East Building, PHH-23
1200 New Jersey Ave, SE
Washington, D.C. 20590

U.S. Department of Transportation

Pipeline and Hazardous Materials Safety Administration

COMPETENT AUTHORITY CERTIFICATION FOR A TYPE A FISSILE RADIOACTIVE MATERIALS PACKAGE DESIGN CERTIFICATE USA/0831/AF-96, REVISION 1

REVALIDATION OF FRENCH COMPETENT AUTHORITY CERTIFICATE F/348/AF-96

The Competent Authority of the United States certifies that the radioactive material package design described in this certificate satisfies the regulatory requirements for a Type AF package as prescribed in the regulations of the International Atomic Energy Agency[1] and the United States of America[2] The package design is approved for use within the United States for import and export shipments made in accordance with applicable international and domestic transport regulations.

1. Package Identification - FCC-4 transport package.

2. Package Description and Authorized Radioactive Contents - as described in French Certificate of Competent Authority F/348/AF-96, Revision Gw (attached).

3. Criticality - The minimum criticality safety index is as given in the French certificate. The maximum number of packages per conveyance is determined in accordance with Table 11 of the IAEA regulations cited in this certificate.

4. General Conditions -

   a. Each user of this certificate must have in his possession a copy of this certificate and all documents necessary to properly prepare the package for transportation. The user shall prepare the package for shipment in accordance with the documentation and applicable regulations.

   b. Each user of this certificate, other than the original petitioner, shall register his identity in writing to the Office of Engineering and Research, (PHH-23), Pipeline and Hazardous

[1] "Regulations for the Safe Transport of Radioactive Material, 2012 Edition, No. SSR-6" published by the International Atomic Energy Agency (IAEA), Vienna, Austria.

[2] Title 49, Code of Federal Regulations, Parts 100-199, United States of America.

Materials Safety Administration, U.S. Department of Transportation, Washington D.C. 20590-0001.

c. This certificate does not relieve any consignor or carrier from compliance with any requirement of the Government of any country through or into which the package is to be transported.

d. Records of Management System activities required by Paragraph 306 of the IAEA regulations[1] shall be maintained and made available to the authorized officials for at least three years after the last shipment authorized by this certificate. Consignors in the United States exporting shipments under this certificate shall satisfy the applicable requirements of Subpart H of 10 CFR 71.

5. Special Conditions -

a. Transport by air is not allowed.

6. Marking and Labeling - The package shall bear the marking USA/0831/AF-96 in addition to other required markings and labeling.

7. Expiration Date - This certificate expires on December 31, 2027. Previous editions which have not reached their expiration date may continue to be used.

This certificate is issued in accordance with paragraph(s) 816 of the IAEA Regulations and Section 173.472 and 173.473 of Title 49 of the Code of Federal Regulations, in response to the August 3, 2022 petition by TN Americas LLC, Columbia, MD, and in consideration of other information on file in this Office.

Certified By:

August 11, 2023

William Schoonover
Associate Administrator for Hazardous Materials Safety

(DATE)

Revision 1 - To revalidate French Certificate F/348/AF-96, Revision Gw.

AUTORITÉ DE SÛRETÉ NUCLÉAIRE
Direction du transport et des sources

APPROVAL CERTIFICATE FOR A PACKAGE DESIGN

The Competent French Authority,

Having regard to Article R. 595-1 of the French Environmental Code;

Having regard to the request submitted by the company Orano NPS in letter COR-22-000220-013 dated 22 February 2022;

Having regard to safety analysis report DOS-18-016472-000 Rev. 5.0 of 21 February 2022;

Having regard to the certificate previously issued under reference F/348/AF-96 (Fu);

Having regard to the results of the public consultation conducted from 29 June 2021 to 14 July 2021;

Hereby certifies that the package design comprising the **FCC4** packaging described hereafter in Appendix 0 revision w and loaded with:

- up to 2 new GAIA PWR 17 x 17 XL, PWR 17 x 17 XLR, PWR 17 x 17 fuel assemblies, in version 1 of the packaging, as described in Appendix 1 revision w; or
- up to 2 new PWR 16 x 16 fuel assemblies, in version 2 of the packaging, as described in Appendix 2 revision w; or
- up to 2 new PWR 18 x 18 PWR fuel assemblies, in version 2 of the packaging, as described in Appendix 3 revision w; or
- up to 2 boxes containing new, unassembled PWR 17 x 17 XL or PWR 17 x 17 XLR fuel rods, in version 1 of the packaging, as described in Appendix 4 revision w; or
- up to 2 boxes containing new, unassembled PWR 17 x 17 twelve-foot fuel rods, in version 1 of the packaging, as described in Appendix 5 revision w; or
- up to 2 boxes containing new, unassembled PWR 15 x 15 fuel rods, in version 1 of the packaging, as described in Appendix 6 revision w; or
- up to 2 boxes containing new, unassembled PWR 14 x 14 eight-foot fuel rods, in version 1 of the packaging, as described in Appendix 7 revision w; or
- up to 2 boxes containing new, unassembled PWR 14 x 14 ten-foot fuel rods, in version 1 of the packaging, as described in Appendix 8 revision w; or
- up to 2 boxes containing new, unassembled PWR 16 x 16 fuel rods, in version 1 of the packaging, as described in Appendix 10 revision w; or
- up to 2 boxes containing new, unassembled PWR 18 x 18 fuel rods, in version 1 of the packaging, as described in Appendix 11 revision w; or
- up to 2 new EPR 17 x 17 fuel assemblies, or one new EPR 17 x 17 fuel assembly fitted with a cluster and a smooth-walled dummy, or an EPR assembly mock-up, in version 1, as described in Appendix 12 revision w; or
- up to 2 boxes containing new EPR 17 x 17 fuel rods, in version 1 of the package, as described in Appendix 13 revision w;

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asn.fr

is compliant, as a **type A package design for fissile materials**, with the requirements for the regulations and agreements listed below:

- International Atomic Energy Agency (IAEA) Regulations for the Safe Transport of Radioactive Material, Safety Standards Series No. SSR-6 (Rev. 1), 2018 Edition;
- Agreement concerning the International Carriage of Dangerous Goods by Road (ADR);
- European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways (ADN);
- Regulation concerning the International Carriage of Dangerous Goods by Rail (RID);
- International Maritime Dangerous Goods Code (IMDG code of the IMO);
- amended French order of 23 November 1987 on the safety of ships, and particularly section 411 of the appended regulation (the "RSN" order);
- amended French Order of 29 May 2009, on the carriage of dangerous goods by overland routes (the "TMD" order).

This certificate does not release the shipper from the obligation to comply with the requirements laid down by the authorities of the countries through or to which the package is to be shipped.

This certificate expires on **31 December 2027.**
Registration number: **CODEP-DTS-2022-027480**.

Signed in Montrouge, 13 June 2022.

On behalf of the President of the French Nuclear Safety Authority by delegation,
the Director of Transport and Sources,

Fabien FÉRON

SUMMARY OF CERTIFICATE ISSUES

Issue date	Expiry date	Type of issue	Certificate reference	Revision														
				body	t	0	1	2	3	4	5	6	7	8	9	10	11	12	13
11/12/17	31/12/22	Renewal	F/348/IF-96	Fo	-	o	o	o	o	o	o	o	o	o	-	o	o	o	o
29/12/17	31/12/22	Modification	F/348/IF-96	Fp	-	p	o	o	o	o	o	o	o	o	-	o	p	o	p
14/08/19	31/12/22	Extension	F/348/AF-96	Fq	-	q	q	q	q	q	q	q	q	q	-	q	q	q	q
20/03/20	31/12/22	Extension	F/348/IF-96	Fr	-	r	r	r	r	r	r	r	r	r	-	r	r	r	r
21/04/21	31/12/22	Extension	F/348/IF-96	Fs	-	s	s	s	s	s	s	s	s	s	-	s	s	s	s
11/03/22	31/12/22	Extension	F/348/IF-96	Ft	-	t	t	t	t	t	t	t	t	t	-	t	t	t	t
~~11/03/22~~	~~31/12/22~~	~~Extension~~	~~F/348/AF-96~~	~~Fu~~	~~-~~	~~u~~	~~u~~	~~u~~	~~u~~	~~u~~	~~u~~	~~u~~	~~u~~	~~u~~	~~-~~	~~u~~	~~u~~	~~u~~	~~u~~
19/04/22	31/12/22	Extension (cancels and replaces)	F/348/AF-96	Fu	-	u	u	u	u	u	u	u	u	u	-	u	u	u	u
13/06/22	31/12/27	Renewal	F/348/IF-96	Gv	-	v	v	v	v	v	v	v	v	v	-	v	v	v	v
13/06/22	31/12/27	Renewal	F/348/AF-96	Gw	-	w	w	w	w	w	w	w	w	w	-	w	w	w	w

APPENDIX 0
FCC4 PACKAGING

1. DESCRIPTION OF THE PACKAGING

The packaging was designed, manufactured, inspected, tested, maintained and used in compliance with safety analysis report DOS-18-016472-000 Rev. 5.0.

The packaging, which is generally cylindrical in shape, is shown in figures 0.1 and 0.2.

The packaging design drawings bear the reference numbers 229K0400 or 229K0600 for version 1 and 229K0500 for version 2.

The overall external dimensions of the packaging are:

- length: 5,748 mm:
- width: 1,134 mm:
- height: 1,297 mm

The maximum permissible mass of the loaded packaging during transport is 5,550 kg.

The packaging comprises the following main sub-assemblies:

1.1 Packaging body

The FCC4 packaging consists of a cylindrical enclosure, with a horizontal axis, composed of two linked half-shells comprising:

- a metal cradle consisting of two longitudinal members and suspended from the lower shell by means of rubber shock absorbers;
- an internal equipment resting on the cradle and intended to house one of the contents.

This internal equipment is composed of :

- a support frame with a rigid, inverted “T”-shaped structure designed to hold the content in place horizontally. The fabricated part of the frame contains neutron-absorbing resin. A tilting pin on the bottom plate allows the support frame to be moved into a vertical position for loading or unloading assemblies;
- two 'L' shaped doors containing neutron-absorbing resin which are attached to the support frame and encapsulate the contents;
- a bottom plate supporting the fuel assemblies during loading and unloading when the support frame is in the upright position;
- a two-piece top plate, which serves to close the cavities and secure the contents at the other end.

1.2 Packaging closing system

The two cylindrical half-shells are connected together using 50 bolts.

The doors and top plates are connected to the frame using ball pins and spindles. The bottom plate is screwed to the frame.

1.3 Shock-absorbing systems

Two axial shock absorbers are attached to the end of the upper shell. They are composed of two metal boxes containing a block of balsa wood.

Two additional axial shock absorbers are attached to the top plates when transporting EPR assemblies.

1.4 Handling and tie-down elements

Items are handled using a suitable lifting beam or slings equipped with shackles or hooks, according to one of the following three lifting methods:

- By 4 lifting boxes welded to the upper shell and made of a folded sheet of metal with a hole in it for a shackle or a hook;
- By 4 lifting boxes welded to the lower shell;
- By fork slots located under the lower shell.

The packaging is also designed so that it can be secured during transportation in accordance with the recommendations in chapter 1.7 of safety analysis report DOS-18-016472-009 Rev. 2.0.

1.5 Safety functions

Containment and **radiation protection** functions are provided by the fuel rods.

Sub-criticality continuity is guaranteed by the isolation system consisting of the elements identified in the appendices describing the contents and, for the packaging, by the following elements:

- the internal equipment, consisting of the frame, doors and end plates and, in the case of rod boxes, the radial and axial spacer system and the rod boxes themselves, together forming two neutron cavities;
- neutron-absorbing resin contained in the doors and frame;
- the upper and lower shells that protect the internal equipment in normal and accident conditions of transport.

