NRC FORM 618
(8-2000)
10 CFR 71

U.S. NUCLEAR REGULATORY COMMISSION

CERTIFICATE OF COMPLIANCE
FOR RADIOACTIVE MATERIAL PACKAGES

1. a. CERTIFICATE NUMBER	b. REVISION NUMBER	c. DOCKET NUMBER	d. PACKAGE IDENTIFICATION NUMBER	PAGE	PAGES
9372	1	71-9372	USA/9372/B(U)F-96	1 OF	9

2. PREAMBLE

a. This certificate is issued to certify that the package (packaging and contents) described in Item 5 below meets the applicable safety standards set forth in Title 10, Code of Federal Regulations, Part 71, "Packaging and Transportation of Radioactive Material."

b. This certificate does not relieve the consignor from compliance with any requirement of the regulations of the U.S. Department of Transportation or other applicable regulatory agencies, including the government of any country through or into which the package will be transported.

3. THIS CERTIFICATE IS ISSUED ON THE BASIS OF A SAFETY ANALYSIS REPORT OF THE PACKAGE DESIGN OR APPLICATION

a. ISSUED TO *(Name and Address)*

Framatome, Inc.
2101 Horn Rapids Rd.
Richland, WA 99354

b. TITLE AND IDENTIFICATION OF REPORT OR APPLICATION

Framatome TN-B1 Safety Analysis Report, FS1-0014159, Revision No. 8, dated March 27, 2018.

4. CONDITIONS

This certificate is conditional upon fulfilling the requirements of 10 CFR Part 71, as applicable, and the conditions specified below.

5.

(a) Packaging

(1) Model No.: TN-B1

(2) Description

The Model No. TN-B1 package is a rectangular box, 742 mm (29.21 in) high by 720 mm (28.35 in) wide by 5,068 mm (199.53 in) long, designed for the transport of unirradiated fuel assemblies or individual fuel rods with an enrichment up to 5.0 weight percent U-235. The package carries a maximum of (i) two Boiling Water Reactor (BWR) fuel assemblies or individual rods, meeting the ASTM C996-96 standard of enriched commercial grade uranium, enriched reprocessed uranium, or (ii) uranium oxide generic pressurized water reactor (PWR) or uranium carbide loose fuel rods in a 5 inch diameter stainless steel pipe.

The package is comprised of one inner container and one outer container both made of stainless steel. The inner container has a double-wall stainless steel sheet structure with an alumina silicate thermal insulator, filling the gap between the two walls, to reduce the flow of the heat into the contents in the event of a fire. Foam polyethylene cushioning material is placed on the inside of the inner container for protection of the fuel assembly.

The outer container is comprised of a stainless steel angular framework covered with stainless steel plates. Inner container clamps are installed inside the outer container with damping devices to minimize vibrations during transport. Wood and honeycomb resin-impregnated kraft paper act as shock absorbers. The fuel rod clad and ceramic nature of the fuel pellets provide primary containment of the radioactive material.

5.(a)(2) continued

The approximate dimensions and weights of the package are as follows:

Maximum gross shipping weight	1,614 kg (3,558 lbs)
Maximum weight of inner container	308 kg (679 lbs)
Maximum weight of outer container	622 kg (1,371 lbs)
Maximum weight of packaging	930 kg (2,050 lbs)
Dimensions of inner container	
Length	4,686 mm (184.49 in)
Width	459 mm (18.07 in)
Height	286 mm (11.26 in)
Dimensions of outer container	
Length	5,068 mm (199.53 in)
Width	720 mm (28.35 in)
Height	742 mm (29.21 in)

(3) Drawings

This packaging is constructed in accordance with the TN-B1 Drawing Nos.:

Outer Container Drawings
105E3737, Rev. 6
105E3738, sheets 1 and 2, Rev. 8
105E3738, sheet 3, Rev. 7
105E3739, Rev. 4
105E3740, Rev. 4
105E3741, Rev. 1
105E3742, Rev. 3
105E3743, Rev. 5
02-9162717, Rev. 1

