U.S. Department of Transportation

Pipeline and Hazardous Materials Safety Administration

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

COMPETENT AUTHORITY CERTIFICATION FOR A TYPE FISSILE RADIOACTIVE MATERIALS PACKAGE DESIGN CERTIFICATE USA/0653/AF-96, REVISION 14

REVALIDATION OF FRENCH COMPETENT AUTHORITY CERTIFICATE F/381/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].

1. Package Identification - TNF-XI.

2. Package Description and Authorized Radioactive Contents - as described in French Certificate of Competent Authority F/381/AF-96 (En) dated March 17, 2022 (attached). Contents listed in Appendix 2 of French certificate shall be in of the type and form described in paragraph 2(a) of this certificate and are subject to the quantity restrictions of paragraphs 2.b.(i), 2.b.(ii) or 2.b.(iii) of this certificate. Contents shown in Appendix 7 of French certificate shall be subject to the quantity restrictions of paragraph 2.b.(iv) of this certificate. Contents shown in Appendix 8 and Appendix 9 are as described in French certificate. Content restrictions:

   a. Type and Form of Material: Uranium oxide pellets, powder and scrap as described below. In Tables 1, 2 and 3, "Homogeneous UO_2 powder" refers to powders, such as fine powder, when those materials have not been subjected to any treatment that would lead to agglomeration; in Tables 1 and 2, "Heterogeneous UO2 material" refers to heterogeneous materials, such as coarse powder, granulated powders, pellets, and scrap, when those materials do not meet the definition of homogeneous powders. In case of a mix of several forms of fissile material, the mix shall be considered heterogeneous material.

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[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.

b. Maximum quantity of material:

i) Uranium oxide pellets, powder, and scrap which meets the requirements of Enriched Commercial Grade Uranium, as defined in ASTM C996-10. U_3O_8 or $UO_{x,x>2}$ are authorized provided that the equivalent UO_2 mass is less than the limits specified in Table 1. For these contents there shall be no more than 25 kg of contents per pail and no more than 300 kg of contents per package. Presence of hydrogenated materials (with a hydrogen concentration less than hydrogen concentration in water) or water inside cavities and pails is allowed. The auto-ignition temperature of the hydrogenated materials (with a hydrogen concentration less than hydrogen concentration in water) shall be greater than 140°C (284°F). The presence of materials containing more hydrogen than water is not allowed in the package.

ii) Uranium oxide pellets, powder, and scrap which meets the requirements of Enriched Commercial Grade Uranium, as defined in ASTM C996-10. U_3O_8 or $UO_{x,x>2}$ are authorized provided that the equivalent UO_2 mass is less than the limits specified in Table 2. For these contents, there shall be no more than 25 kg of contents per pail and no more than 300 kg of contents per package. In each pail, the contents can be put in a polyethylene bag (CH_2) or in a bag made of a material with a hydrogen concentration less than that of polyethylene. The maximum hydrogen content of the bags within each cavity is a mass of 56 g H, which is equivalent to a maximum mass of 390 g polyethylene, considering all sources of hydrogenous material within each cavity. The auto-ignition temperature of the bag material shall be greater than 140°C (284°F). The presence of materials containing more hydrogen than polyethylene is not allowed in the package.

iii) Uranium oxide powder scrap, which may contain impurities, and meets the requirements of Enriched Commercial Grade Uranium, as defined in ASTM C996-10. The impurities aluminum and carbon shall not exceed 5,000 ppm and 10,000 ppm, respectively. U_3O_8 or $UO_{x,x>2}$ are authorized provided that the equivalent UO_2 mass is less than the limits specified in Table 3. For these contents there shall be no more than 25 kg of uranium oxide powder scrap contents per pail and no more than 300 kg of uranium oxide powder scrap contents per package. In each pail, the contents can be put in a polyethylene bag (CH_2) or in a bag made of a material with a hydrogen concentration less than that of polyethylene. The maximum hydrogen content of the bags within each cavity is a mass of 56 g H, which is equivalent to a maximum mass of 390 g polyethylene, considering all sources of hydrogenous material within each cavity. The auto-ignition temperature of the bag material shall be greater than 140°C (284°F). The presence of materials containing more hydrogen than polyethylene is not allowed in the package.