The fuel is protected against impacts by the two half-shells and the internal equipment.

Fire protection is mainly provided by the two half-shells, the internal equipment and the resin in the doors and frame.

2. ACTIONS TO BE TAKEN BY THE SHIPPER PRIOR TO SHIPPING THE PACKAGE

The packaging is to be used in accordance with procedures that comply with the instructions for use in Chapter 1.7 of safety analysis report DOS-18-016472-009 Rev. 2.0.

3. MAINTENANCE PROGRAMME

The packaging is to be maintained in accordance with the procedures described in Chapter 1.8 of safety analysis report DOS-18-016472-010 Rev. 1.0.

4. NOTIFICATION

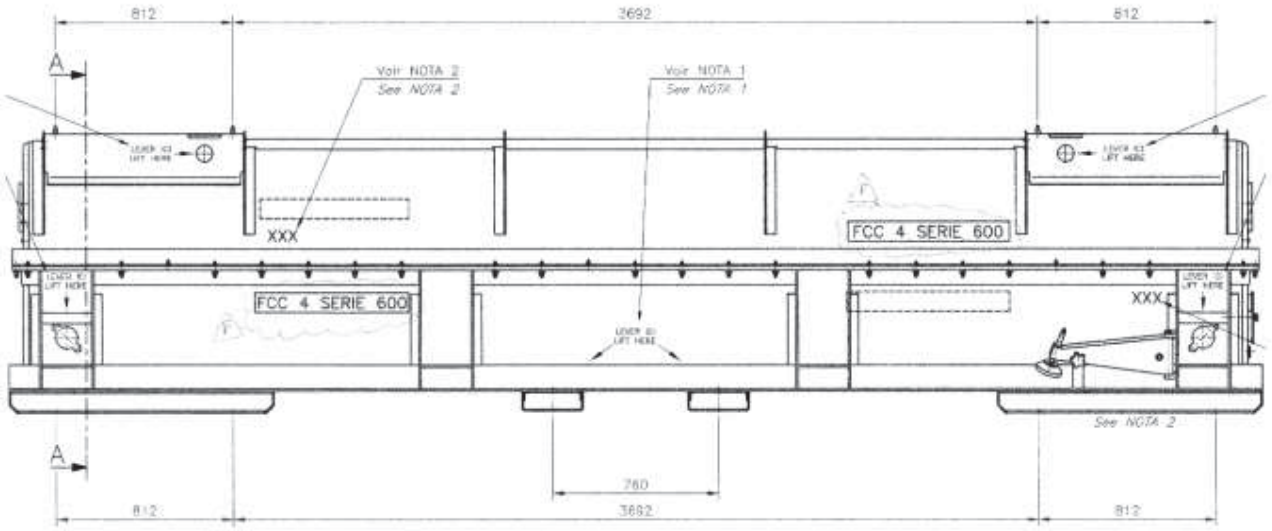
The ASN shall be kept informed via the following email address: dts-transport@asn.fr of any packaging that is taken out of service or transferred to another owner. Accordingly, any owner that transfers a packaging must communicate the name of the new owner.

5. QUALITY MANAGEMENT SYSTEM

The principles of the quality management system to be applied to the design, manufacture, inspection, testing, maintenance and use of the package must comply with the principles described in Chapter 1.9 of safety analysis report DOS-18-016472-008 Rev. 1.0.

FIGURE 0.1

PACKAGING DIAGRAM



Coupe A–A
Cross section A–A
Echelle : 1/5
Scale : 1/5

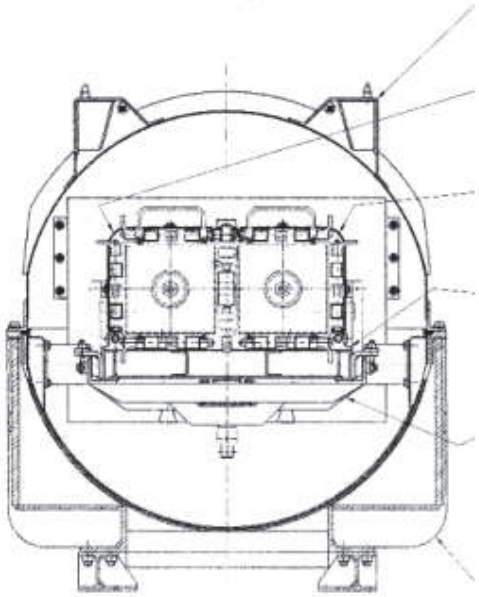
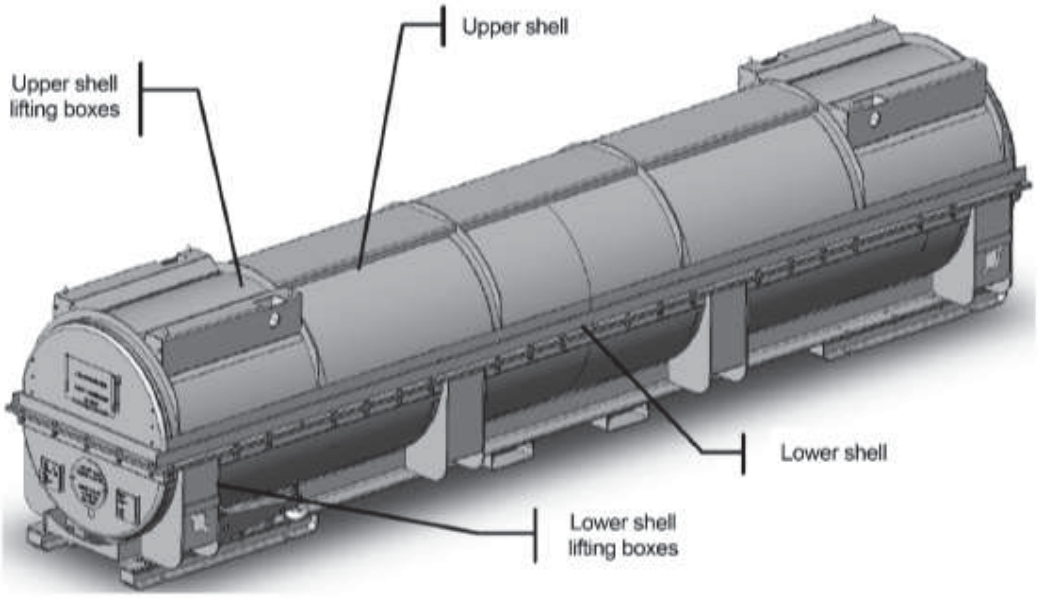


FIGURE 0.2

THREE-DIMENSIONAL VIEW OF THE PACKAGING



ANNEXE 1
CONTENT N°1:
NEW PWR TYPE 17 × 17 FOURTEEN-FOOT XL, XLR OR GAIA FUEL ASSEMBLIES

The safety analysis report justifying the authorised content is report DOS-18-016472-000 Rev. 5.0.
This content is loaded into a version 1 FCC4 packaging.

1. DEFINITION OF AUTHORISED RADIOACTIVE CONTENT

The authorised radioactive content, which are described in Chapter 1.3 of safety analysis report DOS-18-016472-005 Rev. 4.0, consist of a maximum of two new fuel assemblies for pressurized water reactor (PWR), as described below:

Characteristics of the fuel assemblies	
Name	17 x 17 XL, XLR or GAIA (1)
Type of array	17 x 17 fourteen foot
Nominal array pitch (mm)	12.6
Total maximum mass of a fuel assembly with or without a rod cluster (kg)	877
Maximum mass of UO_2 per assembly (kg)	690
Nominal active length (mm)	4,267
Maximum number of fuel rods	288 (2)
Characteristics of fuel rods	
Cladding material	Zirconium alloy, possibly pre-oxidised, possibly chromium-plated
Minimum metal thickness (mm)	0.52
Minimum outer diameter (mm)	9.40
Pellets:	ENU (3)
Maximum diameter (mm)	8.30
Maximum oxide density (100% of the theoretical density)	10.96
Maximum initial enrichment ($^{235}U/U_{total}$) (%)	5
Maximum mass ratio $^{232}U/U_{total}$ (%)	$5x10^{-8}$
Maximum mass ratio $^{234}U/U_{total}$ (%)	0.055
Maximum mass ratio $^{236}U/U_{total}$ (%)	0.05
Maximum absolute internal pressure of fuel rods at 20 °C (in bar)	32.7

(1) 17 x 17 XL, XLR and GAIA refer to the 17 x 17 fourteen foot array of assemblies for 1000, 1300 and 1450 MWe reactors. Authorised contents may be composed of assemblies with different identifiers provided they have the characteristics mentioned in the above table.

(2) This number corresponds to the maximum number of fuel rods that can be inserted into a structure (assembly skeleton or quiver), including guide tubes.

(3) ENU: Enriched Natural Uranium.

Glycerine residues up to a maximum of 5 grams can be present on the fuel assemblies.

The mechanical strength properties of the fuel rod cladding material meet one of the following two triplets:

	1	**2**
$R_{p0.2}$ (MPa)	≥ 520	≥ 250
R_m (MPa)	≥ 710	≥ 400
A_t (% over 50 mm)	≥ 12	≥ 25

Maximum activity per packaging: The maximum activity of the contents is less than 1 A_2.

Physical state: Fuel rod assemblies composed of sintered pellets placed in a cladding. The cladding can be covered with a layer of chromium up to 30 µm thick.

Chemical form: Uranium oxide (UO_2) pellets and/or pellets composed of a mixture of UO_2 and a body that acts as a neutron poison. The pellets may contain chromium oxide (but no other doping agents).

Special form: The material transported is not in any special form.

2. LOADING CONDITIONS

All assemblies in a load meet the conditions defined in the following table:

Maximum initial enrichment per fuel rod for each assembly in the load ($^{235}U/U_{total}$)	Minimum number of fuel rods per fuel assembly in the load (1)
5 %	264
(1) Incomplete UO_2 fuel rod assemblies can be supplemented with gadolinium-carrying rods, rods containing depleted uranium or other metallic material, or bars filled with a metallic material (excluding graphite and beryllium), possibly containing a neutron poison. These supplementary rods or bars will be equivalent in size to the UO_2 rods. The expression "*number of rods per assembly*" is understood to mean the total number of fuel rods and replacement rods or bars.	

All fuel assemblies in the load, except one, can be replaced by fuel assembly skeletons.

The presence of desiccant is permitted.

The presence of materials with more hydrogen content than water is not authorised within the packaging.

3. SUB-CRITICALITY CONTINUITY

Sub-criticality continuity is covered in Chapter 2.5-1 of the safety analysis report.

The "content" part of the isolation system under consideration comprises the following elements:

- the characteristics of the fuel assemblies as described in the Table in Chapter 1 of this Appendix;
- the cladding tubes which guarantee the containment of the fissile material in an accident situation;
- the structure of the assembly (grids, end-pieces).

Criticality Safety Index (CSI): 0.625 ("N" number = 80).

ANNEXE 2
CONTENT NO. 2
PWR TYPE NEW 16 × 16 FUEL ASSEMBLIES

The safety analysis report justifying the authorised content is report DOS-18-016472-000 Rev. 5.0.
This content is loaded into a version 2 FCC4 packaging.

