terms for purposes of FOIA Exemption 4 in, respectively, Critical Mass Energy Project v. Nuclear Regulatory Commission, 975F2d871 (DC Cir. 1992), and Public Citizen Health Research Group v. FDA, 704F2d1280 (DC Cir. 1983).

(4) Some examples of categories of information which fit into the definition of proprietary information are:

a. Information that discloses a process, method, or apparatus, including supporting data and analyses, where prevention of its use by General Electric's competitors without license from General Electric constitutes a competitive economic advantage over other companies;

b. Information which, if used by a competitor, would reduce his expenditure of resources or improve his competitive position in the design, manufacture, shipment, installation, assurance of quality, or licensing of a similar product;

c. Information which reveals cost or price information, production capacities, budget levels, or commercial strategies of General Electric, its customers, or its suppliers;

d. Information which reveals aspects of past, present, or future General Electric customer-funded development plans and programs, of potential commercial value to General Electric;

e. Information which discloses patentable subject matter for which it may be desirable to obtain patent protection.

The information sought to be withheld is considered to be proprietary for the reasons set forth in paragraph (4)b., above.

(5) The information sought to be withheld is being submitted to the NRC in confidence. The information is of a sort customarily held in confidence by GE, and is in fact so held. Its initial designation as proprietary information, and the subsequent steps taken to prevent its unauthorized disclosure, are as set forth in (6) and (7) following. The information sought to be withheld has to the best of my knowledge and belief, consistently been held in confidence by GE, no public disclosure has been made, and it is not available in public sources. All disclosures to third parties including any required transmittals to the NRC, have been made, or must be made, pursuant to regulatory provisions or proprietary agreements which provide for maintenance of the information in confidence.

(6) Initial approval of proprietary treatment of a document is made by the manager of the originating component, the person most likely to be acquainted with the value and sensitivity of the information in relation to industry knowledge. Access to such documents within GE is limited on a "need to know" basis.

(7) The procedure for approval of external release of such a document typically requires review by the staff manager, project manager, principal scientist or other equivalent authority, by the manager of the cognizant marketing function (or his delegate), and by the Legal Operation, for technical content, competitive effect, and determination of the accuracy of the proprietary designation. Disclosures outside GE are limited to regulatory bodies, customers, and potential customers, and their agents, suppliers, and licensees, and others with a legitimate need for the information, and then only in accordance with appropriate regulatory provisions or proprietary agreements.

(8) The information identified in paragraph (2) is classified as proprietary because it contains the data and details of the analytical models used in performing the criticality safety calculations, the results of which are part of the justification of safety.

The development of the criticality safety analyses was achieved at a significant cost to GE.

The development of the evaluation process along with the interpretation and application of the analytical results is derived from the extensive experience database that constitutes a major GE asset.

(9) Public disclosure of the information sought to be withheld is likely to cause substantial harm to GE's competitive position and foreclose or reduce the availability of profit-making opportunities. The information is part of GE's comprehensive BWR safety and technology base, and its commercial value extends beyond the original development cost. The value of the technology base goes beyond the extensive physical database and analytical methodology and includes development of the expertise to determine and apply the appropriate evaluation process. In addition, the technology base includes the value derived from providing analyses done with NRC-approved methods.

The research, development, engineering, analytical, and NRC review costs comprise a substantial investment of time and money by GE.

The precise value of the expertise to devise an evaluation process and apply the correct analytical methodology is difficult to quantify, but it clearly is substantial.

GE's competitive advantage will be lost if its competitors are able to use the results of the GE experience to normalize or verify their own process or if they are able to claim an equivalent understanding by demonstrating that they can arrive at the same or similar conclusions.

The value of this information to GE would be lost if the information were disclosed to the public. Making such information available to competitors without their having been required to undertake a similar expenditure of resources would unfairly provide competitors with a windfall, and deprive GE of the opportunity to exercise its competitive advantage to seek an adequate return on its large investment in development of these very valuable analytical tools.

STATE OF NORTH CAROLINA)
) SS:
COUNTY OF NEW HANOVER)

Charles M. Vaughan, being duly sworn, deposes and says:

That he has read the foregoing affidavit and the matters stated therein are true and correct to the best of his knowledge, information, and belief.

Executed at Wilmington, North Carolina, this 21st day of July, 1998.

ROSA L. DAVIS
NOTARY
PUBLIC
NEW HANOVER COUNTY, NC

Charles M. Vaughan

Charles M. Vaughan
General Electric Company

Subscribed and sworn before me this 21st day of July, 1998.

Rosa L. Davis

Notary Public, State of North Carolina

My commission expires:

12-14-2002

Attachment 3

Non-Proprietary Version of the "Criticality Safety Evaluation - RA-3 Fuel Bundle Contents" Dated 7/21/98

(In addition to the vertical line (I) showing where information has been changed or added, an asterisk (*) has been placed in the right hand column adjacent to where the information has been removed.)

This analysis replaces the previous ones in their entirety and should be placed in the section identified as 7L of the current consolidated application book.

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 is an accumulation of loose fuel rods. Loose fuel rods may be transported in accumulations of no more than 15 rods per bundle which may be held together by metal bands or other equivalent fasteners. Accumulations of more than 15 fuel rods per bundle must be shipped within 5 inch Schedule 40 304 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	15	no limit
Allowable number of packages, N	17.5	8
Transport Index	2.9	6.3

2. PACKAGE DESCRIPTION

2.1 CONTENTS

The RA-3 may be used to transport up to two fuel bundles each containing unirradiated uranium dioxide pellets. The pellets have a nominal outside diameter between 0.340 and 0.515 inch. The maximum fuel pellet enrichment is 5.00 weight percent U-235. Typical fuel rod dimensions are shown in Table 1.

Table 1 Fuel rod dimensions

Rod type	Pellet outer diameter (inch)	Pellet-clad gap (inch)	Clad thickness (inch)
10 X 10	0.340	0.006	0.023
9 X 9	0.377	0.0065	0.025
8 X 8	0.411	0.007	0.029
7 X 7	0.515	0.0055	0.030

2.2 PACKAGING

The packaging consists of the zircaloy or stainless steel fuel rods that contain the fuel pellets, product container (DWG No. 0028B98), RA-3 inner shipping container (DWG No. 769E231), RA-3 outer shipping container (DWG No. 769E229).

2.2.1 Fuel Rods

Pellets and end plugs are contained in fuel rods up to 174 inches (441.96 cm) with dimensions in the range indicated in Table 1. The composition and atom densities of the tubes and other package materials is given in Table 2.

The fuel rods are sealed at both ends with zirconium or stainless steel plugs that are welded in place. The structural evaluation has shown that the fuel rods remain intact, and the pellets remain inside the fuel rod, under normal conditions of transport and hypothetical accident conditions.

For transport in the RA-3 container the fuel rods are sheathed in a 0.004 inch (0.10 mm) nominal thickness plastic sleeve and loaded directly into the inner container channel assembly or product container. Empty space in the channel assembly is filled with ethafoam, polyethylene, or wood packaging and empty space in the product container is usually filled with empty fuel tubes fitted with end plugs welded at both ends. A maximum of one bundle may be loaded into each channel in the channel assembly within the RA-3 inner container.

2.2.2 Product container

The product container is detailed in Drawing No. 0028B98. For the purpose of general discussion in this evaluation, the product container is a pipe that is fabricated from 5-inch, Schedule 40 304 stainless steel. The outside diameter of the pipe is 5.563 inches (141.30 mm) and the nominal wall thickness is 0.258 inches (6.55 mm) per ASTM Specification A 731/A 731M. The minimum wall thickness is 0.226 inches (5.74 mm) per ASTM Specification A 530/A530M. Both ends of the pipe are fitted with a 6.50 inch square, 0.50 inch thick 304 stainless steel plate flange and cover. The pipe length is 167.00 inches from flange to flange. Covers are fastened to each flanged end with four 5/16-18 x 1.50 inch 304 stainless steel bolts and hex nuts. A collar for lifting is installed at two positions typically 6.00 from each end of the pipe. One of the covers is fitted with a breather valve.