Inner Container Drawings
105E3745, sheets 1-4, Rev. 8
105E3746, Rev. 1
105E3747, Rev. 4
105E3748, Rev. 2
02-9162722, Rev. 1

Contents Containers
105E3773, Rev. 1
0028B98, Rev. 1

5. continued

(b) Contents

(1) Type and form of material

Enriched commercial grade uranium or enriched reprocessed uranium, as defined in ASTM C996-96, uranium oxide or uranium carbide fuel rods enriched to no more than 5.0 weight percent U-235, with limits specified in Tables 1 and 2 below.

Table 1: Maximum weight of uranium dioxide pellets per fuel assembly

Type 8x8 fuel assembly	Type 9x9 fuel assembly	Type 10x10 fuel assembly	Type 11x11 fuel assembly
235 kg	240 kg	275 kg	281 kg

Table 2: Maximum Authorized Concentrations

Isotope	Maximum content
U-232	2.00×10^{-9} g/gU
U-234	2.00×10^{-3} g/gU
U-235	5.00×10^{-2} g/gU
U-236	2.50×10^{-2} g/gU
U-238	Balance of Uranium
Np-237	1.66×10^{-6} g/gU
Pu-238	6.20×10^{-11} g/gU
Pu-239	3.04×10^{-9} g/gU
Pu-240	3.04×10^{-9} g/gU
Gamma Emitters	5.18×10^{5} MeV - Bq/kgU

Maximum content of U-238 is 9.23×10^{-1}g/gU for a maximum U-235 concentration of 5%. Since, for concentrations less than 5%, the U238 value will be higher, it is shown as “Balance of Uranium” in Table 2.

5.(b)(1) continued

(i) 8 x 8 fuel assemblies comprised of 60 to 64 rods in a square array with a maximum active fuel rod length of 381 cm. The maximum pellet diameter, minimum clad thickness, rod pitch, water rod and poison rod specifications are in accordance with Table 3 below.

(ii) 9 x 9 fuel assemblies comprised of 72 to 81 rods in a square array with a maximum active fuel rod length of 381 cm. The maximum pellet diameter, minimum clad thickness, rod pitch, water rod and poison rod specifications are in accordance with Table 3 below.

(iii) 10 x 10 fuel assemblies comprised of 91 to 100 rods in a square array with a maximum active fuel rod length of 385 cm. The maximum pellet diameter, minimum clad thickness, rod pitch, water rod and poison rod specifications are in accordance with Table 3 below.

(iv) 11 x 11 fuel assemblies comprised of 112 rods in a square array with a maximum active fuel rod length of 385 cm. The maximum pellet diameter, minimum clad thickness, rod pitch, water rod and poison rod specifications are in accordance with Table 4 below.

(v) Uranium oxide fuel rods configured loose, in a 5 inch diameter schedule 40 stainless steel pipe/protective case or strapped together. When fuel rods are placed in polyethylene sleeves, each polyethylene sleeve shall not exceed 0.0152 cm in thickness. The maximum pellet diameter, minimum clad thickness, and rod specifications are in accordance with Table 5 below.

(vi) Uranium carbide or generic PWR uranium oxide fuel rods configured loose, in a 5 inch diameter schedule 40 stainless steel pipe. When fuel rods are placed in polyethylene sleeves, each polyethylene sleeve shall not exceed 0.0152 cm in thickness. The maximum pellet diameter, minimum clad thickness, and rod specifications are in accordance with Table 5 below.