iv) Uranium oxides in the form of powder and scraps, enriched up to a maximum of 5.0 wt.% U-235, may be mixed with residues consisting of incinerator ashes or earth, sand and residues from dissolution, as described in Appendix 7. U_3O_8 or $UO_{x,x>2}$, non-irradiated, are authorized when the uranium mass is less than 5 kg per well (each well containing three pails), or equivalent UO_2 mass less than 5.68 kg per well (each well containing three pails). For these contents there shall be no more than 75 kg of uranium oxide powder and scraps mixed with residues, consisting of incinerator ashes or earth, sand and residues from dissolution, contents per well. No more than 300 kg uranium oxide powder and scraps mixed with residues, consisting of incinerator ashes or earth, sand and residues from dissolution, contents per package. The incinerator ashes consist of mainly silica, alumina, alumina-silicates, metal oxides, phosphates, aluminum metal, charred wood, and charred plastic. The earth, sand and dissolved residues consist of mainly silica, alumina, titanium, iron oxide and alumina-silicate. Other organic or inorganic compounds may be present in the form of trace amounts. The residues are chemically stable and contain no liquid. The radioactive material may be placed in plastic bags made of a material with a hydrogen concentration less than that of polyethylene. The auto-ignition temperature of the bag material shall be greater than 140°C (284°F}. The presence of material containing more hydrogen than polyethylene is not allowed in the package. The presence of material containing beryllium is not allowed in the package.

CERTIFICATE USA/0653/AF-96, REVISION 14

Table 1

Max ^{235}U Enrichment (weight %)	Homogeneous UO_2 Powder Maximum Loading (kg)	Heterogeneous UO_2 Material (Pellet and Scrap) Maximum Loading (kg)
$\leq$ 4.05	300	300
4.1	300	293
4.15	300	287
4.25	300	271
4.35	300	259
4.45	300	247
4.55	294	238
4.65	281	228
4.75	265	219
4.85	255	208
4.95	244	202
5.0	239	197

Table 2

Max ^{235}U Enrichment (weight %)	Homogeneous UO_2 Powder Maximum Loading (kg)	Heterogeneous UO_2 Material (Pellet and Scrap) Maximum Loading (kg)
$\leq$ 4.05	300	300
4.15	300	284
4.25	300	271
4.35	300	256
4.45	300	247
4.55	286	236
4.65	271	224
4.75	259	216
4.85	248	208
4.95	238	202
5.0	232	196

Table 3

Max ^{235}U Enrichment (weight %)	Homogenous UO_2 Powder Maximum Loading (kg)
≤ 4.05	300
4.15	300
4.25	300
4.35	300
4.45	300
4.55	286
4.65	271
4.75	259
4.85	248
4.95	238
5.0	232

3. Criticality - The minimum criticality safety index is 0.5 for contents described in Appendix 2 of the French certificate subject to type and form requirements of paragraph 2.a and quantity limitations of 2.b.(i), 2.b.(ii) or 2.b.(iii). The minimum criticality safety index is 0.0 for contents described in Appendix 9. 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 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. The package design must be in agreement with Chapter 0, "Description of the TNF-XI Packaging Model," Document No. DOS-19-022728-001, Revision 2.

b. The package must be prepared for shipment and operated in accordance with Chapter 6A, "Typical Operating Instructions of the Packaging," Document No. DOS-19-022728-012, Revision 2; and Chapter 7A, "Acceptance Test and Maintenance Program," Document No. DOS-19-022728-003, Revision 1;

c. The package must be maintained and operated in accordance with Chapter 8A, "Quality Assurance Applicable to TNF-XI Package Model," Document No. DOS-19-022728-013, Revision 1, of the application.

d. The package must be fabricated in accordance with Design Drawing No. 12986-001, Revision K.

e. The minimum thermal conductivity of the stainless-steel material (i.e., entry X2 Cr Ni 18-9 in Table 0.2, Chapter 0, "Description of the TNF-XI Packaging Model," Document No. DOS-06-00037028-004, Revision 5) shall be 14.8 $W \cdot m^{-1} \cdot K^{-1}$ at 20°C.

f. Transport by air is not authorized.

6. Marking and Labeling - The package shall bear the marking USA/0653/AF-96 in addition to other required markings and labeling.

7. Expiration Date - This certificate expires on December 31, 2026. Previous revisions may continue to be used up to their expiration date.