2.2.3 RA-3 Inner Shipping Container

The inner shipping container is detailed in Drawing No. 769E231. For the purpose of general discussion in this evaluation, the inner container is fabricated from 1.5 mm (16 gauge) carbon steel. The inner container [18 1/8 inch (460 mm) by 11 7/16 inch (290 mm) by 182 15/16 inch (4647 mm)] is a welded construction. A channel assembly inside the inner container [6 7/8 inch (175 mm) by 6 7/8 inch (175 mm) by 179 1/4 inch (4553 mm)] retains up to two fuel bundles. The space between the fuel assembly and channel assembly is filled with 5/8 to ¾ inch (15.9 to 19.1 mm) ethafoam cushion and there is 1 inch (25.4 mm) ethafoam in the cover. There are ¾ inch (19 mm) diameter hole on 1 ¾ inch center-to-center spacing fabricated in each channel assembly side and top cover. The top cover and end cap are connected to the body through fourteen lugs on the cover and four lugs on each end cap using 3/8 - 16 UNC mild steel bolts, washers, and nuts. Gasket material that is either neoprene or isoprene 30-55 DURO seals the cover and end cap to the body and a breather plug is located in the end cap of the inner container.

2.2.4 RA-3 Outer Shipping Container

The outer shipping container is detailed in Drawing No. 769E229. For the purpose of general discussion in this evaluation, the transport package uses a wooden outer container (29 ¾ inch (756 mm) by 31inch (787 mm) by 206 ¾ inch (5251 mm). The RA-3 outer container exterior sides are constructed of ½ inch (13 mm) plywood and 2x4 inch (51x102 mm) thick pine or fir support beams. Honeycomb padding and ethafoam pads evenly spaced over the length of the container fill the space between the wooden over pack and inner container. A single inner shipping container is loaded into the outer shipping container.

Table 2. Material Specifications

Material	Density (g/cm3)	Constituent	Atomic density (atoms / b-cm)
U(5.00)O2	10.96	U235	1.237780E-03
		U238	2.322070E-02
		O	4.891270E-02
Water	1.000	H	6.686600E-02
		O	3.343300E-02
304 Stainless Steel	7.92	C	3.169100E-04
		Si	1.694000E-03
		Cr	1.647100E-02
		Fe	6.036000E-02
		Ni	6.483400E-03
		Mn	1.732100E-03
High Density Polyethylene	0.92	H	8.293800E-02
		C	4.146900E-02
Ethafoam	0.035	H	3.030000E-03
		C	1.515000E-03
Honeycomb	0.45	H	3.013100E-03
		C	2.092900E-03
		O	1.221970E-03
Wood	0.64	H	2.133400E-02
		C	1.185800E-02
		O	8.593300E-03
Zirconium	6.51	Zr	4.070910E-02
Carbon Steel	7.82	C	3.921000E-03
		Fe	8.349100E-02

3. CRITICALITY SAFETY ANALYSIS MODELS

3.1.1 GENERAL MODEL

3.1.2 Dimensions

Figure 1a and 1b represent the vertical elevations of the RA-3 inner shipping container and Figure 2 represents the vertical elevations of the RA-3 outer shipping container both seen along a vertical centerline of the package. A cross section of the package along A-A of Figure 2 is displayed in Figure 3. The figure's dimensions are used in the calculations.

FIGURE WITHHELD UNDER 10 CFR 2.390

Figure 1a Radial cross section of single-package inner container with rod bundle w/o product container

FIGURE WITHHELD UNDER 10 CFR 2.390

Figure 1.b Radial cross section of single-package inner container with rod bundle w/ product container

FIGURE WITHHELD UNDER 10 CFR 2.390

Figure 2. Radial cross section of single-package outer container

FIGURE WITHHELD UNDER 10 CFR 2.390

Figure 3. Axial cross section of single-package outer container

3.1.3 Materials

Figures 1a, 1b, 2 and 3 show the cross sections of the single-package models used for the calculations. Table 3a and 3b identify the regions and materials.

Table 3a Material specifications for Figures 1a and 1b - Inner shipping container

Material No.	Material	Density (g/cm3)	Model mass (kg)	Actual mass (kg)
1	UO2	10.96	2.9 - 640.5	2.8 - 506.6
2	High density polyethylene	0.92	.034 - 7.44	0.03 - 5.4
3	Carbon steel	7.82	191.1	198.1
4	Water	0.00 - 1.00	0.0 - 149	0.0
5	Wood	0.64	0.0	1.0
6	Carbon steel	0.85 x 7.82	50.1	49.9
7	Zr	6.51	0.5 - 111.4	.55 - 100.0
8	SS-304	7.92	84.5	102

Table 3b Material specifications for Figures 2 and 3 - Outer shipping container

Material No.	Material	Density (g/cm3)	Model mass (kg)	Actual mass (kg)
1	Ethafoam	0.5 x 0.035	4.65	6.94
2	Honeycomb	0.058	27.7	39.2
3	Wood	0.64	111.0	294.0
4	Carbon Steel	7.82	0	19.3

3.1.4 Models-Actual Package Differences

The contents evaluated were 14 to 20 loose fuel rods per bundle and a variable number of fuel rods in 304 SS product container. The number of loose fuel rods may actually be as few as one per shipping container, and the maximum that can actually be loaded in the 304 SS product container is approximately 90. Loose rods may actually be banded together using steel clamps, but the model does not assume the fuel rod spacing is constrained. Empty space in the 304 SS product container may be filled with sealed rods that contain no fuel pellets.

Loose rods are modeled in a triangular lattice at a variable pitch to determine the water-to-fuel ratio that results in a maximum package reactivity. The minimum pellet diameter of 0.345 $\pm$ 0.005 inches is conservatively modeled at 0.346 inches. None of the packaging material actually used to fill space in the channel assembly or shipping container for loose rods is a more effective moderator than water, with the exception of polyethylene plastic sheath used to package individual rods. The 0.004 inch thick polyethylene sheath is modeled as a 0.010 inch thick annulus of high density polyethylene material in direct contact with the fuel rods. All fuel rods are modeled to contain uranium dioxide enriched to 5.00 wt % U-235, but any fuel rod containing fuel pellets up to an enrichment of 5.00 wt % may be loaded in the RA-3 package.

3.2 CONTENTS MODEL

Figures 1a and 1b show the package contents consisting of pellets in fuel rods as configured for both the single-package and package-array calculations. Each fuel rod is modeled as 174 inches long. Partial-loading configurations are allowed, as are variation in pellet enrichment up to 5.00 wt % U235. Partial loadings do not require further analysis because they are bounded by the more reactive configuration of full loading.

3.2.1 Conservatism in the Model

Fuel rods are included explicitly in the analysis and are modeled very conservatively as equally spaced rods in triangular lattices. Although there are no mechanisms in the package to maintain rod to rod spacing (center to center) in excess of that applicable to rods in contact with each other, the analysis considers spacing from the minimum to the maximum possible. The minimum spacing are the rod plus plastic sleeve outer diameters and the maximum spacing are the dimensions of the channels in the inner container - or the product container inner diameter - (divided by the number of rods in the linear x direction).

A second degree of conservatism is that the water moderator is considered to be up to full density in the channel assembly and product container regions. No interspersed water outside of the fuel regions defined by the channel assembly or product container was assumed. This is especially conservative for the models of loose rods not in the product container since the inner RA container is constructed so that water can not accumulate just in the channels.

3.2.2 Water to Fuel Ratios

Fuel rod spacing is variable from about 1.0 cm to 4.8 cm depending on either the constraint of the inner container channel dimensions or the product container inner diameter for both normal conditions of transport and accident conditions. The fuel rod spacing determines the fuel lattice water to fuel ratio. The space available for fuel rods in the channel assembly is approximately 6- 7/8 inches (175 mm x 175 mm).

Fuel rod spacing for a fixed number of fuel rods is varied within the constraint of the channel assembly dimensions to vary water-to-fuel ratio. The number of fuel rods in the channel assembly is varied from 14 to 20 without the constraint of the product container.

The fuel rod spacing for a triangular lattice in the product container is restricted only by the product container ID and the number of fuel rods to determine the configuration with the optimum water-to-fuel ratio. The product container has a nominal inside diameter of 5.047 inches (128 mm).