1. DEFINITION OF AUTHORISED RADIOACTIVE CONTENT

The authorised radioactive content, which are described in Chapter 1.3 of safety analysis report DOS-18-016472-005 Rev. 4.0, consist of a maximum of two new fuel assemblies for pressurized water reactor (PWR), as described below:

Characteristics of the fuel assemblies	
Type of array	16 x 16
Nominal array pitch (mm)	14.3
Total maximum mass of a fuel assembly with or without a rod cluster (kg)	877
Maximum mass of UO_2 per assembly (kg)	639
Nominal active length (mm)	3,900
Maximum number of fuel rods	236 (1)
Characteristics of fuel rods	
Cladding material	Zirconium alloy, possibly pre-oxidised, possibly chromium-plated
Minimum metal thickness (mm)	0.68
Minimum outer diameter (mm)	10.70
Pellets:	ENU (2)
Maximum diameter (mm)	9.14
Maximum oxide density (100% of the theoretical density)	10.96
Maximum initial enrichment ($^{235}U/U_{total}$) (%)	4.5
Maximum mass ratio $^{232}U/U_{total}$ (%)	$5x10^{-8}$
Maximum mass ratio $^{234}U/U_{total}$ (%)	0.055
Maximum mass ratio $^{236}U/U_{total}$ (%)	0.05
Maximum absolute internal pressure of fuel rods at 20 °C (in bar)	32.7

(1) This number corresponds to the maximum number of fuel rods that can be inserted into a structure (assembly skeleton or quiver), including guide tubes.

(2) ENU: Enriched Natural Uranium.

Glycerine residues up to a maximum of 5 grams can be present on the fuel assemblies.

The mechanical strength properties of the fuel rod cladding material meet one of the following two triplets:

	1	**2**
$R_{p0.2}$ (MPa)	≥ 520	≥ 250
R_m (MPa)	≥ 710	≥ 400
A_t (% over 50 mm)	≥ 12	≥ 25

Maximum activity per packaging: The maximum activity of the contents is less than 1 A_2.

Physical state: Fuel rod assemblies composed of sintered pellets placed in a cladding. The cladding can be covered with a layer of chromium up to 30 µm thick.

Chemical form: Uranium oxide (UO_2) pellets and/or fuel pellets composed of a mixture of UO_2 and a body that acts as a neutron poison. The pellets may contain chromium oxide (but no other doping agents).

Special form: The material transported is not in any special form.

2. LOADING CONDITIONS

All assemblies in a load meet the conditions defined in the following table:

Maximum initial enrichment per fuel rod for each assembly in the load ($^{235}U/U_{total}$)	Minimum number of fuel rods per fuel assembly in the load (1)
4.5 %	236
(1) Incomplete UO_2 fuel rod assemblies can be supplemented with gadolinium-carrying rods, rods containing depleted uranium or other metallic material, or bars filled with a metallic material (excluding graphite and beryllium), possibly containing a neutron poison. These supplementary rods or bars will be equivalent in size to the UO_2 rods. The expression "*number of rods per assembly*" is understood to mean the total number of fuel rods and replacement rods or bars.	

All fuel assemblies in the load, except one, can be replaced by fuel assembly skeletons.

The presence of desiccant is permitted.

The presence of materials with more hydrogen content than water is not authorised within the packaging.

3. SUB-CRITICALITY CONTINUITY

Sub-criticality continuity is covered in Chapter 2.5-1 of the safety analysis report.

The "content" part of the isolation system under consideration comprises the following elements:

- the characteristics of the fuel assemblies as described in the Table in Chapter 1 of this Appendix;
- the cladding tubes which guarantee the containment of the fissile material in an accident situation;
- the structure of the assembly (grids, end-pieces).

Criticality Safety Index (CSI): 8.33 ("N" number = 6).

ANNEXE 3
CONTENT NO. 3
NEW PWR TYPE 18 × 18 FUEL ASSEMBLIES

The safety analysis report justifying the authorised content is report DOS-18-016472-000 Rev. 5.0.
This content is loaded into a version 2 FCC4 packaging.

1. DEFINITION OF AUTHORISED RADIOACTIVE CONTENT

The authorised radioactive content, which are described in Chapter 1.3 of safety analysis report DOS-18-016472-005 Rev. 4.0, consist of a maximum of two new fuel assemblies for pressurized water reactor (PWR), as described below:

Characteristics of the fuel assemblies	
Type of array	18 x 18
Nominal array pitch (mm)	12.7
Total maximum mass of a fuel assembly with or without a rod cluster (kg)	877
Maximum mass of UO_2 per assembly (kg)	630
Nominal active length (mm)	3,900
Maximum number of fuel rods	300 (1)
Characteristics of fuel rods	
Cladding material	Zirconium alloy, possibly pre-oxidised, possibly chromium-plated
Minimum metal thickness (mm)	0.60
Minimum outer diameter (mm)	9.46
Pellets:	ENU (2)
Maximum diameter (mm)	8.08
Maximum oxide density (100% of the theoretical density)	10.96
Maximum initial enrichment ($^{235}U/U_{total}$) (%)	4.5
Maximum mass ratio $^{232}U/U_{total}$ (%)	$5x10^{-8}$
Maximum mass ratio $^{234}U/U_{total}$ (%)	0.055
Maximum mass ratio $^{236}U/U_{total}$ (%)	0.05
Maximum absolute internal pressure of fuel rods at 20 °C (in bar)	32.7

(1) This number of rods corresponds to the maximum number of rods that can be inserted into a structure (assembly skeleton or quiver), including in the guide tubes.

(2) ENU: Enriched Natural Uranium.

Glycerine residues up to a maximum of 5 grams can be present on the fuel assemblies.

The mechanical strength properties of the fuel rod cladding material meet one of the following two triplets:

	1	**2**
$R_{p0.2}$ (MPa)	≥ 520	≥ 250
R_m (MPa)	≥ 710	≥ 400

A_t (% over 50 mm)	≥ 12	≥ 25

Maximum activity per packaging: The maximum activity of the contents is less than 1 A_2.

Physical state: Fuel rod assemblies composed of sintered pellets placed in a cladding. The cladding can be covered with a layer of chromium up to 30 µm thick.

Chemical form: Uranium oxide (UO_2) pellets and/or fuel pellets composed of a mixture of UO_2 and a body that acts as a neutron poison. The pellets may contain chromium oxide (but no other doping agents).

Special form: The material transported is not in any special form.

2. LOADING CONDITIONS

All assemblies in a load meet the conditions defined in the following table:

Maximum initial enrichment per fuel rod for each assembly in the load ($^{235}U/U_{total}$)	Minimum number of fuel rods per fuel assembly in the load (1)
4.5 %	300
(1) Incomplete UO_2 fuel rod assemblies can be supplemented with gadolinium-carrying rods, rods containing depleted uranium or other metallic material, or bars filled with a metallic material (excluding graphite and beryllium), possibly containing a neutron poison. These supplementary rods or bars will be equivalent in size to the UO_2 rods. The expression "*number of rods per assembly*" is understood to mean the total number of fuel rods and replacement rods or bars.	

All fuel assemblies in the load, except one, can be replaced by fuel assembly skeletons.

The presence of desiccant is permitted.

The presence of materials with more hydrogen content than water is not authorised within the packaging.

3. SUB-CRITICALITY CONTINUITY

Sub-criticality continuity is covered in Chapter 2.5-3 of the safety analysis report.

The isolation system under consideration comprises the following elements:

- the characteristics of the fuel assemblies as described in the Table in Chapter 1 of this Appendix;
- the cladding tubes which guarantee the containment of the fissile material in an accident situation;
- the structure of the assembly (grids, end-pieces).

Criticality Safety Index (CSI): 8.33 ("N" number = 6).

ANNEXE 4
CONTENT NO. 4
PWR TYPE 17 × 17 XL OR 17 × 17 XLR FOURTEEN-FOOT FUEL RODS

The safety analysis report justifying the authorised content is report DOS-18-016472-000 Rev. 5.0.
This content is loaded into a version 1 FCC4 packaging.

1. DEFINITION OF AUTHORISED RADIOACTIVE CONTENT

The authorised radioactive content, which are described in Chapter 1.3 of safety analysis report DOS-18-016472-005 Rev. 4.0, consist of new fuel rods for pressurised water reactors (PWR), as described below:

Characteristics of fuel rods	
Name	17 x 17 XL or XLR
Type of assembly array housing these rods	17 x 17 fourteen foot
Maximum total mass per cavity (kg)	856
Maximum total mass of the rods per box (kg)	537
Maximum mass of UO_2 (kg)	443/box
Nominal active length (mm)	4,267
Maximum number of fuel rods per box	185
Cladding material	Zirconium alloy, possibly pre-oxidised, possibly chromium-plated
Minimum metal thickness (mm)	0.52
Minimum outer diameter (mm)	9.40
Pellets:	ENU (2)
Maximum diameter (mm)	8.30
Maximum oxide density (100% of the theoretical density)	10.96
Maximum initial enrichment ($^{235}U/U_{total}$) (%)	5
Maximum mass ratio $^{232}U/U_{total}$ (%)	$5x10^{-8}$
Maximum mass ratio $^{234}U/U_{total}$ (%)	0.055
Maximum mass ratio $^{236}U/U_{total}$ (%)	0.05
Minimum Gd_2O_3 mass content in gadolinium-carrying rods (%) (1)	2
Maximum absolute internal pressure of fuel rods at 20 °C (in bar)	32.7

(1) Fuel rods with a Gd_2O_3 content of less than 2% are considered as (non gadolinium-carrying) UO_2 fuel rods.

(2) ENU: Enriched Natural Uranium.

The mechanical strength properties of the fuel rod cladding material meet one of the following two triplets:

	1	**2**
$R_{p0.2}$ (MPa)	≥ 520	≥ 250
R_m (MPa)	≥ 710	≥ 400
A_t (% over 50 mm)	≥ 12	≥ 25

Maximum activity per packaging: The maximum activity of the contents is less than 1 A_2.

Physical state: Fuel rods composed of sintered pellets placed in a cladding. The cladding can be covered with a layer of chromium up to 30 µm thick.

Chemical form: Uranium oxide (UO_2) pellets and/or fuel pellets composed of a mixture of UO_2 and a body that acts as a neutron poison. The pellets may contain chromium oxide (but no other doping agents).

Special form: The material transported is not in any special form.

2. LOADING CONDITIONS

All fuel rods in a load meet the conditions defined in the following table:

Maximum initial enrichment of each fuel rod in the load ($^{235}U/U_{total}$)	Minimum number of fuel rods per box (1)
5 %	Full row of fuel or inert rods
(1) Incomplete rows of fuel rods are supplemented with solid stainless steel (or zirconium alloy) bars, with a nominal diameter of between 9.5 and 10 mm, possibly containing a neutron poison. The term "*number of rods per box*" is understood to mean the total number of fuel rods and steel (or zirconium alloy) bars.	

The presence of desiccant is permitted.

The presence of materials with more hydrogen content than water is not authorised within the packaging.

3. INTERNAL FITTINGS

The internal fitting is a rod box, which is described in Chapters 1.3-1 and 1.3-2 of the safety analysis report.

3.1 Rod box

The unassembled rods are grouped together in FCC4-type rod boxes, which are inserted in place of the assemblies inside the version 1 FCC4's.

The box is made of a folded U-shaped sheet, which is closed at the ends and reinforced by two members welded to the top of the sheet.

A radial spacer system holds the rods in position. A diagram is provided in Figure 4.1.

The minimum height of the radial spacer is 85 mm.

3.2 Rod box spacers

A set of 2 spacers longitudinally holds the box in place in the cavity (a top spacer and a bottom spacer). A detailed description of the spacers can be found in Chapter 1.3-1 of the safety analysis report.