5.(b)(1) continued

Table 3: Fuel Assembly Parameters (8x8, 9x9, 10x10)

Parameter	**Units**	**Type**	**Type**	**Type**	**Type**
Fuel Assembly Type	Rods	8x8	9x9	FANP 10x10	GNF 10x10
UO_2 Density	%	≤ 98% Theoretical	≤ 98% Theoretical	≤ 98% Theoretical	≤ 98% Theoretical
Number of water rods[a]	#	0, 2x2	0, 2-2x2 off-center diagonal, 3x3	0, 2-2x2 off-center diagonal, 3x3	0, 2-2x2 off-center diagonal, 3x3
Number of fuel rods	#	60 - 64	72 - 81	91 - 100	91 - 100
Fuel Rod OD	cm	≥ 1.176	≥ 1.093	≥ 1.000	≥ 1.010
Fuel Pellet OD	cm	≤ 1.05	≤ 0.96	≤ 0.895	≤ 0.895
Cladding Type		Zirconium Alloy	Zirconium Alloy	Zirconium Alloy	Zirconium Alloy
Cladding ID	cm	≤ 1.10	≤ 1.02	≤ 0.933	≤ 0.934
Cladding Thickness	cm	≥ 0.038	≥ 0.036	≥ 0.033	≥ 0.038
Active fuel length	cm	≤ 381	≤ 381	≤ 385	≤ 385
Nominal Fuel Rod Pitch	cm	1.63	≤ 1.45	≤ 1.30	1.30
U-235 Pellet Enrichment	wt%	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
Maximum Lattice Average Enrichment	wt%	≤ 5.0	≤ 5.0	≤ 5.0	≤ 5.0
Channel Thickness[b]	cm	0.17 – 0.3048	0.17 – 0.3048	0.17 – 0.3048	0.17 – 0.3048
Partial Length Fuel Rods (1/3 through 2/3 normal length)	Max #	None	12	14	14
Gadolinia Requirements					
Lattice Average Enrichment[c]	#				
≤ 5.0 wt% U-235	@ wt%	7 @ 2 wt%	10 @ 2 wt%	12 @ 2 wt%	12 @ 2 wt%
≤ 4.7 wt% U-235	Gd_2O_3	6 @ 2 wt%	8 @ 2 wt%	12 @ 2 wt%	12 @ 2 wt%
≤ 4.6 wt% U-235		6 @ 2 wt%	8 @ 2 wt%	10 @ 2 wt%	10 @ 2 wt%
≤ 4.3 wt% U-235		6 @ 2 wt%	8 @ 2 wt%	9 @ 2 wt%	9 @ 2 wt%
≤ 4.2 wt% U-235		6 @ 2 wt%	6 @ 2 wt%	8 @ 2 wt%	8 @ 2 wt%
≤ 4.1 wt% U-235		4 @ 2 wt%	6 @ 2 wt%	8 @ 2 wt%	8 @ 2 wt%
≤ 3.9 wt% U-235		4 @ 2 wt%	6 @ 2 wt%	6 @ 2 wt%	6 @ 2 wt%
≤ 3.8 wt% U-235		4 @ 2 wt%	4 @ 2 wt%	6 @ 2 wt%	6 @ 2 wt%
≤ 3.7 wt% U-235		2 @ 2 wt%	4 @ 2 wt%	6 @ 2 wt%	6 @ 2 wt%
≤ 3.6 wt% U-235		2 @ 2 wt%	4 @ 2 wt%	4 @ 2 wt%	4 @ 2 wt%
≤ 3.5 wt% U-235		2 @ 2 wt%	2 @ 2 wt%	4 @ 2 wt%	4 @ 2 wt%
≤ 3.3 wt% U-235		2 @ 2 wt%	2 @ 2 wt%	2 @ 2 wt%	2 @ 2 wt%
≤ 3.1 wt% U-235		None	2 @ 2 wt%	2 @ 2 wt%	2 @ 2 wt%
≤ 3.0 wt% U-235		None	None	2 @ 2 wt%	2 @ 2 wt%
≤ 2.9 wt% U-235		None	None	None	None
Polyethylene Equivalent Mass[d] (Maximum per Assembly)	kg	11	11	10.2	10.2

a. For 8 x 8 fuel assembly designs, there can be either 0 or 1 water rod; the water rod location occupies a space equivalent to 2 x 2 fuel rods. This is designated as 0, 2 x 2 in the table. For 9 x 9 and 10 x 10 fuel assembly designs, there can be either 0, 1, or 2 water rods in the assembly; the water rod location occupies a space equivalent to (i) two 2 x 2 fuel rod equivalent spaces on a diagonal at the center of the assembly, or (ii) one 3 x 3 fuel rod equivalent space (9 fuel rods space) in the center of the assembly. These configurations are designated as 0, 2 - 2x2 off-center diagonal, 3x3 in the table.