Each fuel rod is encased in 0.010 inch (0.254 mm) thick polyethylene and the remaining space between the fuel rods is filled with (full density) water. In general, water may leak into the channel assembly or product container, and interstitial water density is varied to determine the most reactive condition.

3.3 SINGLE PACKAGES

The single package model is used to determine the most reactive configuration of contents material and optimum moderation. Water is a more effective reflector than the wood, honeycomb, and ethafoam materials in the outer shipping container; therefore, only close reflection by water on all sides of a single package consisting of the RA-3 inner shipping container is modeled. The only difference between the normal transport condition and hypothetical condition is the presence of the RA-3 outer container; therefore, the model for a single package for normal transport conditions and hypothetical accident conditions is the same.

The RA-3 package was subjected to the tests specified in 10 CFR 71.55, General requirements for all fissile material packages, with a fuel assembly contents, and the geometric form of the package was not substantially altered. No differences between the RA-3 package containing the fuel assembly and the RA-3 package containing loose fuel rods have been identified that invalidate application of RA-3 test conclusions to the RA-3 with the loose rods content.

3.4 PACKAGE ARRAYS

Rectangular parallelepiped packages such as the RA-3 may be shipped in a tightly packed square pitch configuration or shift to that configuration because of hypothetical accident conditions.

Two array model types are included in this evaluation. The first model type consists of an infinite array of close packed, square-pitch, undamaged inner and outer container consistent with the normal condition of transport. The second model type consists of a variable array size of close-packed damaged packages consisting of the inner container only. The array size is dimensioned for the second model type to minimize surface-to-volume ratio. This results in the most reactive configuration because the overall dimensions minimize neutron leakage at the boundary. As required by 10 CFR 71.59, the damaged packages are evaluated with optimum interspersed hydrogenous moderation consistent with tests specified in 10 CFR 71.73, Hypothetical Accident Conditions.

4. METHOD OF ANALYSIS

GEMER, a proprietary General Electric company standard criticality analysis computer code was used in the analysis of these computational models. All calculations were performed using Pentium processors running under Windows 95 or Windows NT.

4.1 COMPUTER CODE SYSTEM

GEMER is a Monte Carlo program which solves the neutron transport equation as an eigenvalue or a fixed source problem including the neutron shielding problem. GEMER adds an advanced geometry input package to the problem solving capability of the Monte Carlo code which is very similar to KENO.

4.2 CROSS SECTIONS AND CROSS-SECTION PROCESSING

GEMER uses cross sections processed from the ENDF/B-IV library tapes. These cross section are prepared in 190 group format and those in the resonance region may have the form of the resonance parameters or Doppler broadened multigroup cross section. Thermal scattering of hydrogen in water is represented by the $S(\alpha,\beta)$ data in the ENDF/B-IV library. The types of reactions considered in the Monte Carlo calculation are fission, elastic, inelastic, and (n,2n) reactions; the absorption is implicitly treated by reducing the neutron weight by the non-absorption probability on each collision.

4.3 CODE INPUT

All problems were started with a flat neutron distribution over the system, in the fissile material only. All problems were run for at least 110 generations of 1000 neutrons per generation, skipping the first ten generations, for a total of 100,000 histories. Mirror reflection was applied to the orthogonal-plane boundaries of the single package model to simulate infinite array-package models. Close, full-density, 30.48 cm (12 inch) thick water reflector was modeled explicitly.

Figures 3a through 3d are sample input files. The files correspond to single packages and package arrays typically used in the calculation of k_{eff}.

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WITHHELD FROM PUBLIC DISCLOSURE

Figure 3a. Single-package without product container, file b709uf20

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WITHHELD FROM PUBLIC DISCLOSURE

Figure 3b Single-package with product container, file ra10su8

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Figure 3c Package Array without product container, file b709-f18

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Figure 3d   Package Array with product container, file ra10-s8g

4.4 CONVERGENCE OF CALCULATIONS

Problem convergence was determined by examining plots of k_{eff} by generation run and skipped, as well as the final k_{eff} edit tables. No trends were observed either in k_{eff} by generation run over the last half of total generations or, correspondingly in k_{eff} by generation skipped over the first half of total generation. No sudden changes of greater than one standard deviation in k_{eff} by generation run or skipped, resulting from an abnormal k_{eff} generation, were found. Frequency distribution bar graphs appear to approximate normal distributions with single peaks and no significant outlying values.

5. VALIDATION OF CALCULATION METHOD

Validation of GEMER consists of performing calculation of benchmark experiments including the area of applicable to the low enriched fuel rod lattice. Bias for GEMER and the ENDF/B-IV library has been established for the area of applicability for the RA-3 package. The bias determined using a set of 79 critical benchmark experiments specific to UO2 rod lattices is no greater than 0.012 ($\Delta k_u - \beta$) at a 99% confidence level. The area of applicability for the benchmark calculations are enrichment ranges from 1.29 to 9.83 weight percent U-235 and H/U-235 ratio 41 to 866.

Using a general equation for the upper safety limit (USL) and requirements of 10 CFR 71, calculations are considered subcritical, if the following condition is satisfied:

$$k_{eff} + 2\sigma \leq 0.95 - \Delta k_u + \beta$$
$$k_{eff} + 2\sigma \leq 0.938$$

6. CRITICALITY CALCULATIONS AND RESULTS

This evaluation demonstrates the subcriticality of a single package (Section 6.1) and an array of packages (Section 6.2) during normal conditions of transport and hypothetical accident conditions. The transport index (TI) is determined for criticality control (Section 6.3).

6.1 SINGLE PACKAGE

Calculations show that a single package remains subcritical under general requirements for fissile material packages for both normal conditions of transport and hypothetical accident conditions. The effect of increasing fuel rod pitch is evaluated to determine the most reactive contents for a single damaged package for two configurations of rod bundles. The first configuration is loose fuel rods in the channel assembly, and the second configuration is a lattice of loose fuel rods in a product container. Full-density water is used to determine optimum moderation for both content configurations.

Fuel rod pitch is directly related to water-to-fuel ratio within the contents. Optimum moderation for fuel rods occurs at a fuel rod pitch somewhere in the range between a close packed lattice and the maximum lattice spacing possible within the constraint of the channel assembly or product container. A reduced number of fuel rods in the product container (less than the actual capacity) is evaluated to obtain a maximum reactive contents.

Optimum moderation for a fixed number of fuel rods in the channel assembly occurs at a water-to-fuel ratio in the range of 7 to 14 corresponding to an H/U of 20 to 40 for UO2 in water. The effect of moderation on the contents is evaluated for the range of fuel pellet diameters using bundles of 20 fuel rods. The maximum reactivity occurs for the largest pellet diameter because this results in the maximum mass of uranium in the system.

For the lattices of fuel rods in the product container, the number of fuel rods is reduced as the pitch is increased to change the water-to-fuel ratio. Optimum moderation for a fixed geometry of fuel rods contained in the product container occurs at a water-to-fuel ratio in the range of 2 to 4 which corresponds to an H/U of 7 to 12.

Tables 4a and 4b summarize the most reactive condition for a single package. The effect of moderation on reactivity of a single damaged package is displayed in Figure 4a for both content configurations. Figure 4b shows the sensitivity of single package reactivity to the fuel pellet diameter.

