71-9191

RETURN TO 396-SS

Babcock & Wilcox
a McDermott company

Naval Nuclear Fuel Division

P. O. Box 785
Lynchburg, Virginia 24505-0785
(804) 522-6000

'87 OCT -7 A8:37

U. S. Nuclear Regulatory Commission
Attn: C. E. MacDonald, Chief
Transportation Certification Branch
Division of Fuel Cycle and Material Safety, NMSS
Washington DC 20555

September 24, 1987
87-165

Gentlemen:

The Babcock & Wilcox Company, Naval Nuclear Fuel Division is requesting a modification to Shipping Container USA/9191/AF, Certificate of Compliance Number 9191 in accordance with 10 CFR 71.31(b). The modifications will enable this package to be used for transporting low enriched silicide/aluminum Petten Fuel elements (with loadings not exceeding 626 grams U-235 per element) as a Fissile Class I, II, or III shipment.

The nuclear criticality safety analysis of the Petten fuel element transported in the 9191 Container is provided in the attached document from the NNFD Research Laboratory to C. C. Boyd, dated September 2, 1987 titled, "Nuclear Safety Analysis of the Unirradiated Fuel Shipping Container for Shipment of Petten Elements".

Pending approval, please make the following changes to Certificate of Compliance Number 9191 dated April 23, 1984:

5 (b) Contents
  (1) Type & form of material
    Unirradiated uranium fuel element enriched in the U-235 isotope composed of aluminum plates.
  (2) Maximum quantity of material per package

ORNL-BNL Container
Seven (7) uranuim silicide (U_3Si_2/Al) fuel elements containing a maximum of 626 grams U-235 per fuel element with a U-235 enrichment of ≤20 weight % U-235.

A check for $150.00 is attached to cover the initial amendment fee.

NNFD requests a priority review by your office so that the necessary endorsements may be obtained for an international shipment.

DOCKETED
USNRC
OCT 7 1987
NMSS
MAIL SECTION
DOCKET CLERK

Sincerely,

Charlie C. Boyd Jr.

Charlie C. Boyd Jr.
Nuclear Safety & Licensing Officer

Log Oct-88-1
Remitter
Check No. 11934
Amount $150
Fee Category 10D
Type of Fee Amd
Date Check Rec'd 10/8/87
Date Completed 10/8/87
By

CCB/slh
Attachments

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RECEIVED

UNCLASSIFIED

WM Harvey 9/28/87
Classifier Date

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PDR ADOCK 07109191
C PDR

28658

References

1. Certificate of Compliance No. 9191 dated April 23, 1984.

2. Safety Analysis Report for Packaging: The Unirradiated Fuel Shipping Container ORNL/ENG/TM-15, September 1979.

3. Babcock & Wilcox Application dated April 5, 1984.

4. Nuclear Criticality Safety Assessment of ORR, NBS, and HFBR Fuel Element Shipping Package, J. T. Thomas, ORNL/CSD/TM-77, January 1979.

5. Union Carbide Letter dated March 21, 1979 from J. T. Thomas to R. W. Knight.

6. Union Carbide Letter dated September 10, 1979 from J. T. Thomas to J. H. Evans.

7. Babcock & Wilcox Memo dated March 20, 1984 from M. N. Baldwin to N. R. Regan.

8. Babcock and Wilcox Memo dated September 2, 1987 from M. N. Baldwin to C. C. Boyd.

LRC 254

Babcock & Wilcox
a McDermott company

Research and Development Division
Lynchburg Research Center
Lynchburg, Virginia 24505

Copies:
FM Alcorn
MA Austin-NNFD/42
RL Bennett
RE Carson-NNFD/42
AJ Koudelka
RE Taylor-NNFD/42
LK Trent-NNFD/31

To

C. C. BOYD, NNFD-42

From

M. N. BALDWIN, NUCLEAR CRITICALITY SAFETY, NNFD-RL

Cust.

File No. or Ref. MNB87-24

Subj.

NUCLEAR SAFETY ANALYSIS OF THE UNIRRADIATED FUEL
SHIPPING CONTAINER FOR SHIPMENT OF PETTEN ELEMENTS

Date

September 2, 1987

This letter to cover one customer and one subject only.

The analysis of the unirradiated fuel shipping container, designed by ORNL is complete. The attached analysis shows that the container is suitable for shipping up to seven LEU, Petten fuel elements with loadings not exceeding 626 grams U-235 per element. The attachment may be used as a basis for amending Certificate of Compliance #9191 to include the Petten elements.

M. N. Baldwin

M. N. Baldwin

bp

Q. A. Statement:

I have reviewed the work reported in this memo. I have checked the input and output of five computer cases and compared this work to the previous work of Reference 3. I concur with the methodology, the computer model, the results and conclusions.

F. M. Alcorn

F. M. Alcorn

UNCLASSIFIED

W.M. Harvey 9/28/87
Classifier Date

Introduction

The unirradiated fuel shipping container, designed by Oak Ridge National Laboratory and licensed by NRC (see Reference 1) for shipping R-2 fuel elements, is herein examined from a nuclear criticality safety point of view for its suitability for shipping Petten fuel elements. The overall safety analysis of the container has been reported in Reference 2 and the nuclear criticality safety analysis for R-2 fuel elements was detailed in Reference 3.