b. Transport with or without channels is acceptable

c. Required gadolinia rods must be distributed symmetrically along the major diagonal.

d. Polyethylene equivalent mass calculation per Section 6.3.2.2 of the application.

5.(b)(1) continued

Table 4: Fuel Assembly Parameters (11x11)

Parameter	Units	Value
Fuel Assembly Type	Rods	11x11
UO_2 Density[a]	g/cm^3	≤10.763
Number of water rods	#	3x3 center
Number of fuel rods	#	112
Fuel rod OD	cm	≥0.930
Fuel Pellet OD	cm	≤0.820
Cladding Type		Zirconium Alloy
Cladding ID	cm	≤0.840
Cladding Thickness	cm	≥0.045
Equivalent Nominal Fuel Rod Pitch	cm	≤1.195
U-235 Pellet Enrichment	wt%	≤5.0
Maximum Lattice Average Enrichment	wt%	≤5.0
Fuel Channel Side Thickness[b]	cm	≤0.254
Full Length Fuel Rods Quantity Active Length	 # cm	 92 ≤385
Short Part Length Fuel Rods Quantity Active Length	 # cm	 12 ≤155.1
Long Part Length Fuel Rods Quantity Active Length	 # cm	 8 ≤236.8
Gadolinia Requirements Lattice Average Enrichment[c] ≤ 5.0 wt% U-235 ≤ 4.8 wt% U-235 ≤ 4.6 wt% U-235 ≤ 4.4 wt% U-235 ≤ 4.2 wt% U-235 ≤ 4.1 wt% U-235 ≤ 3.9 wt% U-235 ≤ 3.8 wt% U-235 ≤ 3.6 wt% U-235 ≤ 3.5 wt% U-235 ≤ 3.3 wt% U-235 ≤ 3.2 wt% U-235 ≤ 2.9 wt% U-235	 # @ wt% Gd_2O_3	 13 @ 2 wt% 12 @ 2 wt% 11 @ 2 wt% 10 @ 2 wt% 9 @ 2 wt% 8 @ 2 wt% 7 @ 2 wt% 6 @ 2 wt% 5 @ 2 wt% 4 @ 2 wt% 3 @ 2 wt% 2 @ 2 wt% None
Polyethylene Equivalent Mass (Maximum per Assembly)[d]	kg	10.2

a. Density based on a pellet modeled as a right cylinder
b. Transport with or without channels is acceptable.
c. Required gadolinia rods must be distributed symmetrically along the major diagonal, and shall not be placed on the periphery.
d. Refer to Section 6.3.2.2 of the application.