4. SUB-CRITICALITY CONTINUITY

Sub-criticality continuity is covered in Chapter 2.5-2 of the safety analysis report.
The isolation system under consideration comprises the following elements:

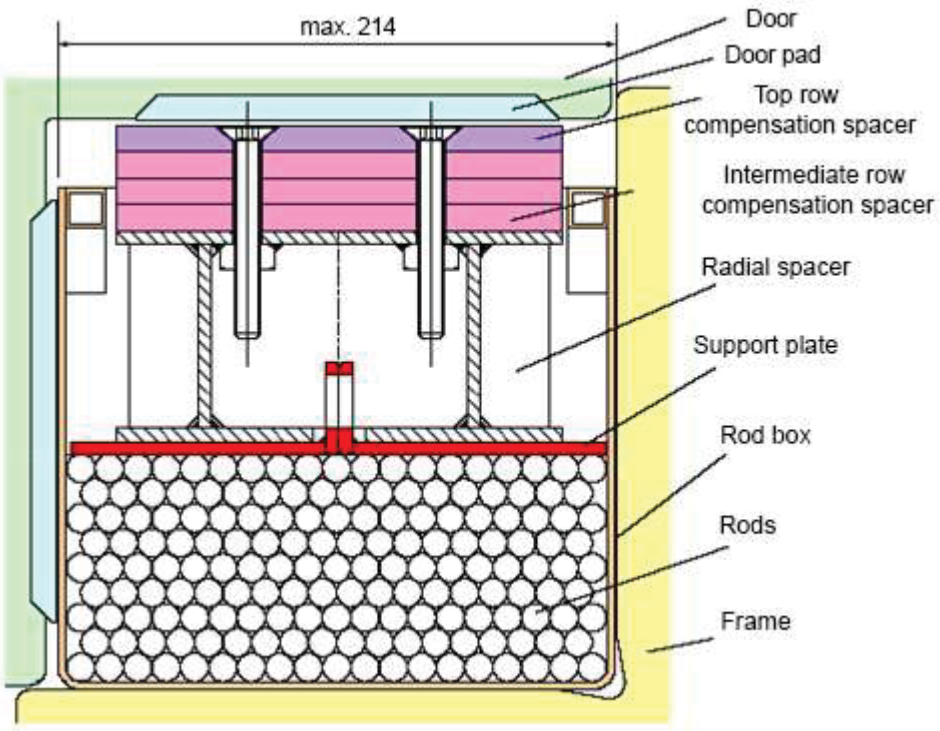
- the characteristics of the fuel rods as described in the table in Chapter 1 of this Appendix;
- the cladding tubes which guarantee the containment of the fissile material in an accident situation.

Criticality Safety Index (CSI):

- when UO_2 rods are transported, the criticality safety index is equal to 0 (number N = infinity),
- when UO_2-Gd_2O_3 rods are transported, the criticality safety index is 0 (number N = infinity).

FIGURE 4.1

DIAGRAM OF THE RODS BOX



ANNEXE 5
CONTENT NO. 5
PWR TYPE 17 × 17 TWELVE-FOOT FUEL RODS

The safety analysis report justifying the authorised content is report DOS-18-016472-000 Rev. 5.0.
This content is loaded into a version 1 FCC 4 packaging.

1. DEFINITION OF AUTHORISED RADIOACTIVE CONTENT

The authorised radioactive content, which are described in Chapter 1.3 of safety analysis report DOS-18-016472-005 Rev. 4.0, consist of new fuel rods for pressurised water reactors, as described below:

Characteristics of fuel rods	
Type of assembly array housing these rods	17 x 17 twelve foot
Maximum total mass per cavity (kg)	856
Maximum total mass of the rods per box (kg)	461
Maximum mass of UO_2 (kg)	380/box
Nominal active length (mm)	3,658
Maximum number of fuel rods per box	185
Cladding material	Zirconium alloy, possibly pre-oxidised, possibly chromium-plated
Minimum metal thickness (mm)	0.52
Minimum outer diameter (mm)	9.40
Pellets:	ENU (2)
Maximum diameter (mm)	8.30
Maximum oxide density (100% of the theoretical density)	10.96
Maximum initial enrichment ($^{235}U/U_{total}$) (%)	5
Maximum mass ratio $^{232}U/U_{total}$ (%)	$5x10^{-8}$
Maximum mass ratio $^{234}U/U_{total}$ (%)	0.055
Maximum mass ratio $^{236}U/U_{total}$ (%)	0.05
Minimum Gd_2O_3 mass content in gadolinium-carrying rods (%) (1)	2
Maximum absolute internal pressure of fuel rods at 20 °C (in bar)	32.7

(1) Fuel rods with a Gd_2O_3 content of less than 2% are considered as (non gadolinium-carrying) UO_2 fuel rods.

(2) ENU: Enriched Natural Uranium.

The mechanical strength properties of the fuel rod cladding material meet one of the following two triplets:

	1	2
$R_{p0.2}$ (MPa)	≥ 520	≥ 250
R_m (MPa)	≥ 710	≥ 400
A_t (% over 50 mm)	≥ 12	≥ 25

Maximum activity per packaging: The maximum activity of the contents is less than 1 A_2.

Physical state: Fuel rods composed of sintered pellets placed in a cladding. The cladding can be covered with a layer of chromium up to 30 µm thick.

Chemical form: Uranium oxide (UO_2) pellets and/or fuel pellets composed of a mixture of UO_2 and a body that acts as a neutron poison. The pellets may contain chromium oxide (but no other doping agents).

Special form: The material transported is not in any special form.

2. LOADING CONDITIONS

All fuel rods in a load meet the conditions defined in the following table:

Maximum initial enrichment of each fuel rod in the load ($^{235}U/U_{total}$)	Minimum number of fuel rods per box (1)
5 %	Full row of fuel or inert rods
(1) Incomplete rows of fuel rods must be supplemented with solid stainless steel (or zirconium alloy) bars, with a nominal diameter of between 9.5 mm and 10 mm, possibly containing a neutron poison. The term "*number of rods per box*" is understood to mean the total number of fuel rods and steel (or zirconium alloy) bars.	

The presence of desiccant is permitted.

The presence of materials with more hydrogen content than water is not authorised within the packaging.

3. INTERNAL FITTINGS

The internal fitting is a rod box, which is described in Chapters 1.3-1 and 1.3-2 of the safety analysis report.

3.1 Rod box

The unassembled rods are grouped together in FCC4-type rod boxes, which are inserted in place of the assemblies inside the version 1 FCC4's.

The box is made of a folded U-shaped sheet, which is closed at the ends and reinforced by two members welded to the top of the sheet.

A system of axial and radial spacers is used to adapt to the lengths of the rods and to hold them in position. A diagram is provided in Figure 5.1.

The minimum height of the radial spacer is 85 mm.

3.2 Rod box spacers

A set of 2 spacers longitudinally holds the box in place in the cavity (a top spacer and a bottom spacer). A detailed description of the spacers can be found in Chapter 1.3-1 of the safety analysis report.

4. SUB-CRITICALITY CONTINUITY

Sub-criticality continuity is covered in Chapter 2.5-2 of the safety analysis report.
The "content" part of the isolation system under consideration comprises the following elements:

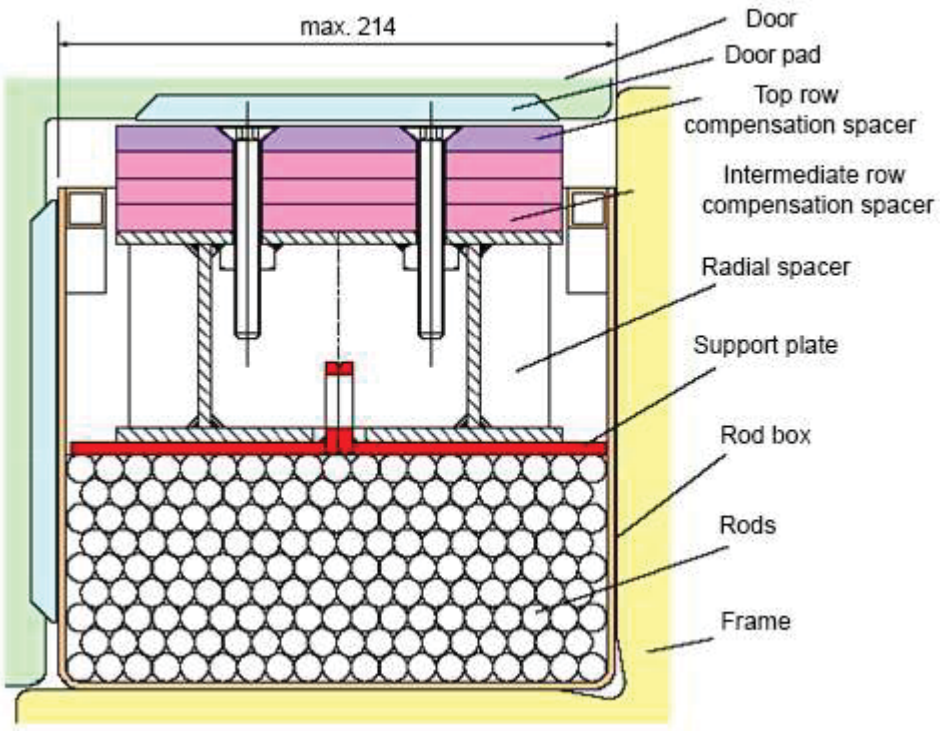
- the characteristics of the fuel rods as described in the table in Chapter 1 of this Appendix;
- the cladding tubes which guarantee the containment of the fissile material in an accident situation.

Criticality Safety Index (CSI):

- when UO_2 rods are transported, the criticality safety index is equal to 0 (number N = infinity);
- when UO_2-Gd_2O_3 rods are transported, the criticality safety index is 0 (number N = infinity).

FIGURE 5.1

DIAGRAM OF THE RODS BOX



ANNEXE 6
CONTENT NO. 6
PWR TYPE 15 × 15 FUEL RODS

The safety analysis report justifying the authorised content is report DOS-18-016472-000 Rev. 5.0.
This content is loaded into a version 1 FCC4 packaging.

1. DEFINITION OF AUTHORISED RADIOACTIVE CONTENT

The authorised radioactive content, which are described in Chapter 1.3 of safety analysis report DOS-18-016472-005 Rev. 4.0, consist of new fuel rods for pressurised water reactors (PWR), as described below:

Characteristics of fuel rods	
Type of assembly array housing these rods	15 x 15
Maximum total mass per cavity (kg)	856
Maximum total mass of the rods per box (kg)	470
Maximum mass of UO_2 (kg)	389/box
Nominal active length (mm)	3,658
Maximum number of fuel rods per box	148
Cladding material	Zirconium alloy, possibly pre-oxidised, possibly chromium-plated
Minimum metal thickness (mm)	0.57
Minimum outer diameter (mm)	10.68
Pellets:	ENU (2)
Maximum diameter (mm)	9.40
Maximum oxide density (100% of the theoretical density)	10.96
Maximum initial enrichment ($^{235}U/U_{total}$) (%)	5
Maximum mass ratio $^{232}U/U_{total}$ (%)	$5x10^{-8}$
Maximum mass ratio $^{234}U/U_{total}$ (%)	0.055
Maximum mass ratio $^{236}U/U_{total}$ (%)	0.05
Minimum Gd_2O_3 mass content in gadolinium-carrying rods (%) (1)	2
Maximum absolute internal pressure of fuel rods at 20 °C (in bar)	32.7

(1) Fuel rods with a Gd_2O_3 content of less than 2% are considered as (non gadolinium-carrying) UO_2 fuel rods.

(2) ENU: Enriched Natural Uranium.

The mechanical strength properties of the fuel rod cladding material meet one of the following two triplets:

	1	2
$R_{p0.2}$ (MPa)	≥ 520	≥ 250
R_m (MPa)	≥ 710	≥ 400
A_t (% over 50 mm)	≥ 12	≥ 25

Maximum activity per packaging: The maximum activity of the contents is less than 1 A_2.

Physical state: Fuel rods composed of sintered pellets placed in a cladding. The cladding can be covered with a layer of chromium up to 30 µm thick.