Table 4a. Single-package calculation, fuel rod bundle without product container

Case	Description	$k_{eff} \pm \sigma$
b707uf20	water-to-fuel ratio 7.31 in fuel rod bundle, damaged package (20 fuel rods, 0.515 in pellet OD)	0.49888 ± 0.00210
b709uf20	water-to-fuel ratio 8.97 in fuel rod bundle, damaged package (20 fuel rods, 0.515 in pellet OD)	0.56539 ± 0.00249
b711uf20	water-to-fuel ratio 10.96 in fuel rod bundle, damaged package (20 fuel rods, 0.515 in pellet OD)	0.62892 ± 0.00243
b713uf20	water-to-fuel ratio 13.41 in fuel rod bundle, damaged package (20 fuel rods, 0.515 in pellet OD)	0.64882 ± 0.00194
b109uf20	full density water in fuel rod bundle, damaged package (20 fuel rods, 0.346 in pellet OD)	0.53504 ± 0.00215
b909uf20	full density water in fuel rod bundle, damaged package (20 fuel rods, 0.376 in pellet OD)	0.56700 ± 0.00215
b809uf20	full density water in fuel rod bundle, damaged package (20 fuel rods, 0.411 in pellet OD)	0.59848 ± 0.00244
b709uf20	full density water in fuel rod bundle, damaged package (20 fuel rods, 0.515 in pellet OD)	0.68000 ± 0.00250

Table 4b. Single-package calculation, fuel rod bundle with product container

Case	Description	$k_{eff} \pm \sigma$
rasu5ful	water-to-fuel ratio 0.96, damaged package	0.47220 ± 0.00257
rasu6ful	water-to-fuel ratio 1.54 , damaged package	0.50541 ± 0.00223
rasu7ful	water-to-fuel ratio 1.96, damaged package	0.51575 ± 0.00243
rasu11ful	water-to-fuel ratio 3.14, damaged package	0.50068 ± 0.00254

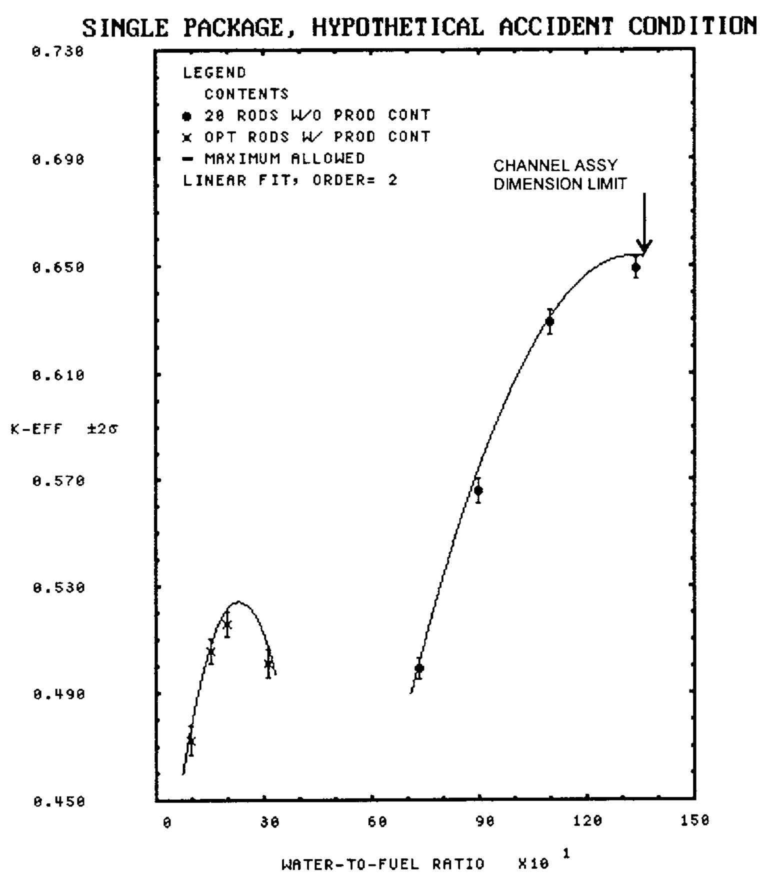

Figure 4a Typical reactivity, k_{eff}, vs contents moderation for single package

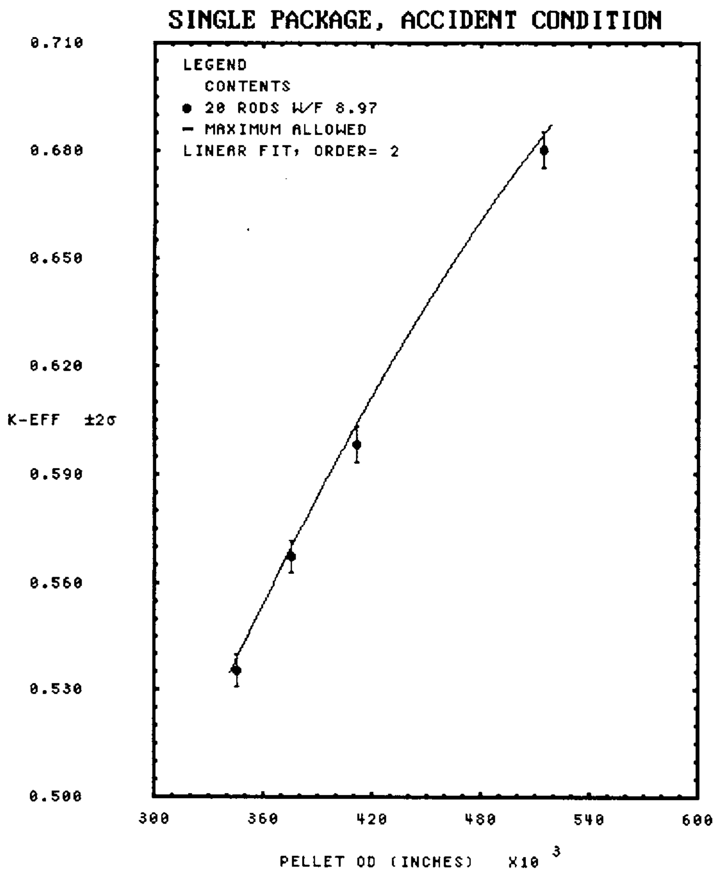

Figure 4b Typical reactivity, k_{eff}, vs. pellet size for single package, 20 fuel rods without product container

6.2 PACKAGE ARRAYS

The calculation results displayed in Table 5 demonstrate that an infinite array of packages is adequately subcritical under normal conditions of transport. The package arrays evaluated using the damaged single package are more reactive than those arrays using the undamaged single package. The accident condition array assumes the hypothetical accident condition for all packages.

The number of damaged packages without the product container is adequately subcritical is 35 packages containing a maximum of 15 fuel rods in each bundle. The number of fuel rods per bundle is reduced from the 20 evaluated in the single package to allow the maximum number of packages in the array to increase to 35.

The maximum allowed number of damaged packages with the product container is determined for a range of fuel rod pitches within the product container. The number of rods in the product container decreases as the fuel rod pitch increases. Optimum moderation of the contents is full density water as demonstrated by the most single package calculations. Void space in the inner shipping package outside the product container results in maximum interaction between the contents of the single packages. Therefore, the package arrays are most reactive with no interstitial moderation outside the product container.

Tables 5a, 5b, and 5c summarize the cases used to determine the maximum allowed number of damaged packages, 2N, for a range of fuel rod pitches. Fuel rod pitch corresponds to a specific number of rods that fit into the product container. The maximum allowed k_{eff} is the USL specified in Section 5, "Validation of Calculation Method".

Table 5a. Results for array calculations, normal transport condition

Case	Description	$k_{eff} \pm \sigma$
ra10b000	Infinite array, optimum moderation, undamaged package w/ product container	0.85872 ± 0.00255
b700ifl14	Infinite array, optimum moderation, undamaged package w/o product container	0.73010 ± 0.00173
b700ifl18	Infinite array, optimum moderation, undamaged package w/o product container	0.76323 ± 0.00088

Table 5b. Results for package array calculations, hypothetical accident condition, 5 x 7, 0.515 inch pellet OD, without product container

Case	Description	$k_{eff} \pm \sigma$
b707-f14	7.31 water-to-fuel ratio in channel assembly, 14 fuel rods per bundle	0.76853 ± 0.00226
b709-f14	8.97 water-to-fuel ratio in channel assembly, 14 fuel rods per bundle	0.85850 ± 0.00217
b711-f14	10.96 water-to-fuel ratio in channel assembly, 14 fuel rods per bundle	0.82678 ± 0.00201
b707-f18	7.31 water-to-fuel ratio in channel assembly, 18 fuel rods per bundle	0.93585 ± 0.00259
b709-f18	8.97 water-to-fuel ratio in channel assembly, 18 fuel rods per bundle	0.97894 ± 0.00206
b711-f18	10.96 water-to-fuel ratio in channel assembly, 18 fuel rods per bundle	0.99745 ± 0.00196
b713-f18	13.41 water-to-fuel ratio in channel assembly, 18 fuel rods per bundle	0.98665 ± 0.00175
b707-f20	7.31 water-to-fuel ratio in channel assembly, 20 fuel rods per bundle	1.01738 ± 0.00264
b709-f20	8.97 water-to-fuel ratio in channel assembly, 20 fuel rods per bundle	1.04345 ± 0.00261
b711-f20	10.96 water-to-fuel ratio in channel assembly, 20 fuel rods per bundle	1.02842 ± 0.00245