5.(b)(1) continued

Table 5: Fuel Rod Parameters

Parameter	**Units**	**Type**						
Fuel Assembly Type		8x8 (UO_2)	9x9 (UO_2)	10x10 (UO_2)	11x11 (UO_2)	CANDU-14 (UC)	CANDU-25 (UC)	Generic PWR (UO_2)
UO_2 or UC Fuel Density[a]	g/cm^3	≤10.74	≤10.74	≤10.74	≤10.763	≤13.36	≤13.36	≤10.74
Fuel rod OD	cm	≥1.10	≥1.02	≥1.00	≥0.930	≥1.340	≥0.996	≥1.118
Fuel Pellet OD	cm	≤1.05	≤0.96	≤0.90	≤0.820	≤1.254	≤0.950	≤0.98
Cladding Type		Zirc. Alloy	Zirc. Alloy	Zirc. Alloy	Zirc. Alloy	Zirc. Alloy or SS	Zirc. Alloy or SS	Zirc. Alloy or SS
Cladding ID	cm	≤1.10	≤1.02	≤1.00	≤0.930	≤1.267	≤0.951	≤1.004
Cladding Thickness	cm	≥0.038	≥0.036	≥0.038	≥0.045	≥0.033	≥0.033	≥0.033
Active fuel Length	cm	≤381	≤381	≤385	≤385	≤47.752	≤40.013	≤450
Maximum U-235 Pellet Enrichment	wt.%	≤5.0	≤5.0	≤5.0	≤5.0	≤5.0	≤5.0	≤5.0
Maximum Average fuel rod Enrichment	wt.%	≤5.0	≤5.0	≤5.0	≤5.0	≤5.0	≤5.0	≤5.0
Loose Rod Configuration								
Freely Loose or Strapped Together	#	≤25	≤25	≤25	≤25	N/A	N/A	N/A
Packed in 5” SS Pipe or protective Case, i.e., SS Box with Lid	#	≤22	≤26	≤30	≤30	≤74[b]	≤130[b]	≤105[b]

a. Density based on a pellet modeled as a right cylinder.
b. Including partial rods –using dense packing of congruent rods- in the 5” SS pipe

5.(b)(2) Maximum quantity of material per package

Total weight of payload contents (fuel assemblies, or fuel rods, and rod shipping containers) not to exceed 684 kg (1508 pounds).

(i) For the contents described in 5(b)(1)(i), 5(b)(1)(ii), 5(b)(1)(iii), and 5(b)(1)(iv): two fuel assemblies.

(ii) For the contents described in 5(b)(1)(v) and 5(b)(1)(vi): allowable number of fuel rods per compartment (2 compartments per package).

(c) Criticality Safety Index, except for contents described in 5(b)(1)(vi) and limited in 5(b)(2)(ii) 1.0

Criticality Safety Index for contents described in 5(b)(1)(vi) and limited in 5(b)(2)(ii) 2.1

6. In addition to the requirements of Subpart G of 10 CFR Part 71:

(a) The package shall be prepared for shipment and operated in accordance with Chapter 7 of the application.

(b) The packaging must meet the Acceptance Tests and Maintenance Program of Chapter 8 of the application.

(c) Prior to each shipment, the fuel rods shall conform to the leak tests and specific inspection techniques used for qualification and in-process inspections as defined in Chapter 8. Stainless steel components of the packaging must be visually inspected. Packages in which stainless steel components show pitting corrosion, cracking, or pinholes, are not authorized for transport.

(d) If wrapping is used on the unirradiated fuel assemblies, their ends must be assured to be open during transport.

7. All fuel to be shipped must meet the maximum P(r/t) criterion–product of the pre-pressure and of the maximum Inside Radius/Thickness- of 10.18653 MPa. Shipment of 11x11 fuel designs manufactured by other suppliers than Framatome is not authorized. ATRIUM 11x11 fuel shall contain only commercial grade uranium, i.e., cannot be made from down-blended low enrichment fuel or reprocessed uranium.

8. Cluster separators are optional and may be comprised of polyethylene or other plastics. Polyethylene or plastic mass limits shall be determined in accordance with Section 6.3.2.2 (Material Specifications) of the application.

9. The package authorized by this certificate is hereby approved for use under the general license provisions of 10 CFR 71.17.

10. Transport by air of fissile material is not authorized.

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9372	1	71-9372	USA/9372/B(U)F-96	9 OF	9

11. Revision No. 0 of this certificate may be used until April 30, 2019.

12. Expiration date: April 30, 2019.

REFERENCES

Framatome TN-B1 Safety Analysis Report, FS1-0014159, Revision 8, dated March 27, 2018.

FOR THE U.S. NUCLEAR REGULATORY COMMISSION

/RA/

John McKirgan, Chief
Spent Fuel Licensing Branch
Division of Spent Fuel Management
Office of Nuclear Material Safety
and Safeguards

Date: June 21, 2018