Chemical form: Uranium oxide (UO_2) pellets and/or fuel pellets composed of a mixture of UO_2 and a body that acts as a neutron poison. The pellets may contain chromium oxide (but no other doping agents).

Special form: The material transported is not in any special form.

2. LOADING CONDITIONS

All fuel rods in a load meet the conditions defined in the following table:

Maximum initial enrichment of each fuel rod in the load ($^{235}U/U_{total}$)	Minimum number of fuel rods per box (1)
5 %	Full row of fuel or inert rods
(1) Incomplete rows of fuel rods are supplemented with solid stainless steel (or zirconium alloy) bars, with a nominal diameter of between 10.7 mm and 11 mm, possibly containing a neutron poison. The term "*number of rods per box*" is understood to mean the total number of fuel rods and steel (or zirconium alloy) bars.	

The presence of desiccant is permitted.

The presence of materials with more hydrogen content than water is not authorised within the packaging.

3. INTERNAL FITTINGS

The internal fitting is a rod box, which is described in Chapters 1.3-1 and 1.3-2 of the safety analysis report.

3.1 Rod box

The unassembled rods are grouped together in FCC4-type rod boxes, which are inserted in place of the assemblies inside the version 1 FCC4's.

The box is made of a folded U-shaped sheet, which is closed at the ends and reinforced by two members welded to the top of the sheet.

A system of axial and radial spacers is used to adapt to the lengths of the rods and to hold them in position. A diagram is provided in Figure 6.1.

The minimum height of the radial spacer is 85 mm.

3.2 Rod box spacers

A set of 2 spacers longitudinally holds the box in place in the cavity (a top spacer and a bottom spacer). A detailed description of the spacers can be found in Chapter 1.3-1 of the safety analysis report.

4. SUB-CRITICALITY CONTINUITY

Sub-criticality continuity is covered in Chapter 2.5-2 of the safety analysis report.
The "content" part of the isolation system under consideration comprises the following elements:

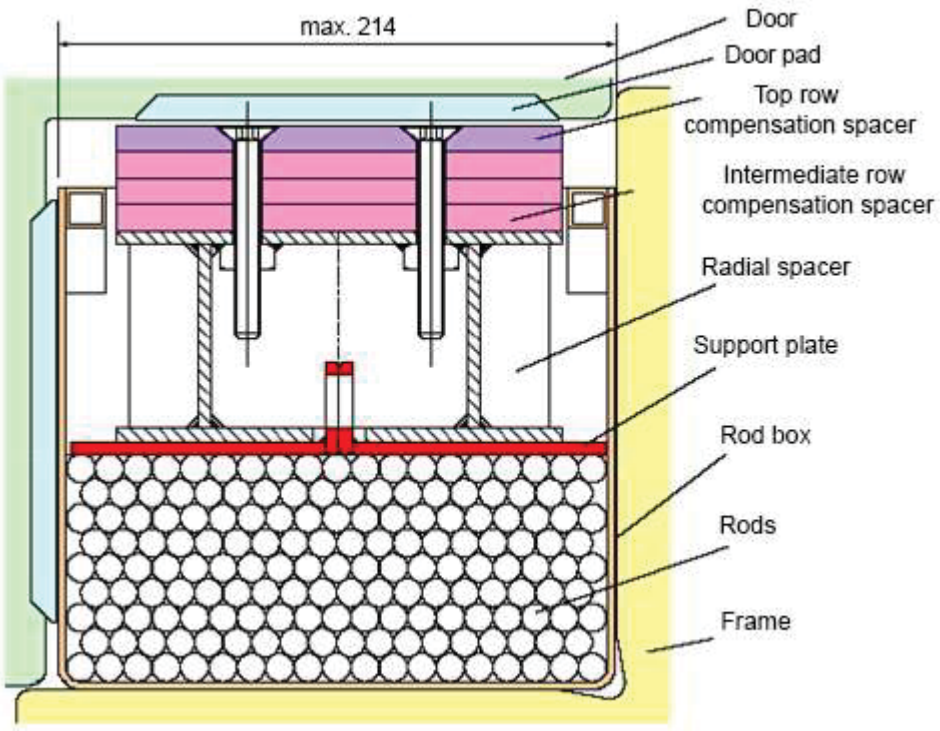
- the characteristics of the fuel rods as described in the table in Chapter 1 of this Appendix;
- the cladding tubes which guarantee the containment of the fissile material in an accident situation.

Criticality Safety Index (CSI):

- when UO_2 rods are transported, the criticality safety index is equal to 0 (number N = infinity);
- when UO_2-Gd_2O_3 rods are transported, the criticality safety index and 0 (number N = infinity).

FIGURE 6.1

DIAGRAM OF THE RODS BOX



ANNEXE 7
CONTENT NO. 7
PWR TYPE 14 × 14 EIGHT-FOOT FUEL RODS

The safety analysis report justifying the authorised content is report DOS-18-016472-000 Rev. 5.0.
This content is loaded into a version 1 FCC4 packaging.

1. DEFINITION OF AUTHORISED RADIOACTIVE CONTENT

The authorised radioactive content, which are described in Chapter 1.3 of safety analysis report DOS-18-016472-005 Rev. 4.0, consist of new fuel rods for pressurised water reactors (PWR), as described below:

Characteristics of fuel rods	
Type of assembly array housing these rods	14 x 14 eight foot
Maximum total mass per cavity (kg)	856
Maximum total mass of the rods per box (kg)	471
Maximum mass of UO_2 (kg)	394/box
Nominal active length (mm)	2,413
Maximum number of fuel rods per box	222
Cladding material	Zirconium alloy, possibly pre-oxidised, possibly chromium-plated
Minimum metal thickness (mm)	0.57
Minimum outer diameter (mm)	10.68
Pellets:	ENU (2)
Maximum diameter (mm)	9.40
Maximum oxide density (100% of the theoretical density)	10.96
Maximum initial enrichment ($^{235}U/U_{total}$) (%)	5
Maximum mass ratio $^{232}U/U_{total}$ (%)	$5x10^{-8}$
Maximum mass ratio $^{234}U/U_{total}$ (%)	0.055
Maximum mass ratio $^{236}U/U_{total}$ (%)	0.05
Minimum Gd_2O_3 mass content in gadolinium-carrying rods (%) (1)	2
Maximum absolute internal pressure of fuel rods at 20 °C (in bar)	32.7

(1) Fuel rods with a Gd_2O_3 content of less than 2% are considered as (non gadolinium-carrying) UO_2 fuel rods.

(2) ENU: Enriched Natural Uranium.

The mechanical strength properties of the fuel rod cladding material meet one of the following two triplets:

	1	2
$R_{p0.2}$ (MPa)	≥ 520	≥ 250
R_m (MPa)	≥ 710	≥ 400
A_t (% over 50 mm)	≥ 12	≥ 25

Maximum activity per packaging: The maximum activity of the contents is less than 1 A_2.

Physical state: Fuel rods composed of sintered pellets placed in a cladding. The cladding can be covered with a layer of chromium up to 30 µm thick.

Chemical form: Uranium oxide (UO_2) pellets and/or fuel pellets composed of a mixture of UO_2 and a body that acts as a neutron poison. The pellets may contain chromium oxide (but no other doping agents).

Special form: The material transported is not in any special form.

2. LOADING CONDITIONS

All fuel rods in a load meet the conditions defined in the following table:

Maximum initial enrichment of each fuel rod in the load ($^{235}U/U_{total}$)	Minimum number of fuel rods per box (1)
5 %	Full row of fuel or inert rods
(1) Incomplete rows of fuel rods are supplemented with solid stainless steel (or zirconium alloy) bars, with a nominal diameter of between 10.7 mm and 11 mm, possibly containing a neutron poison. The term "*number of rods per box*" is understood to mean the total number of fuel rods and steel (or zirconium alloy) bars.	

The presence of desiccant is permitted.

The presence of materials with more hydrogen content than water is not authorised within the packaging.

3. INTERNAL FITTINGS

The internal fitting is a rod box, which is described in Chapters 1.3-1 and 1.3-2 of the safety analysis report.

3.1 Rod box

The unassembled rods are grouped together in FCC4-type rod boxes, which are inserted in place of the assemblies inside the version 1 FCC4's.

The box is made of a folded U-shaped sheet, which is closed at the ends and reinforced by two members welded to the top of the sheet.

A system of axial and radial spacers is used to adapt to the lengths of the rods and to hold them in position. A diagram is provided in Figure 7.1.

The minimum height of the radial spacer is 85 mm.

3.2 Rod box spacers

A set of 2 spacers longitudinally holds the box in place in the cavity (a top spacer and a bottom spacer). A detailed description of the spacers can be found in Chapter 1.3-1 of the safety analysis report.

4. SUB-CRITICALITY CONTINUITY

Sub-criticality continuity is covered in Chapter 2.5-2 of the safety analysis report.
The "content" part of the isolation system under consideration comprises the following elements:

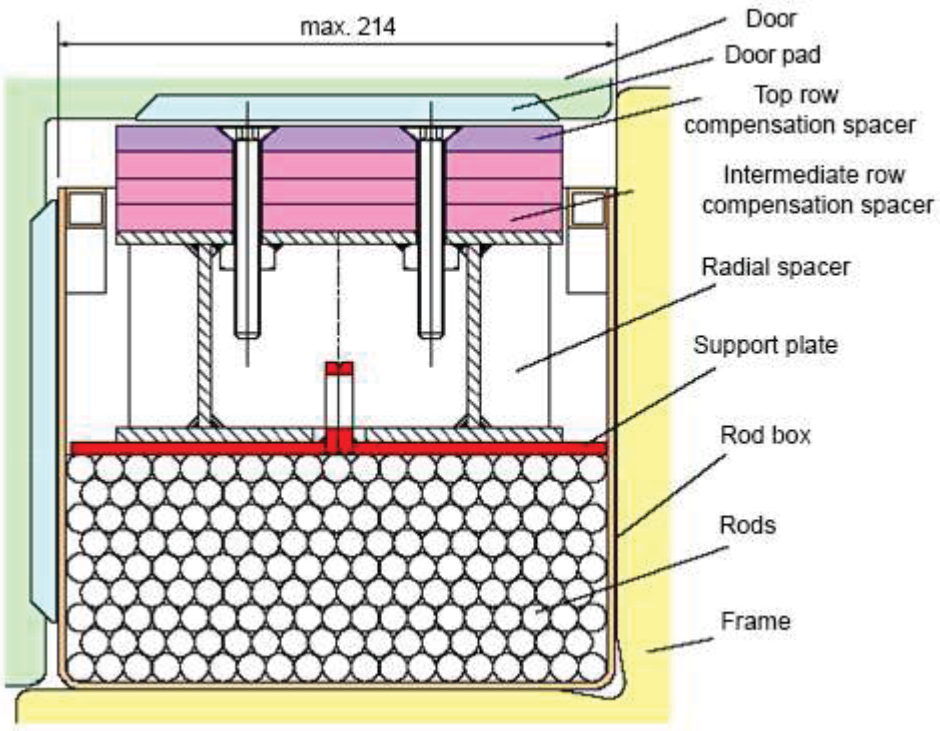
- the characteristics of the fuel rods as described in the table in Chapter 1 of this Appendix;
- the cladding tubes which guarantee the containment of the fissile material in an accident situation.

Criticality Safety Index (CSI):

- when UO_2 rods are transported, the criticality safety index is equal to 0 (number N = infinity);
- when UO_2-Gd_2O_3 rods are transported, the criticality safety index is 0 (number N = infinity).

FIGURE 7.1

DIAGRAM OF THE RODS BOX



ANNEXE 8
CONTENT NO. 8
PWR TYPE 14 × 14 TEN-FOOT FUEL RODS

The safety analysis report justifying the authorised content is report DOS-18-016472-000 Rev. 5.0.
This content is loaded into a version 1 FCC4 packaging.