Table 5c. Results for package array calculations, hypothetical accident condition with product container

Case	Description						$k_{eff} \pm \sigma$
ra10-s1	fuel rod pitch 1.077 cm	10	x	15	x	1	0.92429 ± 0.00139
ra10-s1a	no. fuel rods 109	8	x	12	x	1	0.90051 ± 0.00133
ra10-s1b		6	x	9	x	1	0.85031 ± 0.00127
ra10-s1c		5	x	7	x	1	0.80441 ± 0.00154
ra10-s1d		4	x	8	x	1	0.79575 ± 0.00148
ra10-s1e		4	x	6	x	1	0.75885 ± 0.00200
ra10-s1f		4	x	5	x	1	0.72779 ± 0.00194
ra10-s2	fuel rod pitch 1.177 cm	10	x	15	x	1	0.99215 ± 0.00152
ra10-s2a	no. fuel rods 92	8	x	12	x	1	0.96575 ± 0.00153
ra10-s2b		6	x	9	x	1	0.92001 ± 0.00152
ra10-s2c		5	x	7	x	1	0.87514 ± 0.00158
ra10-s2d		4	x	8	x	1	0.86290 ± 0.00158
ra10-s2e		4	x	6	x	1	0.82827 ± 0.00153
ra10-s2f		4	x	5	x	1	0.80381 ± 0.00231
ra10-s3	fuel rod pitch 1.227 cm,	10	x	15	x	1	1.01564 ± 0.00149
ra10-s3a	no. fuel rods 84	8	x	12	x	1	0.99079 ± 0.00157
ra10-s3b		6	x	9	x	1	0.94598 ± 0.00164
ra10-s3c		5	x	7	x	1	0.89884 ± 0.00159
ra10-s3d		4	x	8	x	1	0.88773 ± 0.00151
ra10-s3e		4	x	6	x	1	0.85655 ± 0.00163
ra10-s3f		4	x	5	x	1	0.83091 ± 0.00217
ra10-s4	fuel rod pitch 1.277 cm,	10	x	15	x	1	1.02236 ± 0.00177
ra10-s4a	no. fuel rods 76	8	x	12	x	1	0.99758 ± 0.00162
ra10-s4b		6	x	9	x	1	0.95600 ± 0.00164
ra10-s4c		5	x	7	x	1	0.91137 ± 0.00162
ra10-s4d		4	x	8	x	1	0.90418 ± 0.00176
ra10-s4e		4	x	6	x	1	0.86651 ± 0.00161
ra10-s4f		4	x	5	x	1	0.84094 ± 0.00199

Table 5c. Results for package array calculations, hypothetical accident condition with product container (continued)

Case	Description						$k_{eff} \pm \sigma$
ra10-s5	fuel rod pitch 1.327 cm,	10	x	15	x	1	1.04891 ± 0.00155
ra10-s5a	no. fuel rods 73	8	x	12	x	1	1.02520 ± 0.00164
ra10-s5b		6	x	9	x	1	0.97702 ± 0.00157
ra10-s5c		5	x	7	x	1	0.93548 ± 0.00159
ra10-s5d		4	x	8	x	1	0.93070 ± 0.00162
ra10-s5e		4	x	6	x	1	0.89639 ± 0.00182
ra10-s5f		4	x	5	x	1	0.87062 ± 0.00199
ra10-s6	fuel rod pitch 1.477 cm,	10	x	15	x	1	1.07766 ± 0.00193
ra10-s6a	no. fuel rods 61	8	x	12	x	1	1.05544 ± 0.00230
ra10-s6b		6	x	9	x	1	1.00542 ± 0.00213
ra10-s6c		5	x	7	x	1	0.96973 ± 0.00211
ra10-s6d		4	x	8	x	1	0.95861 ± 0.00268
ra10-s6e		4	x	6	x	1	0.92410 ± 0.00261
ra10-s6f		4	x	5	x	1	0.89870 ± 0.00211
ra10-s6g							0.81720 ± 0.00234
ra10-s7	fuel rod pitch 1.577 cm,	10	x	15	x	1	1.08508 ± 0.00147
ra10-s7a	no. fuel rods 55	8	x	12	x	1	1.06262 ± 0.00146
ra10-s7b		6	x	9	x	1	1.02191 ± 0.00167
ra10-s7c		5	x	7	x	1	0.98169 ± 0.00162
ra10-s7d		4	x	8	x	1	0.96797 ± 0.00161
ra10-s7e		4	x	6	x	1	0.93445 ± 0.00174
ra10-s7f		4	x	5	x	1	0.91320 ± 0.00159
ra10-s7g							0.86419 ± 0.00248
ra10-s8c	fuel rod pitch 1.625cm,	5	x	7	x	1	1.00078 ± 0.00167
ra10-s8d	no. fuel rods 55	4	x	8	x	1	0.99459 ± 0.00215
ra10-s8e		4	x	6	x	1	0.95879 ± 0.00242
ra10-s8f		4	x	5	x	1	0.93053 ± 0.00226
ra10-s8g		4	x	4	x	1	0.89822 ± 0.00218

Table 5c. Results for package array calculations, hypothetical accident condition with product container (continued)

Case	Description							$k_{eff} \pm \sigma$
ra10-s9d	fuel rod pitch 1.650 cm	4	x	8	x	1		0.99276 ± 0.00156
ra10-s9e	no. fuel rods 55	4	x	6	x	1		0.96207 ± 0.00165
ra10-s9f		4	x	5	x	1		0.93751 ± 0.00168
ra10-s9g		4	x	4	x	1		0.89227 ± 0.00243
ra10s10d	fuel rod pitch 1.700 cm	4	x	8	x	1		0.94894 ± 0.00243
ra10s10e	no. fuel rods 53	4	x	6	x	1		0.94468 ± 0.00242
ra10s10f		4	x	5	x	1		0.92416 ± 0.00218
ra10s10g		4	x	4	x	1		0.88831 ± 0.00255
ra10s11	fuel rod pitch 1.827 cm	10	x	15	x	1		1.01056 ± 0.00202
ra10s11a	no. fuel rods 37	8	x	12	x	1		0.99237 ± 0.00205
ra10s11b		6	x	9	x	1		0.91668 ± 0.00192
ra10s11c		5	x	7	x	1		0.91459 ± 0.00213
ra10s11d		4	x	8	x	1		0.90652 ± 0.00245
ra10s11e		4	x	6	x	1		0.88407 ± 0.00229
ra10s11f		4	x	5	x	1		0.86219 ± 0.00214
ra10s11g		4	x	4	x	1		0.88659 ± 0.00228
ra10s12	fuel rod pitch 2.077 cm	10	x	15	x	1		0.97282 ± 0.00225
ra10s12a	no. fuel rods 30	8	x	12	x	1		0.95380 ± 0.00228
ra10s12b		6	x	9	x	1		0.91668 ± 0.00192
ra10s12c		5	x	7	x	1		0.88515 ± 0.00225
ra10s12d		4	x	8	x	1		0.87633 ± 0.00251
ra10s12e		4	x	6	x	1		0.85097 ± 0.00253
ra10s12f		4	x	5	x	1		0.83855 ± 0.00223
ra10s12g		4	x	4	x	1		0.79650 ± 0.00212

The k_{eff} results may be plotted for a specific array size to determine the optimum fuel rod pitch. Figure 5a displays the relationship between k_{eff} and moderation typical for the package array for 14, 18, and 20 fuel rods without the product container. The optimum moderation occurs at a water-to-fuel ratio in the range of 7 to 11 for the 5 x 7 array size. This is consistent with the most reactive condition for a single package without the product container and typical of k_{eff} calculations for fixed mass systems.