CERTIFICATE USA/0653/AF-96, REVISION 14

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 June 14, 2022 petition by TN Americas LLC, Columbia, MD, and in consideration of other information on file in this Office.

Certified By:

William Schoonover
Associate Administrator for Hazardous Materials Safety

December 07, 2022
(DATE)

Revision 14 - Issued to revalidate French Certificate of Approval No. F/381/AF-96 (En) dated March 17, 2022 with contents as described in Appendices 2, 7, 8 and 9. Description of Type and Form of Approved Material and quantity limits identified in previous revisions of this certificate are included in this certificate and remain in effect.

AUTORITÉ DE SÛRETÉ NUCLÉAIRE
Direction du transport et des sources

APPROVAL CERTIFICATE FOR A PACKAGE DESIGN

The Competent French Authority,

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

Having regard to the request presented by Orano Nuclear Packages and Services (NPS) by letter COR-21-000208-066 dated 07 December 2021;

Having regard to the Orano NPS Safety Analysis Report reference DOS-19-022728-000 Version 3.0 of 06 December 2021,

Hereby certifies that the package design consisting of the **TNF-XI** packaging described hereafter in Appendix 0, revision n and loaded with:

- unirradiated uranium oxides enriched to a maximum ^{235}U content of 5% by mass, as described in Appendix 2, revision n;
- unirradiated uranium oxides enriched to a maximum ^{235}U content of 5% by mass, as described in Appendix 7, revision n;
- uranium in the form of oxides of uranyl nitrate, sodium diuranate or ammonium diuranate, mixed with residues, as described in Appendix 8, revision n;
- unirradiated uranium oxides enriched to a maximum ^{235}U content of 5% by mass, as described in Appendix 9, revision n;

is compliant, as a **type A package design loaded with fissile materials**, with the requirements of 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, 2012 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);
- Order of 23 November 1987, as amended, concerning the Safety of Ships, division 411 of the attached regulation (the “RSN order”);
- Order of 29 May 2009, as amended, concerning the Overland Carriage of Dangerous Goods (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 will be transported.

This certificate expires on 31 December 2026.

Registration number: **CODEP-DTS-2021-060240**

Signed in Montrouge, 17 March 2022

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

Fabien FÉRON

SUMMARY OF CERTIFICATE ISSUES

Issue date	Expiry date	Type of issue	Certificate number	Revision											
				body	t	0	1	2	3	4	5	6	7	8	9
10/10/2011	31/12/2016	Renewal	AF-96	Cf	-	f	f	f	-	-	-	-	-	-	-
10/10/2011	31/12/2016	Renewal	IF-96	Cg	-	g	-	-	g	g	-	-	-	-	-
11/08/2014	31/12/2016	Extension	AF-96	Ch	-	h	-	-	-	-	-	h	-	-	-
06/09/2016	31/12/2021	Renewal and extension	AF-96	Di	-	i	-	i	-	-	-	-	i	-	-
06/09/2016	31/12/2021	Renewal	IF-96	Dj	-	j	-	-	-	j	-	-	-	-	-
09/04/2018	31/12/2021	Extension	AF-96	Dk	-	k	-	-	-	-	-	-	-	k	-
~~25/06/2021~~	~~31/12/2026~~	~~Renewal and extension~~ (cancelled)	~~AF-96~~	~~El~~	~~-~~	~~l~~	~~-~~	~~l~~	~~-~~	~~-~~	~~-~~	~~-~~	~~l~~	~~l~~	~~l~~
~~25/06/2021~~	~~31/12/2026~~	~~Renewal~~ (cancelled)	~~IF-96~~	~~Em~~	~~-~~	~~m~~	~~-~~	~~-~~	~~-~~	~~m~~	~~-~~	~~-~~	~~-~~	~~-~~	~~-~~
06/07/2021	31/12/2026	Renewal and extension	AF-96	El	-	l	-	l	-	-	-	-	l	l	l
06/07/2021	31/12/2026	Renewal	IF-96	Em	-	m	-	-	-	m	-	-	-	-	-
17/03/2022	31/12/2026	Extension	AF-96	En	-	n	-	n	-	-	-	-	n	n	n

APPENDIX 0
TNF-XI PACKAGING

1. PACKAGING DESCRIPTION

The TNF-XI packaging was designed, manufactured, inspected, tested, maintained and used in compliance with the Orano NPS Safety Analysis Report DOS-19-022728-000 Version 3.0 of 06 December 2021.