1. DEFINITION OF AUTHORISED RADIOACTIVE CONTENT

The authorised radioactive content, which are described in Chapter 1.3 of safety analysis report DOS-18-016472-005 Rev. 4.0, consist of new fuel rods for pressurised water reactors (PWR), as described below:

Characteristics of fuel rods	
Type of assembly array housing these rods	14 x 14 ten foot
Maximum total mass per cavity (kg)	856
Maximum total mass of the rods per box (kg)	443
Maximum mass of UO_2 (kg)	374/box
Nominal active length (mm)	3,048
Maximum number of fuel rods per box	167
Cladding material	Zirconium alloy, possibly pre-oxidised, possibly chromium-plated
Minimum metal thickness (mm)	0.57
Minimum outer diameter (mm)	10.68
Pellets:	ENU (2)
Maximum diameter (mm)	9.40
Maximum oxide density (100% of the theoretical density)	10.96
Maximum initial enrichment ($^{235}U/U_{total}$) (%)	5
Maximum mass ratio $^{232}U/U_{total}$ (%)	$5x10^{-8}$
Maximum mass ratio $^{234}U/U_{total}$ (%)	0.055
Maximum mass ratio $^{236}U/U_{total}$ (%)	0.05
Minimum Gd_2O_3 mass content in gadolinium-carrying rods (%) (1)	2
Maximum absolute internal pressure of fuel rods at 20 °C (in bar)	32.7

(1) Fuel rods with a Gd_2O_3 content of less than 2% are considered as (non gadolinium-carrying) UO_2 fuel rods.

(2) ENU: Enriched Natural Uranium.

The mechanical strength properties of the fuel rod cladding material meet one of the following two triplets:

	1	2
$R_{p0.2}$ (MPa)	≥ 520	≥ 250
R_m (MPa)	≥ 710	≥ 400
A_t (% over 50 mm)	≥ 12	≥ 25

Maximum activity per packaging: The maximum activity of the contents is less than 1 A_2.

Physical state: Fuel rods composed of sintered pellets placed in a cladding. The cladding can be covered with a layer of chromium up to 30 µm thick.

Chemical form: Uranium oxide (UO_2) pellets and/or fuel pellets composed of a mixture of UO_2 and a body that acts as a neutron poison. The pellets may contain chromium oxide (but no other doping agents).

Special form: The material transported is not in any special form.

2. LOADING CONDITIONS

All fuel rods in a load meet the conditions defined in the following table:

Maximum initial enrichment of each fuel rod in the load ($^{235}U/U_{total}$)	Minimum number of fuel rods per box (1)
5 %	Full row of fuel or inert rods
(1) Incomplete rows of fuel rods are supplemented with solid stainless steel (or zirconium alloy) bars, with a nominal diameter of between 10.7 mm and 11 mm, possibly containing a neutron poison. The term "*number of rods per box*" is understood to mean the total number of fuel rods and steel (or zirconium alloy) bars.	

The presence of desiccant is permitted.

The presence of materials with more hydrogen content than water is not authorised within the packaging.

3. INTERNAL FITTINGS

The internal fitting is a rod box, which is described in Chapters 1.3-1 and 1.3-2 of the safety analysis report.

3.1 Rod box

The unassembled rods are grouped together in FCC4-type rod boxes, which are inserted in place of the assemblies inside the version 1 FCC4's.

The box is made of a folded U-shaped sheet, which is closed at the ends and reinforced by two members welded to the top of the sheet.

A system of axial and radial spacers is used to adapt to the lengths of the rods and to hold them in position. A diagram is provided in Figure 8.1.

The minimum height of the radial spacer is 85 mm.

3.2 Rod box spacers

A set of 2 spacers longitudinally holds the box in place in the cavity (a top spacer and a bottom spacer). A detailed description of the spacers can be found in Chapter 1.3-1 of the safety analysis report.

4. SUB-CRITICALITY CONTINUITY

Sub-criticality continuity is covered in Chapter 2.5-2 of the safety analysis report.
The "content" part of the isolation system under consideration comprises the following elements:

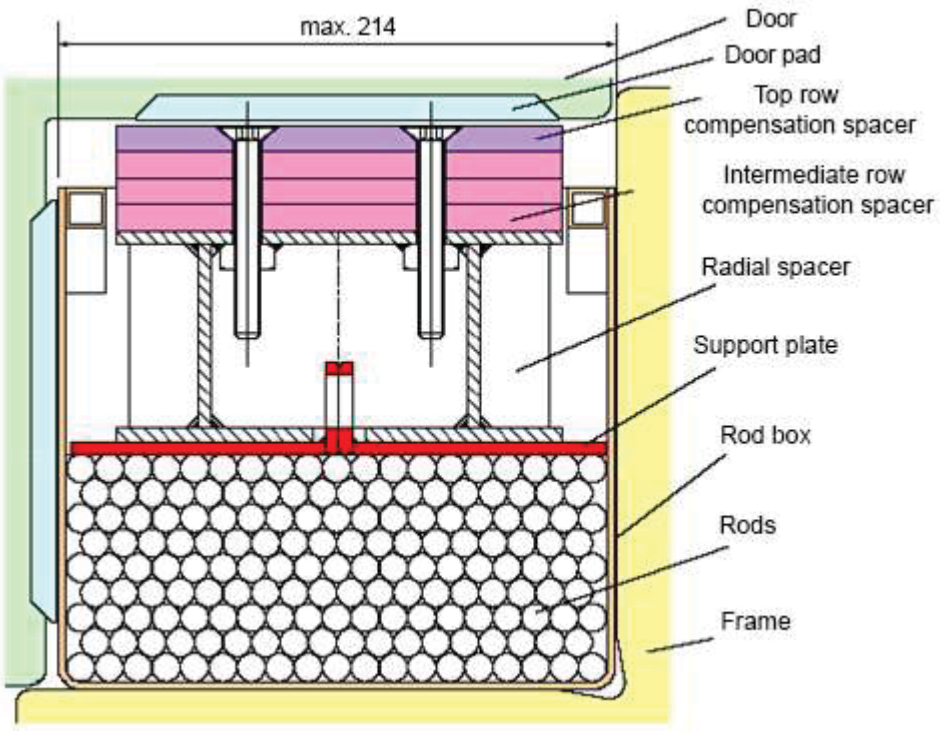
- the characteristics of the fuel rods as described in the table in Chapter 1 of this Appendix;
- the cladding tubes which guarantee the containment of the fissile material in an accident situation.

Criticality Safety Index (CSI):

- when UO_2 rods are transported, the criticality safety index is equal to 0 (number N = infinity);
- when UO_2-Gd_2O_3 rods are transported, the criticality safety index is 0 (number N = infinity).

FIGURE 8.1

DIAGRAM OF THE RODS BOX



ANNEXE 10
CONTENT NO. 10
PWR TYPE 16 × 16 FUEL RODS

The safety analysis report justifying the authorised content is report DOS-18-016472-000 Rev. 5.0.
This content is loaded into a version 1 FCC4 packaging.

1. DEFINITION OF AUTHORISED RADIOACTIVE CONTENT

The authorised radioactive content, which are described in Chapter 1.3 of safety analysis report DOS-18-016472-005 Rev. 4.0, consist of new fuel rods for pressurised water reactors (PWR), as described below:

Characteristics of fuel rods	
Type of assembly array housing these rods	16 x 16
Maximum total mass per cavity (kg)	856
Maximum total mass of the rods per box (kg)	504
Maximum mass of UO_2 (kg)	401/box
Nominal active length (mm)	3,900
Maximum number of fuel rods per box	148
Cladding material	Zirconium alloy, possibly pre-oxidised, possibly chromium-plated
Minimum metal thickness (mm)	0.68
Minimum outer diameter (mm)	10.70
Pellets:	ENU (2)
Maximum diameter (mm)	9.14
Maximum oxide density (100% of the theoretical density)	10.96
Maximum initial enrichment ($^{235}U/U_{total}$) (%)	5
Maximum mass ratio $^{232}U/U_{total}$ (%)	$5x10^{-8}$
Maximum mass ratio $^{234}U/U_{total}$ (%)	0.055
Maximum mass ratio $^{236}U/U_{total}$ (%)	0.05
Minimum Gd_2O_3 mass content in gadolinium-carrying rods (%) (1)	2
Maximum absolute internal pressure of fuel rods at 20 °C (in bar)	32.7

(1) Fuel rods with a Gd_2O_3 content of less than 2% are considered as (non gadolinium-carrying) UO_2 fuel rods.

(2) ENU: Enriched Natural Uranium.

The mechanical strength properties of the fuel rod cladding material meet one of the following two triplets:

	1	2
$R_{p0.2}$ (MPa)	≥ 520	≥ 250
R_m (MPa)	≥ 710	≥ 400
A_t (% over 50 mm)	≥ 12	≥ 25

Maximum activity per packaging: The maximum activity of the contents is less than 1 A_2.

Physical state: Fuel rods composed of sintered pellets placed in a cladding. The cladding can be covered with a layer of chromium up to 30 µm thick.

Chemical form: Uranium oxide (UO_2) pellets and/or fuel pellets composed of a mixture of UO_2 and a body that acts as a neutron poison. The pellets may contain chromium oxide (but no other doping agents).

Special form: The material transported is not in any special form.

2. LOADING CONDITIONS

All fuel rods in a load meet the conditions defined in the following table:

Maximum initial enrichment of each fuel rod in the load ($^{235}U/U_{total}$)	Minimum number of fuel rods per box (1)
5 %	Full row of fuel or inert rods
(1) Incomplete rows of fuel rods are supplemented with solid stainless steel (or zirconium alloy) bars, with a nominal diameter of between 10.7 mm and 11 mm, possibly containing a neutron poison. The term "*number of rods per box*" is understood to mean the total number of fuel rods and steel (or zirconium alloy) bars.	

The presence of desiccant is permitted.

The presence of materials with more hydrogen content than water is not authorised within the packaging.

3. INTERNAL FITTINGS

The internal fitting is a rod box, which is described in Chapters 1.3-1 and 1.3-2 of the safety analysis report.

3.1 Rod box

The unassembled rods are grouped together in FCC4-type rod boxes, which are inserted in place of the assemblies inside the version 1 FCC4's.

The box is made of a folded U-shaped sheet, which is closed at the ends and reinforced by two members welded to the top of the sheet.

A system of axial and radial spacers is used to adapt to the lengths of the rods and to hold them in position. A diagram is provided in Figure 10.1.

The minimum height of the radial spacer is 85 mm.

3.2 Rod box spacers

A set of 2 spacers longitudinally holds the box in place in the cavity (a top spacer and a bottom spacer). A detailed description of the spacers can be found in Chapter 1.3-1 of the safety analysis report.