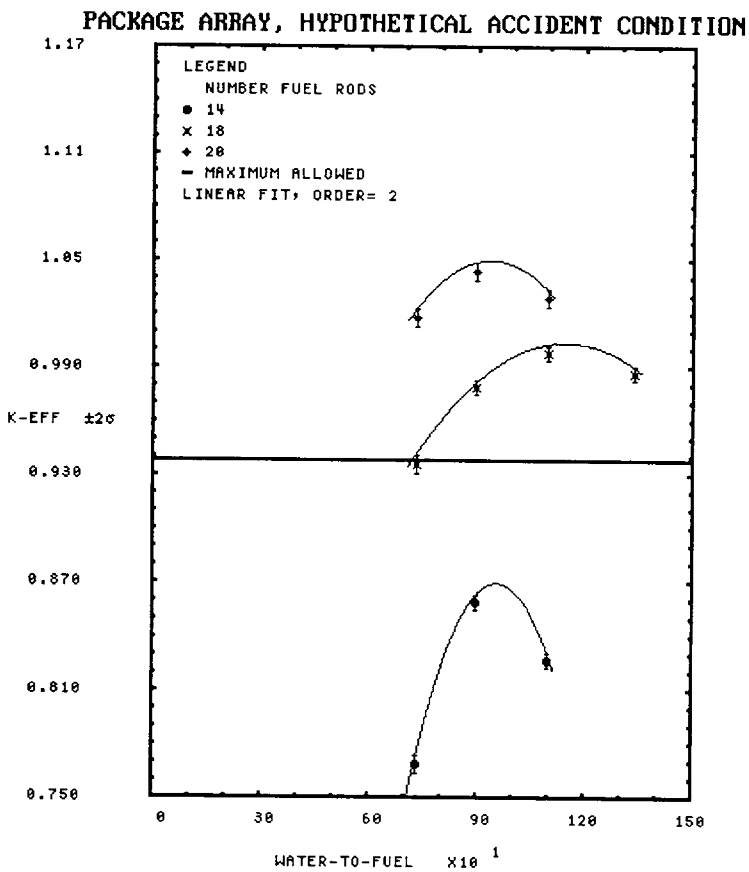

Figure 5a Typical reactivity, k_{eff}, vs. moderation of fuel rods without the product container for package array (5 x 7 x 1)

The k_{eff} results may be plotted for a specific array size to display sensitivity of the number of fuel rods loaded. Figure 5b displays the relationship between k_{eff} and moderation typical for the package array for 14, 18, and 20 fuel rods without the product container for the optimum moderation. The 5 x 7 x 1 package array is adequately subcritical when the number of fuel rods in each side of the channel assembly is limited to 15.

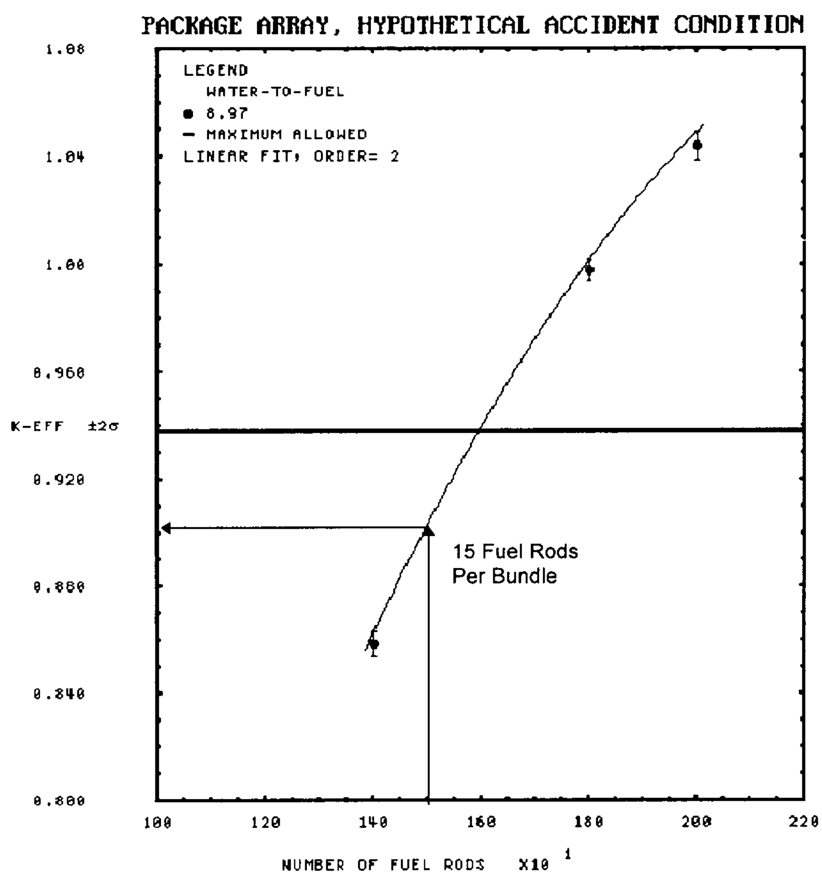

Figure 5b Typical reactivity, k_{eff}, vs. number of fuel rods (0.515 OD) without the product container for package array (5 x 7 x 1)

The k_{eff} results may be plotted for a specific array size to determine the optimum fuel rod pitch. Figure 5c displays the relationship between k_{eff} and moderation typical for the package array with the product container. The optimum moderation occurs at a fuel rod pitch between 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 for infinite fuel rod lattices or fixed geometry systems.

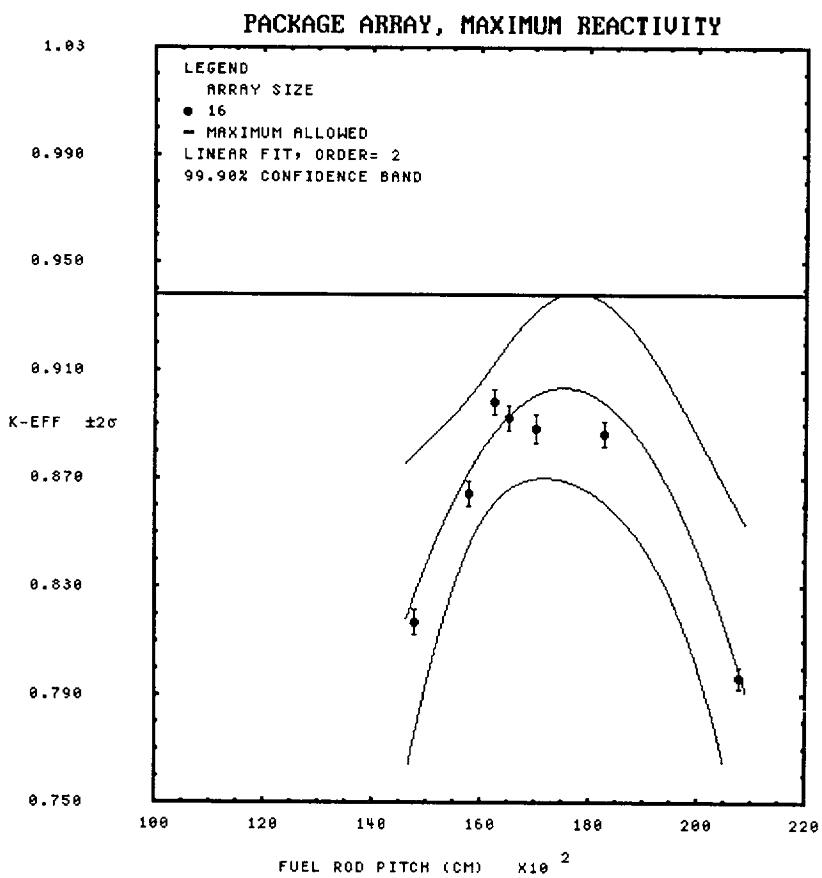

Figure 5c Typical reactivity, k_{eff}, vs. moderation of product container for package array (4 x 4 x 1)

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 5d 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.