The generally parallelepiped packaging is presented in Figure 0.1. The packaging design drawing is in drawing COGEMA LOGISTICS 12986-01 Rev. K.

The overall external dimensions of the packaging are:

- 1,040 mm high;
- 1,100 × 1,100 mm (nominal dimension) cross-section.

The mass of the empty packaging is 660 kg ± 10 kg.

The maximum permissible mass of the loaded packaging during transport is 1,050 kg.

The packaging is made up of the main sub-assemblies described below.

1.1 Body

The packaging body comprises a steel, parallelepiped external casing and four cylindrical internal enclosures, made of stainless steel, separated by shock-absorbing and insulating phenolic foam.

Each internal enclosure comprises two shells separated by a neutron-absorbing resin and a flat bottom welded to these shells.

The cavity of each enclosure holds three pails containing the radioactive material.

1.2 Closing system

Each internal enclosure is closed by a primary lid equipped with an elastomer gasket. A bayonet system located on the internal side of the primary lid is used to close the internal enclosure on the flange.

The primary lid is protected by a top plug made up of a stack of discs surrounded by a thin steel casing. A bayonet system located on the top side of the plug is used to fasten the plug on the flange of the packaging body. Sealing between the top plug and the packaging body is ensured by a gasket.

The primary lid and its closing system, including the top plug, are made of stainless steel.

1.3 Handling elements

The underside of the packaging is equipped with steel forklift slots for handling.

2. SAFETY FUNCTIONS

Containment is provided by:

- the four internal enclosures,
- the four primary lids and their gasket,
- the pails and the plastic bags described in Appendices 2, 7, 8 and 9.

Radiological protection is provided mainly by:

- the neutron-absorbing resin between the shells of each internal enclosure,

- the phenolic foam in the packaging body,
- the steel and borated steel plates present in the primary lids, internal enclosures, top plugs and packaging body.

Sub-criticality continuity is provided by the isolation system, which is made up of the elements described in Chapter 5A of the Safety Analysis Report.

Shock protection is mainly provided by the phenolic foam in the packaging body.

Fire protection is provided chiefly by the phenolic foam.

3. SERVICING PROGRAMME

The packaging is maintained in accordance with the servicing programme described in Chapter 7A of the Safety Analysis Report.

4. NOTIFICATION

The ASN is kept informed, at the following email address: dts-transport@asn.fr, of any packaging that is taken out of service or transferred to another owner. For that purpose, any owner who transfers a packaging provides the name of the new owner.