4. SUB-CRITICALITY CONTINUITY

Sub-criticality continuity is covered in Chapter 2.5-2 of the safety analysis report.
The "content" part of the isolation system under consideration comprises the following elements:

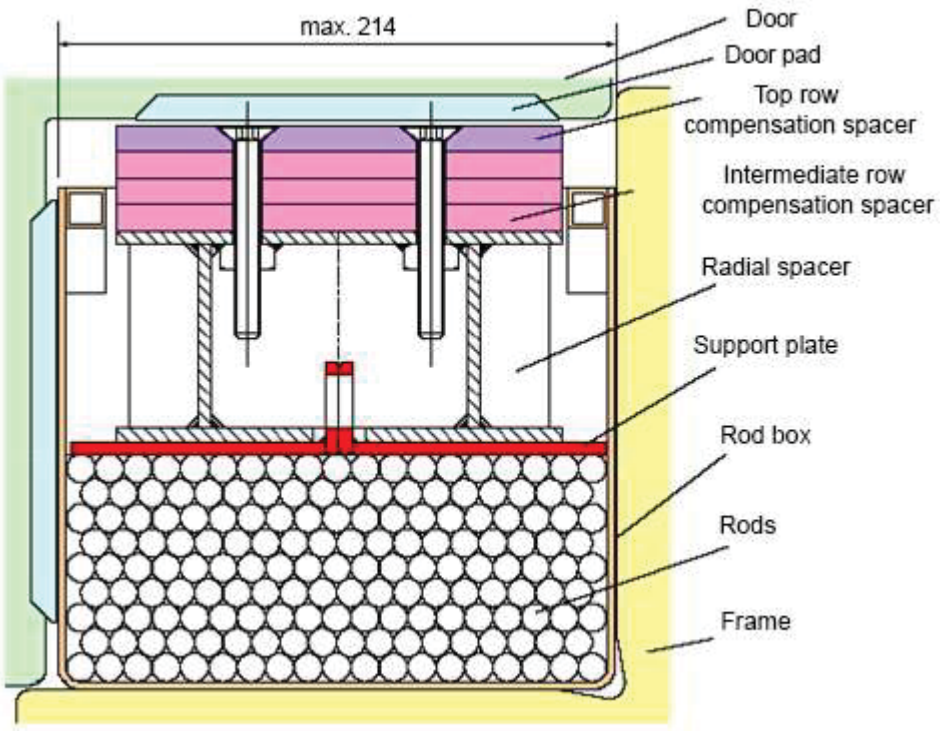
- the characteristics of the fuel rods as described in the table in Chapter 1 of this Appendix;
- the cladding tubes which guarantee the containment of the fissile material in an accident situation.

Criticality Safety Index (CSI):

- when UO_2 rods are transported, the criticality safety index is equal to 0 (number N = infinity);
- when UO_2-Gd_2O_3 rods are transported, the criticality safety index is 0 (number N = infinity).

FIGURE 10.1

DIAGRAM OF THE RODS BOX



ANNEXE 11
CONTENT NO. 11
PWR TYPE 18 × 18 FUEL RODS

The safety analysis report justifying the authorised content is report DOS-18-016472-000 Rev. 5.0.
This content is loaded into a version 1 FCC4 packaging.

1. DEFINITION OF AUTHORISED RADIOACTIVE CONTENT

The authorised radioactive content, which are described in Chapter 1.3 of safety analysis report DOS-18-016472-005 Rev. 4.0, consist of new fuel rods for pressurised water reactors (PWR), as described below:

Characteristics of fuel rods	
Type of assembly array housing these rods	18 x 18
Maximum total mass per cavity (kg)	856
Maximum total mass of the rods per box (kg)	544
Maximum mass of UO_2 (kg)	430/box
Nominal active length (mm)	3,900
Maximum number of fuel rods per box	205
Cladding material	Zirconium alloy, possibly pre-oxidised, possibly chromium-plated
Minimum metal thickness (mm)	0.60
Minimum outer diameter (mm)	9.46
Pellets:	ENU (2)
Maximum diameter (mm)	8.08
Maximum oxide density (100% of the theoretical density)	10.96
Maximum initial enrichment ($^{235}U/U_{total}$) (%)	5
Maximum mass ratio $^{232}U/U_{total}$ (%)	$5x10^{-8}$
Maximum mass ratio $^{234}U/U_{total}$ (%)	0.055
Maximum mass ratio $^{236}U/U_{total}$ (%)	0.05
Minimum Gd_2O_3 mass content in gadolinium-carrying rods (%) (1)	2
Maximum absolute internal pressure of fuel rods at 20 °C (in bar)	32.7

(1) Fuel rods with a Gd_2O_3 content of less than 2% are considered as (non gadolinium-carrying) UO_2 fuel rods.

(2) ENU: Enriched Natural Uranium.

The mechanical strength properties of the fuel rod cladding material meet one of the following two triplets:

	1	2
$R_{p0.2}$ (MPa)	≥ 520	≥ 250
R_m (MPa)	≥ 710	≥ 400
A_t (% over 50 mm)	≥ 12	≥ 25

Maximum activity per packaging: The maximum activity of the contents is less than 1 A_2.

Physical state: Fuel rods composed of sintered pellets placed in a cladding. The cladding can be covered with a layer of chromium up to 30 µm thick.

Chemical form: Uranium oxide (UO_2) pellets and/or fuel pellets composed of a mixture of UO_2 and a body that acts as a neutron poison. The pellets may contain chromium oxide (but no other doping agents).

Special form: The material transported is not in any special form.

2. LOADING CONDITIONS

All fuel rods in a load meet the conditions defined in the following table:

Maximum initial enrichment of each fuel rod in the load ($^{235}U/U_{total}$)	Minimum number of fuel rods per box (1)
5 %	Full row of fuel or inert rods
(1) Incomplete rows of fuel rods are supplemented with solid stainless steel (or zirconium alloy) bars, with a nominal diameter of between 9.5 mm and 10 mm, possibly containing a neutron poison. The term "*number of rods per box*" is understood to mean the total number of fuel rods and steel (or zirconium alloy) bars.	

The presence of desiccant is permitted.

The presence of materials with more hydrogen content than water is not authorised within the packaging.

3. INTERNAL FITTINGS

The internal fitting is a rod box, which is described in Chapters 1.3-1 and 1.3-2 of the safety analysis report.

3.1 Rod box

The unassembled rods are grouped together in FCC4-type rod boxes, which are inserted in place of the assemblies inside the version 1 FCC4's.

The box is made of a folded U-shaped sheet, which is closed at the ends and reinforced by two members welded to the top of the sheet.

A system of axial and radial spacers is used to adapt to the lengths of the rods and to hold them in position. A diagram is provided in Figure 11.1.

The minimum height of the radial spacer is 85 mm.

3.2 Rod box spacers

A set of 2 spacers longitudinally holds the box in place in the cavity (a top spacer and a bottom spacer). A detailed description of the spacers can be found in Chapter 1.3-1 of the safety analysis report.

4. SUB-CRITICALITY CONTINUITY

Sub-criticality continuity is covered in Chapter 2.5-2 of the safety analysis report.

The "content" part of the isolation system under consideration comprises the following elements:

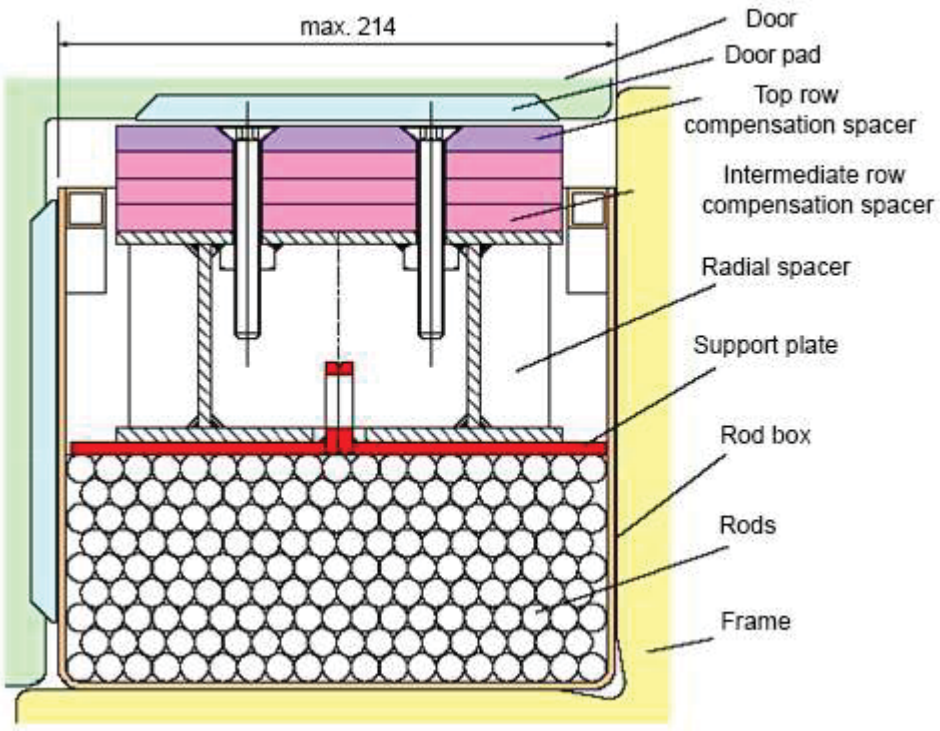
- the characteristics of the fuel rods as described in the table in Chapter 1 of this Appendix;
- the cladding tubes which guarantee the containment of the fissile material in an accident situation.

Criticality Safety Index (CSI):

- when UO_2 rods are transported, the criticality safety index is equal to 0 (number N = infinity);
- when UO_2-Gd_2O_3 rods are transported, the criticality safety index is 0 (number N = infinity).

FIGURE 11.1

DIAGRAM OF THE RODS BOX



ANNEXE 12
CONTENT NO. 12
EPR TYPE 17 X 17 FUEL ASSEMBLIES

The safety analysis report justifying the authorised content is report DOS-18-016472-000 Rev. 5.0.
This content is loaded into a version 1 FCC4 packaging.

1. DEFINITION OF AUTHORISED RADIOACTIVE CONTENT

The authorised radioactive content, which is described in Chapter 1.3 of safety analysis report DOS-18-016472-005 Rev. 4.0, is composed of:

- up to two new fuel assemblies as described below;
- or a new fuel assembly fitted with a cluster and a dummy assembly or a mock-up assembly, as described below:

Characteristics of the fuel assemblies	
Name	17 x 17, EPR type
Type of array	17 x 17
Nominal array pitch (mm)	12.6
Total maximum mass of a fuel assembly with or without a rod cluster (kg)	877
Maximum mass of UO_2 per assembly (kg)	681
Nominal active length (mm)	4,200
Maximum number of fuel rods	289 (1)
Characteristics of fuel rods	
Cladding material	Zirconium alloy, possibly pre-oxidised, possibly chromium-plated
Minimum metal thickness (mm)	0.52
Minimum outer diameter (mm)	9.40
Pellets:	ENU (2)
Maximum diameter (mm)	8.30
Maximum oxide density (100% of the theoretical density)	10.96
Maximum initial enrichment ($^{235}U/U_{total}$) (%)	5
Maximum mass ratio $^{232}U/U_{total}$ (%)	$5x10^{-8}$
Maximum mass ratio $^{234}U/U_{total}$ (%)	0.055
Maximum mass ratio $^{236}U/U_{total}$ (%)	0.05
Maximum absolute internal pressure of fuel rods at 20 °C (in bar)	32.7

(1) This number corresponds to the maximum number of fuel rods that can be inserted into a structure (assembly skeleton or quiver), including guide tubes.
(2) ENU: Enriched Natural Uranium.

Glycerine residues up to a maximum of 5 grams can be present on the fuel assemblies.

The mechanical strength properties of the fuel rod cladding material meet one of the following two triplets:

	1	2
$R_{p0.2}$ (MPa)	≥ 520	≥ 250
R_m (MPa)	≥ 710	≥ 400
A_t (% over 50 mm)	≥ 12	≥ 25

The mock-up assembly is composed of the same structural elements as an EPR fuel assembly, as described above, except that it contains tungsten carbide pellets instead of fuel pellets. Its maximum mass is 877 kg.

The smooth-walled dummy assembly and its radial spacers, which are described in Figure 12.1, are made of stainless steel. The maximum total mass of the smooth-walled dummy assembly and its spacers is 877 kg.

Maximum activity per packaging: The maximum activity of the contents is less than 1 A_2.

Physical state: For fuel assemblies, fuel rod assemblies consisting of sintered pellets placed in a cladding. The cladding can be covered with a layer of chromium up to 30 µm thick.