The Petten element is similar in geometry and composition to the R-2 element for which the container is already licensed. Both are "MTR Type Elements". Both contain proliferation resistant low enriched uranium (less than 20 wt% U-235), and both incorporate U_3Si_x/Al as the core material. Each Petten element is made up of 20 fuel plates, and each plate is loaded with up to 31.3 grams U-235 (i.e., 626 grams for the entire element). The fueled section of the element is illustrated in Figure 1. Total length of the Petten fuel elements including end adapters is 35.748 inches.

Method of Analysis

This criticality safety analysis, showing that the Petten fuel is acceptable in the shipping cask, is identical to that used in Reference 3 to show the acceptability of the R-2 elements. The only difference in the two analyses is the substitution of Petten elements for R-2 elements.

Both analyses follow that used by Thomas (Refs. 4, 5, and 6), i.e., the KENO IV code and the Hansen-Roach cross section sets were used, nine element positions were assumed per cask rather than the actual seven, the steel forming the inner basket was associated with each element in an identical manner, the nature of the container was identical, the geometric representation of the container was identical, and a reduced density phenolic foam was assumed.

The validity of using the KENO IV code and Hansen-Roach cross-section set for LEU fuel (approximately 20% enriched) was demonstrated by a calculation of the LEU critical experiment which was conducted at the Ford Nuclear Reactor, University of Michigan, in December, 1981. This calculation explicitly modeled each fuel plate and water gap as has been done in the present safety evaluation. This benchmark calculation gave a result that exceeded the measured value by a ΔK of 0.027 ± 0.007. Details of this calculation are reported in Reference 7. Thomas (Ref. 4) references the work of D. W. Mugnuson for validation of the code and cross-section sets used with borate-phenolic foam.

Results of Calculations

Results of the calculations for casks containing Petten elements (each element loaded to 626 grams U-235 in a fuel matrix of $U_3Si_{1.5}/Al$) are presented in

Tables 1 and 2. Note that an infinite array of packages under normal conditions gives a very low K-eff of less than 0.3. When the interiors of the casks are flooded and no water is present between the casks to provide isolation, K-eff reaches a maximum. In this latter case, K-eff reaches 0.95 when nine elements per cask are assumed loaded and the cask is assumed damaged. When the number of elements is reduced to seven, by filling two element positions with water (designated by the letter "W" on the arrangement diagram in Tables 1 and 2), K-eff of the infinite array of packages is well below 0.9 for all postulated conditions.

These results are almost identical to those calculated for the R-2 elements, for which the cask was licensed in 1984. This is explained by a comparison of the K-eff for single, fully flooded and reflected Petten and R-2 elements. As shown in Table 3, their K-eff values are virtually identical. Table 3 also shows that reasonable differences in the Si and Al content of the fuel meat of the Petten elements has essentially no effect on the resulting K-eff value.

As a part of this evaluation effort, eight cases run in 1984 to show the R-2 elements acceptable in this cask were repeated. All re-run results were within two standard deviations of the previous results.

Conclusions

Calculations show that up to seven LEU/silicide/aluminum Petten fuel elements with loadings not exceeding 626 grams U-235 per element, meet the requirements of a fissile Class I package in transport, when loaded into an unirradiated fuel shipping container identical to the ones licensed under Certificate of Compliance 9191. Since a fissile Class I package is more restrictive than a fissile Class II or III (from a nuclear criticality safety viewpoint), the package evaluation is acceptable for all class shipments.

References

1. Certificate of Compliance No. 9191 dated April 23, 1984.

2. Safety Analysis Report for Packaging: The Unirradiated Fuel Shipping Container ORNL/ENG/TM-15, September 1979.

3. Babcock & Wilcox Application dated April 5, 1984.

4. Nuclear Criticality Safety Assessment of ORR, NBS, and HFBR Fuel Element Shipping Package, J. T. Thomas, ORNL/CSD/TM-77, January 1979.

5. Union Carbide Letter dated March 21, 1979, from J. T. Thomas to R. W. Knight.

6. Union Carbide Letter dated September 10, 1979 from J. T. Thomas to J. H. Evans.

7. Babcock & Wilcox Memo dated March 20, 1984, from M. N. Baldwin to F. M. Alcorn.

Table 1

COMPUTED K-eff VALUES FOR THE UNDAMAGED CASK

Number of Casks	Condition	K-eff ± 2σ & Run Identifier		Arrangement of 7 Elements
		9 Elem/Cask	7 Elem/Cask	
Infinite Array	No water present	0.286 ± 0.004 (AUG87*PETA)	---	---
Infinite Array	Casks flooded and water between casks	0.808 ± 0.008 (AUG87*PETB)	---	---
Infinite Array	Casks flooded and no water between casks	0.911 ± 0.006 (AUG87*PETC)	0.842 ± 0.008 (AUG87*PETF)	EEW EEE EEW