5. QUALITY MANAGEMENT SYSTEM

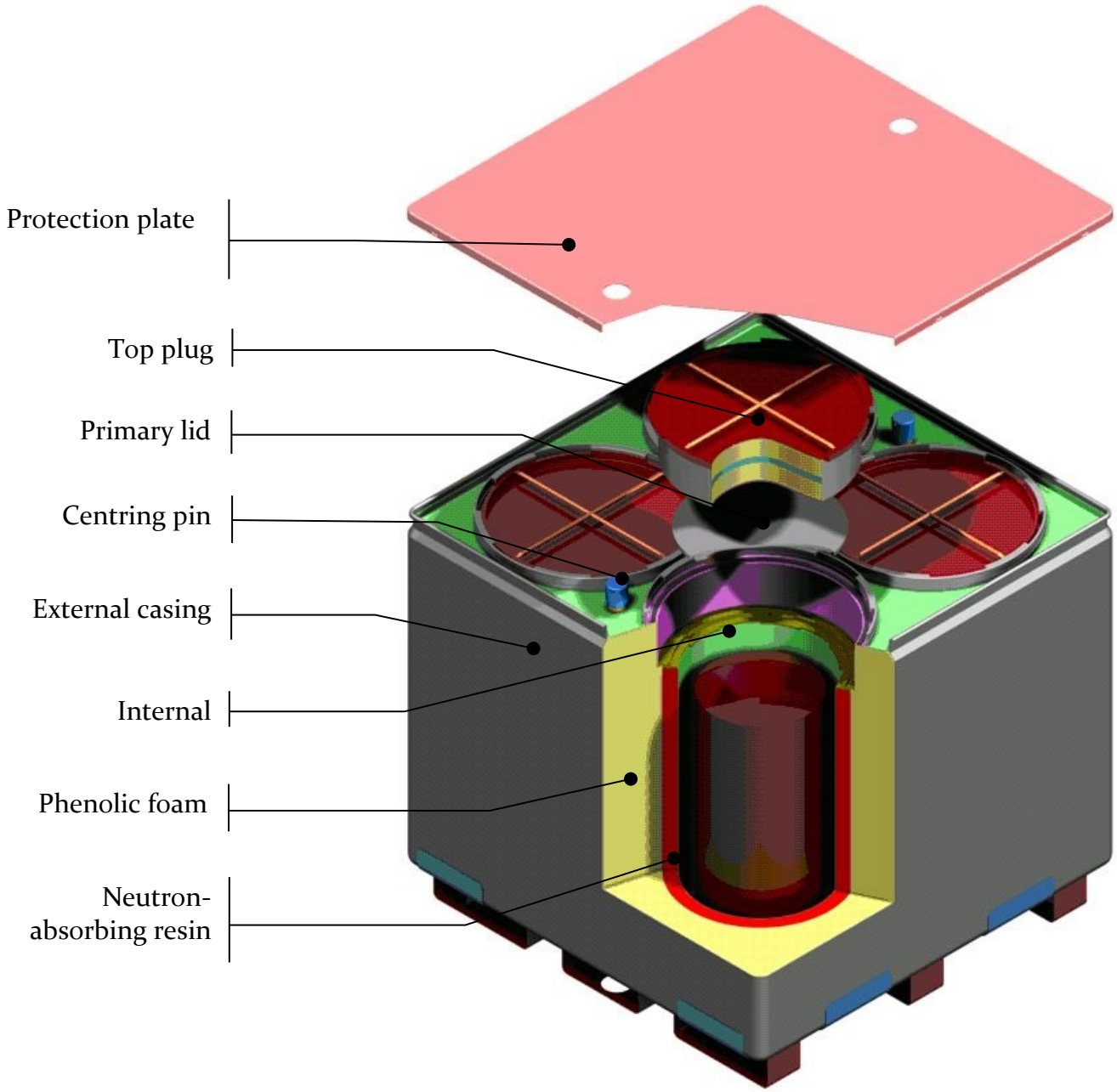
The quality management system principles applied during the design, manufacture, inspection, testing, maintenance and use of the package are consistent with those described in Chapter 8A of the Safety Analysis Report.

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

The packaging is used according to procedures consistent with the instructions for use in Chapter 6A of the Safety Analysis Report.

The closure of the pails is visually inspected before they are loaded in the internal enclosures of the packaging.

FIGURE 0.1
PACKAGING DIAGRAM



APPENDIX 2
URANIUM OXIDES (UO_2, UO_3 or U_3O_8)

The authorised radioactive content is described in the Orano NPS Safety Analysis Report DOS-19-022728-000 Version 3.0 dated 06 December 2021.

1. DEFINITION OF AUTHORISED CONTENT

1.1 Physical form

The radioactive content is made up of uranium oxides (UO_2, UO_3 or U_3O_8) in powder, pellet or fragment form.

1.2 Isotopic composition and maximum permissible masses

The maximum permissible mass of uranium oxide per cavity (divided into three pails) of the packaging is defined by the maximum enrichment rate of the ^{235}U content, its physical form and its density, as shown below:

Physical form		**UO_2, UO_3, U_3O_8 (no pellets allowed)**	**UO_2, UO_3, U_3O_8 (pellets allowed)**
Maximum density		4 g/cm³	10.96 g/cm³
Maximum enrichment by mass of the cavity (e = $^{235}U/U_{tot}$)	4.15%	75.0 kg	60.0 kg
	4.45%	64.5 kg	39.5 kg
	4.65%	58.5 kg	
	4.85%	53.5 kg	
	4.95%	51.5 kg	
	5%	50.0 kg	

The content may contain additives. The mass of additives with a greater hydrogen content than water is limited to 390 g.

The powder may contain impurities. The impurities do not exceed the limits below:

Impurity	**Maximum content (ppm)**
Aluminium	5,000
Carbon	10,000
Sum of C, Al, Ca, Mg, Cl, Co, Cu, F, N, P, Si, Ta, Sn, V, Fe, Cr, Ni impurities	30,000

Other impurities do not exceed the limits in table 1 of standard ASTM C753 – 16.a published on 01/04/2016.