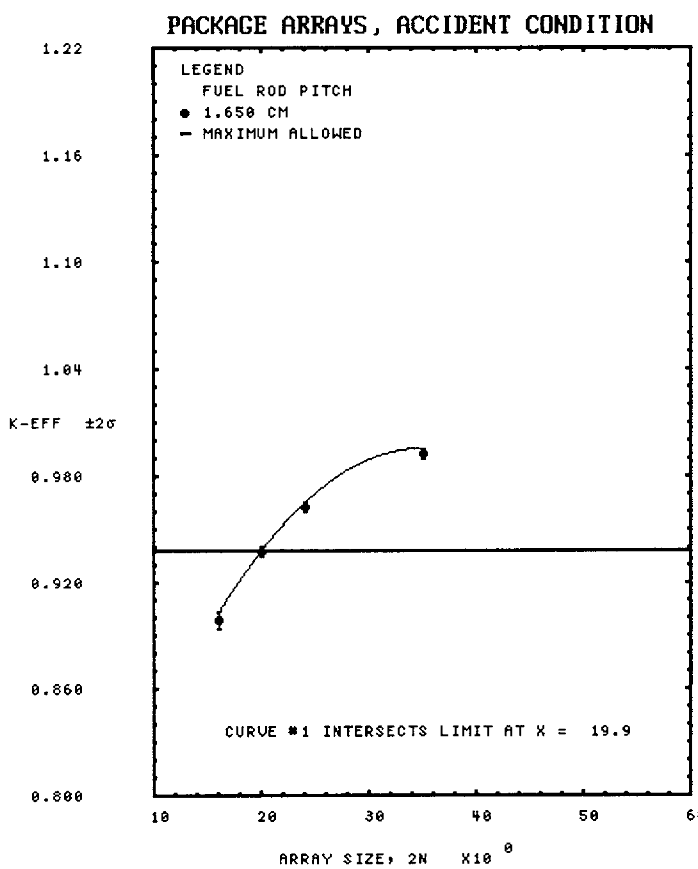

Figure 5d Typical reactivity, k_{eff}, vs. array size for product container contents (fuel rod pitch 1.650, 55 fuel rods)

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 5d. 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 5e.

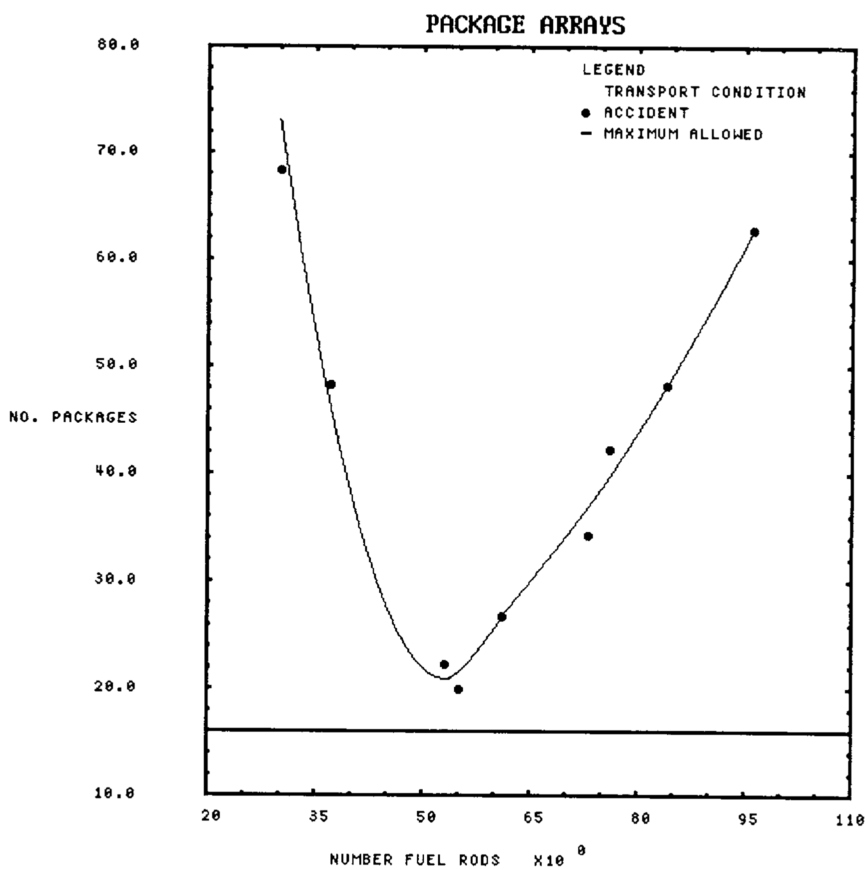

Figure 5e Maximum allowed number of damaged packages, 2N, with product container contents

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, 35 packages with bundles of 15 fuel rods loaded directly in each side of the channel assembly is subcritical. Therefore, 2N is equal to 35 when the product container is not used. When the product container is used, an array of 16 damaged packages is subcritical, and is used to determine the Transport Index.

Based on the above, the Transport Index assigned to the RA-3 package with loose rod bundle contents is as follows: A TI = 2.9 shall be assigned for the case when the number of fuel rods is limited to 15 per bundle and the product container is not used. A TI = 6.3 shall be assigned when the product container is used, and in this case there is no limit on the number of fuel rods that may be loaded in the product container.

Attachment 4

Detailed Explanation of Changes Made to
the Drawing for the RA-3 Inner Container

(Our criticality safety function has reviewed changes to this drawing and have determined that the changes do not affect the criticality safety analysis.)

The following is a description and explanation of the changes made to the RA-3 Inner Shipping Container Licensing Drawing 769E231 Rev. 8.

NO.	DRAW. ZONE	DESCRIPTION OF CHANGE
1	J-1	LUG HEIGHT - CHANGED TOLERANCE FROM: +/- ¼ TO: + ¼ / - ½
2	I-4	HANDLE WIDTH - CHANGED TOLERANCE FROM: +/- ¼ TO: +/- ½
3	G-5	BODY LENGTH - CHANGED TOLERANCE FROM: +/- 3/8 TO: +/- ¾
4	D-9	COVER LENGTH - CHANGED TOLERANCE FROM: +/- 3/8 TO: +/- ¾
5	C-1	LUG POSITION - CHANGED TOLERANCE FROM: 1 ¾ +/- ¼ TO: 7/8" MIN / 2 ¼ MAX
6	A-2	COVER WIDTH - CHANGED TOLERANCE FROM: +/- 1/8 TO: +/- ¼
7	F-3	FOAM THICKNESS - CHANGED TOLERANCE FROM: 9/16" MIN / 13/16" MAX TO: ½"MIN / 7/8" MAX
8	H-11	LUG POSITION - CHANGED TOLERANCE FROM: 1 ¾" MAX TO: 2 ¼" MAX

All of the above changes involve only a slight relaxation in tolerances for certain features and have no effect on the structural integrity or safety of the container.

Attachment 5

Description of the Changes

Section / Appendix	Page(s)	Description of Change
3.0	3-1	Changed the revision number of the drawing for the Model RA-3 Inner Container to Revision 8 and replaced the drawing.
6.0	6-3	Changed the maximum number of rods that may be placed in each side (channel) of the RA-3 inner container from 20 to 15. Also changed allowed total of loose rods for the inner container from 40 to 30. The changes are indicated with an asterisk (*) in the right hand column.
7.0 and 8.0	7-2 and 8-2	Added appropriate date to Appendix L.
Appendix L	7-L1 and 8-L1	Added the appropriate dates. Revised the Transport Index from 3.0 to 2.9. Revised the number of loose fuel rods that may be shipped not in a product container from 20 to 15. Provided additional discussion sections to explain the calculations and results.

Attachment 6

These are the pages for insertion into the consolidated application.

1) Page 3-1 of Section 3.0 updating the drawing Revision number to 8.

2) Drawing 769E231, Revision 8, Model RA-3 Inner Container

3) Page 6-3 of Section 6.0 describing the allowable number of loose rods that may be packed in the RA-3 Inner

4) Pages 7-2 and 7-L1 of Section 7.0 and pages 8-2 and 8-L1 of Section 8.0, added the dates of the criticality safety analyses

3.0 DRAWINGS

The General Electric drawings, to which RA-series packages are constructed, are enclosed in this section.