Chemical form: For fuel assemblies, uranium oxide (UO_2) pellets and/or fuel pellets composed of a mixture of UO_2 and a body that acts as a neutron poison.

The pellets may contain chromium oxide (but no other doping agents).

Special form: The material transported is not in any special form.

2. LOADING CONDITIONS

All assemblies in a load meet the conditions defined in the following table:

Maximum initial enrichment per fuel rod for each assembly in the load ($^{235}U/U_{total}$)	Minimum number of fuel rods per fuel assembly in the load (1)
5 %	265
(1) Incomplete UO_2 fuel rod assemblies can be supplemented with gadolinium-carrying rods, rods containing depleted uranium other metallic material, or bars filled with a metallic material (excluding graphite and beryllium), possibly containing a neutron poison. These supplementary rods or bars will be equivalent in size to the UO_2 rods. The expression "*number of rods per assembly*" is understood to mean the total number of fuel rods and replacement rods or bars.	

The presence of desiccant is permitted.

The presence of materials with more hydrogen content than water is not authorised within the packaging.

3. SUB-CRITICALITY CONTINUITY

Sub-criticality continuity is covered in Chapter 2.5-1 of the safety analysis report.

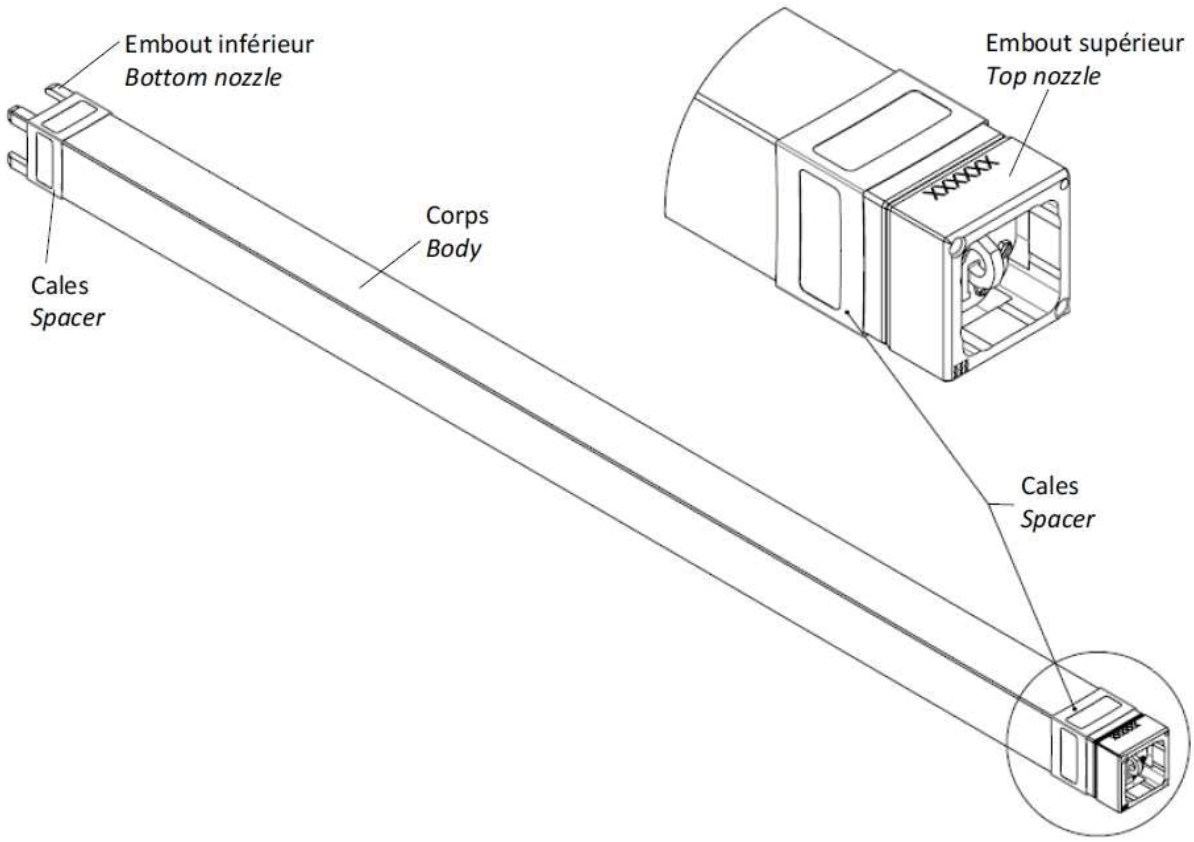
The isolation system under consideration comprises the following elements:

- the characteristics of the fuel assemblies as described in the Table in Chapter 1 of this Appendix;
- the cladding tubes which guarantee the containment of the fissile material in an accident situation;
- the structure of the assembly (grids, end-pieces).

Criticality Safety Index (CSI): 0.625 ("N" number = 80).

FIGURE 12.1

DIAGRAM OF DUMMY ASSEMBLY



ANNEXE 13
CONTENT NO. 13
EPR TYPE 17 X 17 FUEL RODS

The safety analysis report justifying the authorised content is report DOS-18-016472-000 Rev. 5.0.
This content is loaded into a version 1 FCC4 packaging.

1. DEFINITION OF AUTHORISED RADIOACTIVE CONTENT

The authorised radioactive content, which is described in Chapter 1.3 of safety analysis report DOS-18-016472-005 Rev. 4.0 is composed of new fuel rods, as described below:

Characteristics of fuel rods	
Name	17 x 17, EPR type
Type of assembly array housing these rods	17 x 17
Maximum total mass per cavity (kg)	856
Maximum total mass of the rods per box (kg)	537
Maximum mass of UO_2 (kg)	436/box
Nominal active length (mm)	4,200
Maximum number of fuel rods per box	185
Cladding material	Zirconium alloy, possibly pre-oxidised, possibly chromium-plated
Minimum metal thickness (mm)	0.52
Minimum outer diameter (mm)	9.40
Pellets:	ENU (2)
Maximum diameter (mm)	8.30
Maximum oxide density (100% of the theoretical density)	10.96
Maximum initial enrichment ($^{235}U/U_{total}$) (%)	5
Maximum mass ratio $^{232}U/U_{total}$ (%)	$5x10^{-8}$
Maximum mass ratio $^{234}U/U_{total}$ (%)	0.055
Maximum mass ratio $^{236}U/U_{total}$ (%)	0.05
Minimum Gd_2O_3 mass content in gadolinium-carrying rods (%) (1)	2
Maximum absolute internal pressure of fuel rods at 20 °C (in bar)	32.7

(1) Fuel rods with a Gd_2O_3 content of less than 2% are considered as (non gadolinium-carrying) UO_2 fuel rods.
(2) ENU: Enriched Natural Uranium.

The mechanical strength properties of the fuel rod cladding material meet one of the following two triplets:

	1	2
$R_{p0.2}$ (MPa)	≥ 520	≥ 250
R_m (MPa)	≥ 710	≥ 400
A_t (% over 50 mm)	≥ 12	≥ 25

Maximum activity per packaging: The maximum activity of the contents is less than 1 A_2.

Physical state: Fuel rods composed of sintered pellets placed in a cladding. The cladding can be covered with a layer of chromium up to 30 μm thick.

Chemical form: Uranium oxide (UO_2) pellets and/or fuel pellets composed of a mixture of UO_2 and a body that acts as a neutron poison. The pellets may contain chromium oxide (but no other doping agents).

Special form: The material transported is not in any special form.

2. LOADING CONDITIONS

All fuel rods in a load meet the conditions defined in the following table:

Maximum initial enrichment of each fuel rod in the load ($^{235}U/U_{total}$)	Minimum number of fuel rods per box (1)
5 %	Full row of fuel or inert rods
(1) Incomplete rows of fuel rods are supplemented with solid stainless steel (or zirconium alloy) bars, with a nominal diameter of between 9.5 mm and 10 mm, possibly containing a neutron poison. The term "*number of rods per box*" is understood to mean the total number of fuel rods and steel (or zirconium alloy) bars.	

The presence of desiccant is permitted.

The presence of materials with more hydrogen content than water is not authorised within the packaging.

3. INTERNAL FITTING

The internal fitting is a rod box, which is described in Chapters 1.3-1 and 1.3-2 of the safety analysis report.

The unassembled rods are grouped together in EPR-type rod boxes, which are inserted in place of the assemblies inside the version 1 FCC4's.

The box is made of a folded U-shaped sheet, which is closed at the ends and reinforced by two members welded to the top of the sheet.

A radial spacer system holds the rods in position. A diagram is provided in Figure 13.1.

The minimum height of the radial spacer is 85 mm.

4. SUB-CRITICALITY CONTINUITY

Sub-criticality continuity is covered in Chapter 2.5-2 of the safety analysis report.

The "content" part of the isolation system under consideration comprises the following elements:

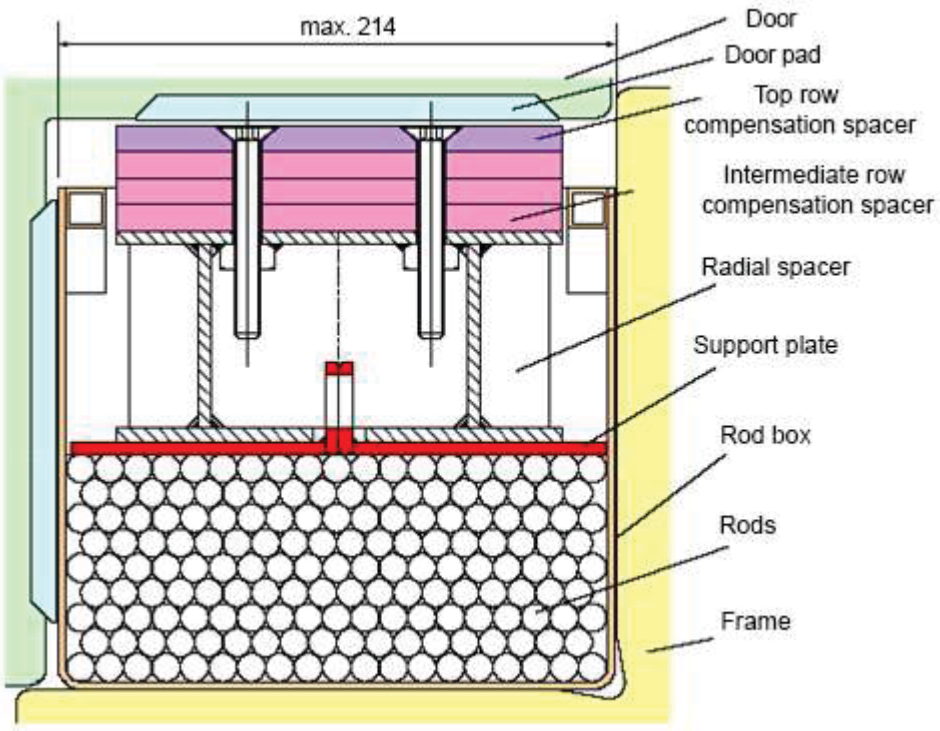
- the characteristics of the fuel rods as described in the table in Chapter 1 of this Appendix;
- the cladding tubes which guarantee the containment of the fissile material in an accident situation.

Criticality Safety Index (CSI):

- when UO_2 rods are transported, the criticality safety index is equal to 0 (number N = infinity);
- when UO_2-Gd_2O_3 rods are transported, the criticality safety index is 0 (number N = infinity).

FIGURE 13.1

DIAGRAM OF THE RODS BOX



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U.S. Department of
Transportation

**Pipeline and
Hazardous Materials
Safety Administration**

CERTIFICATE NUMBER: USA/0831/AF-96

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