The radioactive content meets the definition of "*unirradiated uranium*" given in Article 246 of the above-mentioned Regulations for the Safe Transport of Radioactive Material No. SSR-6.

The total mass of the content (pails, shimming system, bags and radioactive material) in all the cavities does not exceed 386 kg, without causing the maximum permissible mass of the packaging loaded for transport, laid down in Appendix 0, to be exceeded.

2. PACKING

The material is placed in two bags (one inside the other) made of materials that may have a greater hydrogen content than water. Each bag is closed.

The bagged material is placed in internal primary containers, which are the pails (three for each of the four cavities) meeting the criteria in the table below.

Each pail is fitted with a ring, the characteristics of which are set out in the table below.

Part	Position in packaging	Material	Nominal external diameter (mm)	Nominal height (mm)	Minimum thickness (mm)
Pail	Vertical	Stainless steel	287.4	Internal: 205	1
Ring	/	Borated steel (minimum boron concentration by mass: 1%)	$280 \leq x \leq 285$	≥ 180	2

From 1 December 2022 at the latest, each cavity shall have a shimming system consisting of:

- a centring shim placed at the bottom of the cavity,
- one or more top shim(s) placed on top of the three pails to provide less than 10 mm of clearance between the content and the closing system of the packaging.

3. SUB-CRITICALITY CONTINUITY STUDY

The sub-criticality continuity study is covered in Chapters 5A and 5A-4 of the Safety Analysis Report.

The isolation system used is described in Chapter 5A of the Safety Analysis Report.

The criticality safety index (CSI) is 0.

APPENDIX 7
URANIUM OXIDES (UO_2, UO_3 OR U_3O_8)

The authorised radioactive content is described in the Orano NPS Safety Analysis Report DOS-19-022728-000 Version 3.0 dated 06 December 2021.

4. DEFINITION OF AUTHORISED CONTENT

4.1 Physical form

The radioactive content is made up of uranium oxides (UO_2, UO_3 or U_3O_8) in powder or fragment form, mixed with solid residues from incineration or residues of earth, sand and dissolution.
The residues from incineration are mainly made up of silica, alumina, aluminosilicate, metal oxides, phosphates, aluminium, wood or plastic.

The earth, sand and dissolution residues are mainly made up of silica, alumina, titanium oxide, iron oxide and aluminosilicate. Other organic or inorganic compounds may be present in the form of traces.

4.2 Isotopic composition and maximum permissible masses

The maximum permissible mass of uranium per cavity (divided among three pails) of the packaging is limited to 5 kg. The ^{235}U enrichment by mass is limited to 5%.
The total mass of uranium oxides and residues per cavity does not exceed 75 kg.

The radioactive content meets the definition of "*unirradiated uranium*" given in Article 246 of the above-mentioned Regulations for the Safe Transport of Radioactive Material No. SSR-6.

The total mass of the content (pails, shimming system, bags and radioactive material) in all the cavities does not exceed 386 kg, without causing the maximum permissible mass of the packaging loaded for transport, laid down in Appendix 0, to be exceeded.

5. PACKING

The material is placed in two bags (one inside the other) made of materials that may have a greater hydrogen content than water. Each bag is closed. The bagged material is placed in internal primary containers, which are the pails (three for each of the four cavities) meeting the criteria in the table below.

Each pail is fitted with a ring, the characteristics of which are set out in the table below.

Part	Position in packaging	Material	Nominal external diameter (mm)	Nominal height (mm)	Minimum thickness (mm)
Pail	Vertical	Stainless steel	287.4	/	1
Ring	/	Steel, possibly borated	$280 \leq x \leq 285$	≥ 180	2

From 1 December 2022 at the latest, each cavity shall have a shimming system consisting of:

- a centring shim placed at the bottom of the cavity,
- one or more top shim(s) placed on top of the three pails to provide less than 10 mm of clearance between the content and the closing system of the packaging.

6. SUB-CRITICALITY CONTINUITY STUDY

The sub-criticality continuity study is covered in Chapters 5A and 5A-6 of the Safety Analysis Report.
The isolation system used is described in Chapter 5A of the Safety Analysis Report.
The criticality safety index (CSI) is 0.