		GE Dwg.	Revision #	
3.1	Model RA-3 Inner Container The RA-3 model inner container is constructed in accordance with	769E231	Rev. 8	*
3.2	Model RA-3 Wooden Outer Container The RA-series wooden outer container is constructed in accordance with	769E229	Rev. 9	
3.3	Shipping Container Loose Fuel Rods (Product Container) The five-inch, Schedule 40, stainless steel pipe is constructed in accordance with	0028B98	Rev. 0	

FIGURE WITHHELD UNDER 10 CFR 2.390

REV		DESCRIPTION	BY	CR'd	APPROVAL	DATE
8	PECN 942		R. STRAKE		RES	7-20-[illegible]
7	PECN 941		R. STRAKE		RES	[illegible]
6	PECN 937		R. STRAKE		RES	[illegible]
5	PECN 901		R. STRAKE		RES	[illegible]
4	PECN 710				JA	[illegible]

REVISIONS

SIGNATURES	DATE
R. PAOLLA	[illegible]-79
UNKNOWN	10-30-80

SCALE ______ ALL DIM'S ✓

UNLESS OTHERWISE SPECIFIED
TOLERANCES ON :
2 PLACE DECIMALS ± FRACTIONS ±
3 PLACE DECIMALS ± ANGLES ±

NEP — GENERAL ELECTRIC COMPANY

SHIPPING CONTAINER

RA-3 INNER

DWG NO. 769E231 REV 8

6.1.16 Verify loaded RA outer for proper closure and tampersafe seals.

6.1.17 Survey and release loaded RA outer for compliance to DOT shipping regulations.

6.2 Operating Procedures - Loose Rods in Channel or Pipe

The following describes procedures for packing loose rods into the RA-3 inner container as necessary for quality assurance and criticality safety purposes.

6.2.1 A maximum of 15 rods may be placed in each side (channel) of the RA-3 inner container for a total of 30 rods. The rods may be banded together. Banding is not required for criticality safety purposes. *

6.2.1.1 Sleeve each rod in polyethylene not to exceed a 5 mil maximum thickness. The ends of the sleeve may be closed in a manner such as knotting or taping with the excess trimmed away.

6.2.1.2 Protective pads such as ethafoam are used to protect the rods when the clamps are tightened where banding is used.

6.2.1.3 The loose rods and/or banded rods are securely packed inside the RA side (channel) with packing material to minimize movement during shipment.

6.2.1.4 Section 6.1.9 through 6.1.17 describes activities to be conducted after packing the loose rods into the inner container for closing the RA inner and outer container. *

6.2.2 For loose rods in the five-inch, Schedule 40 Pipe. *

6.2.2.1 Sleeve each fuel rod in polyethylene not to exceed a 5 mil maximum thickness. The ends of the sleeve may be closed in a manner such as knotting or taping with the excess trimmed away. *

6.2.2.2 Ethafoam pads may be placed inside the capped ends to prevent damage to the rods. *

6.2.2.3 Insert sleeved fuel rods into the pipe (product) container. There is no upper or lower limit for the number of fuel rods that may be placed in the pipe container. If dunnage is used to fill the void space, any number of empty metal tubes welded shut with end plugs on both ends may be placed in the pipe container. The empty tubes do not need to have polyethylene sleeving. *

6.2.2.4 Close the pipe by installing the gasket, cover and bolts. *

6.2.2.5 Once placed inside the inner metal RA, ethafoam padding may be placed against the outside of the pipe to provide padding during shipment. *

6.2.2.6 Section 6.1.9 through 6.1.17 describes activities to be conducted after placing the five-inch, Schedule 40 pipe(s) into the RA metal inner. *

7.0 NON-PROPRIETARY VERSION OF THE CRITICALITY SAFETY INFORMATION

This section contains non-proprietary versions of the criticality safety information for the contents allowed in the certificate of compliance.

Contents from the March 15, 1982, submittal were page and drawing revisions to the March 1, 1982, application and are included in Sections 1.0, 2.0, 6.0, and the drawings of this application.

Appendix A: Non-proprietary version of the analysis for the 8x8 fuel design containing maximum enrichments of up to 5% U^{235} and taking into account the effects of pellet cladding dimensions and nuclear poison specifications. The original submittal was made April 29, 1986.

Appendix B: Non-proprietary version of the July 22, 1988, submittal to cut out a small section of ethafoam in the RA inner container.

Appendix C: Non-proprietary version of the 9x9 fuel design, one assembly, per RA container. The original submittal was made July 12, 1989.

Appendix D: Non-proprietary version for the 8x8 fuel design showing safety with various gad rod locations. The original submittal was made August 24, 1990, and included reference to the April 29, 1986, submittal.

Appendix E: Non-proprietary version for a specific 9x9 fuel assembly design specification. The original submittals were made April 16, April 17, and May 7, 1991.

Appendix F: Non-proprietary version for a specific 9x9 fuel assembly design specification. The original submittals were made August 22 and October 29, 1991.

Appendix G: Non-proprietary version for using cluster separators in 9x9 design fuel assemblies. The submittal was made 3/18/93.

Appendix H: Non-proprietary criticality safety analysis for using cluster separators in 8x8 design fuel assemblies. The submittal was made 6/27/95.

Appendix I: Non-proprietary criticality safety analysis for using cluster separators in 9x9 design fuel assemblies. The submittal was made 6/27/95.

Appendix J: Non-proprietary criticality safety analysis for using cluster separators in 10x10 design fuel assemblies. The submittal was made 6/27/95.

Appendix K: Non-proprietary version of the NRC's request for additional information dated 10/19/95 and GE's responses dated 11/1/95 and 11/3/95.

Appendix L: Non-proprietary version of the criticality safety analysis for the shipment of loose rods in the RA packaging. The submittals were made *
6/5/98, 7/1/98 and 7/21/98. *

SECTION 7.0

APPENDIX L

Non-proprietary version of the "Criticality Safety Evaluation - RA-3 Fuel Bundle Contents" Dated 7/21/98 *

SECTION 8.0

APPENDIX L

Proprietary version of the "Criticality Safety Evaluation - RA-3 Fuel Bundle Contents" dated 7/21/98. *

8.0 PROPRIETARY VERSION OF THE CRITICALITY SAFETY INFORMATION

This section contains **proprietary** versions of the criticality safety information for the contents allowed in the certificate of compliance.

Appendix A: Proprietary version of the analysis of the 8x8 fuel design containing maximum enrichments of up to 5% U^{235} and taking into account the effects of pellet and cladding dimensions and nuclear poison specifications. The original submittal was made April 29, 1986.

Appendix B: There is no proprietary information contained in the July 22, 1988, submittal. The submittal allows for cutting out a small section of ethafoam in the inner RA container. This note is intended to maintain Appendices sequence correlation between Sections 7.0 and 8.0 of this application.

Appendix C: There is no proprietary information contained in the July 12, 1989, submittal for the 9x9 fuel design, one assembly per RA container. This note is intended to maintain Appendices correlation between Sections 7.0 and 8.0 of this application.

Appendix D: Proprietary version for the 8x8 fuel design showing safety with various gad rod locations. The original submittal was made August 24, 1990, and included reference to the April 29, 1986, submittal.

Appendix E: Proprietary version for a specific 9x9 fuel assembly design specification. The original submittals were made April 16, 17, and May 7, 1991.

Appendix F: Proprietary version for a specific 9x9 fuel assembly design specification. The original submittals were made August 22 and October 29, 1991.

Appendix G: Proprietary version for using cluster separators in 9x9 design fuel assemblies. The submittal was made 3/18/93.

Appendix H: Proprietary criticality safety analysis for using cluster separators in 8x8 design fuel assemblies. The submittal was made 6/27/95.

Appendix I: Proprietary criticality safety analysis for using cluster separators in 9x9 design fuel assemblies. The submittal was made 6/27/95.

Appendix J: Proprietary criticality safety analysis for using cluster separators in 10x10 design fuel assemblies. The submittal was made 6/27/95.

Appendix K: Proprietary version of the NRC's request for additional information dated 10/19/95, and GE's responses dated 11/1/95 and 11/3/95.

Appendix L: Proprietary version of the criticality safety analysis for the shipment of loose rods in the RA packaging. The submittals were made 6/5/98, *
7/1/98 and 7/21/98. *