Table 2

COMPUTED K-eff VALUES FOR THE DAMAGED CASK

Number of Casks	Condition	K-eff ± 2σ & Run Identifier		Arrangement of 7 Elements
		9 Elem/Cask	7 Elem/Cask	
Infinite Array	Casks flooded and water between casks	0.813 ± 0.008 (AUG87*PETD)	---	---
Infinite Array	Casks flooded and no water between casks	0.937 ± 0.008 (AUG87*PETE)	0.855 ± 0.008 (AUG87*PETG)	EEW EEE WEE
Infinite Array	Casks flooded and no water between casks	---	0.859 ± 0.008 (AUG87*PETH)	EEW EEE EEW

Table 3

COMPARISON OF SINGLE FULLY FLOODED AND WATER REFLECTED ELEMENTS
OF SLIGHTLY DIFFERENT COMPOSITION

Element Geometry	U-235 Loading	Composition of Fuel Meat	K-eff ± 2σ	Input ID
Petten	626 gm	$U_3Si_{1.5}/Al$	0.470 ± 0.006	AUG87*PETK
Petten	626 gm	$U_3Si_{1.5}/Al$ +10% Si	0.467 ± 0.006	AUG87*PETL
Petten	626 gm	$U_3Si_{1.5}/Al$ -10% Al	0.467 ± 0.006	AUG87*PETM
Petten	626 gm	U_3Si_2/Al	0.463 ± 0.006	AUG87*PETP
R2	500 gm	U_3Si_2/Al	0.464 ± 0.006	AUG87*R2A

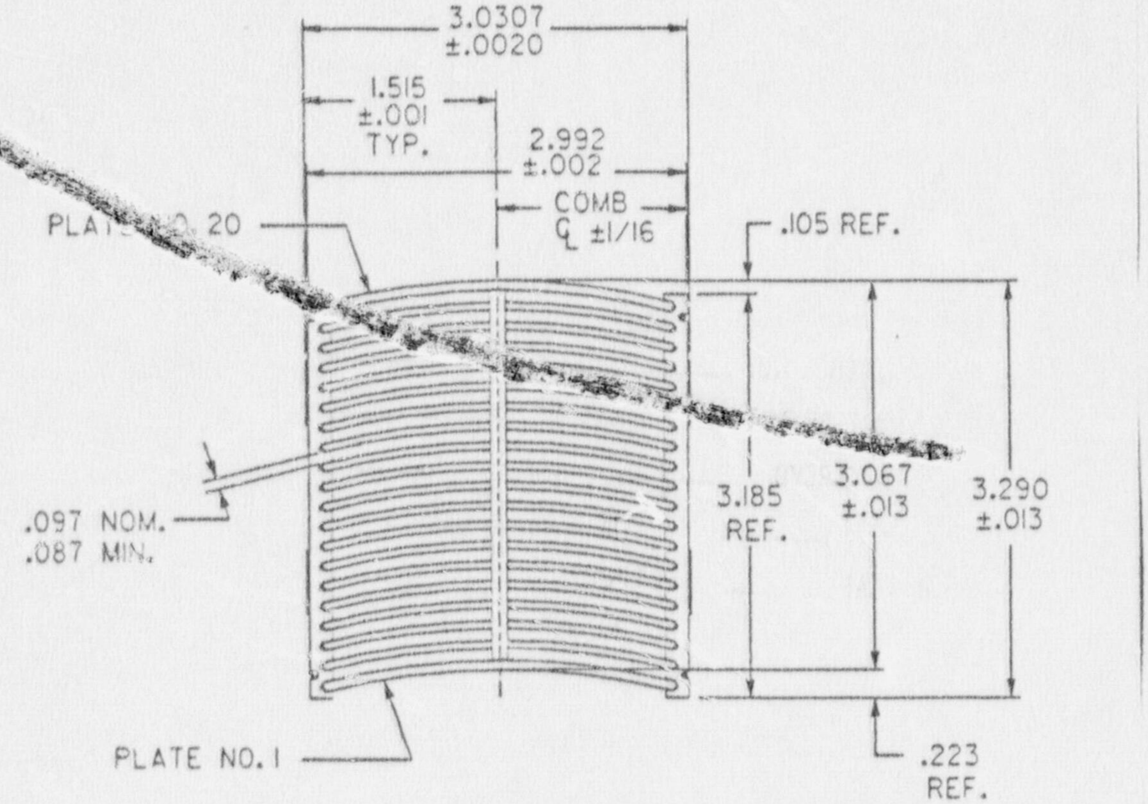

Figure 1. Section Through Petten 20-Plate Fuel Element.

DOCKET NO. 71-9191

CONTROL NO. 28658

DATE OF DOC. 09/24/87

DATE RCVD. 10/07/87

FCUF

PDR ✓

FCAF

LPDR ✓

I & E REF.

SAFEGUARDS

FCTC ✓

OTHER

DATE 10/7/87

INITIAL CEC