APPENDIX 8
URANIUM IN THE FORM OF OXIDES OF URANYL NITRATE, SODIUM DIURANATE OR AMMONIUM DIURANATE, MIXED WITH RESIDUES

1. DEFINITION OF AUTHORISED CONTENT

The authorised radioactive content is described in the Orano NPS Safety Analysis Report DOS-19-022728-000 Version 3.0 dated 06 December 2021.

1.1 Physical form and nature

The radioactive content is made up of uranium in the form of oxides of uranyl nitrate, sodium diuranate or ammonium diuranate. These uranium-bearing complexes, in solid form, are mixed with residues, which are:

- inorganic residues: oxides and metal precipitates, glass or mineral complexes. These residues are mainly made up of:
  - calcined filtering substrate (calcined silicon dioxide, aluminium oxide, aluminosilicate), with small quantities of iron and gadolinium oxides, or
  - calcium and aluminium fluoride, or
  - sodium nitrate and gadolinium (hydr)oxides, or
  - glass, or
  - glass wool or rock wool, or
  - concrete and cement, or
  - plaster, or
  - aluminium oxides and brick;
- or organic residues, mainly composed of:
  - polyethylene resin loaded or not with carbon black, or
  - polyvinyl chloride loaded or not with carbon black, or
  - rubber;
- or organic and inorganic residues mainly composed of aluminium in the form of fine sheets, kraft paper and composite fibres (synthetic fibres or glass fibres).

Other organic or inorganic compounds may be present in the form of traces.

Only aluminium fluoride and sodium nitrate, as defined by UN 1759 and 1498 respectively, are authorised as non-radioactive dangerous substances. The quantity of these materials per cavity does not exceed:

- 1 kg for aluminium fluoride classified in group II;
- 5 kg for sodium nitrate and aluminium fluoride classified in group III.

The aluminium is not in powder form.

So as not to damage the pails, the radioactive content does not have sharp points or shapes if it is made of a material as strong as or stronger than the steel of the pails. More generally, when loading, a visual inspection is carried out to ensure there are no protruding parts that could damage the pails.

At temperatures of 100°C or less, the content does not interact with the materials of the packing bags, pails, shimming system, internal enclosure and primary lid gasket.

1.2 Isotopic composition and maximum permissible masses

The radioactive content meets the definition of "*unirradiated uranium*" given in Article 246 of the above-mentioned Regulations for the Safe Transport of Radioactive Material No. SSR-6.

The maximum permissible mass of uranium, in all the possible forms listed in section 1.1, is limited per internal enclosure (for all three pails) of the packaging, to:

- 5 kg for a ^{235}U enrichment by mass of 5% or less;
- 0.5 kg for a ^{235}U enrichment by mass of strictly more than 5% and less than or equal to 20%.

In the case of a mixture of both types of enrichments in one package, the more restrictive maximum permissible mass of uranium is applied.

The maximum permissible mass of uranium and residues per internal enclosure is limited to 75 kg.

The total mass of the content (pails, shimming system, bags and radioactive material) in all the cavities does not exceed 386 kg, without causing the maximum permissible mass of the packaging loaded for transport, laid down in Appendix 0, to be exceeded.

2. PACKING

The material is placed in two bags (one inside the other) made of materials that may have a greater hydrogen content than water. Each bag is closed. The bagged material is placed in internal primary containers, which are the pails (three for each of the four cavities) meeting the criteria in the table below.

Each pail is fitted with a ring, the characteristics of which are set out in the table below.

Part	Position in packaging	Material	Nominal external diameter (mm)	Nominal height (mm)	Minimum thickness (mm)
Pail	Vertical	Stainless steel	287.4	/	1
Ring	/	Steel, possibly borated	$280 \leq x \leq 285$	≥ 180	2

From 1 December 2022 at the latest, each cavity shall have a shimming system consisting of:

- a centring shim placed at the bottom of the cavity,
- one or more top shim(s) placed on top of the three pails to provide less than 10 mm of clearance between the content and the closing system of the packaging.

3. SUB-CRITICALITY CONTINUITY STUDY

The sub-criticality continuity study is covered in Chapters 5A and 5A-6 of the Safety Analysis Report.

The isolation system used is described in Chapter 5A of the Safety Analysis Report.

The criticality safety index (CSI) is 0.

APPENDIX 9
URANIUM OXIDES (UO_2, UO_3 OR U_3O_8)

1. DEFINITION OF AUTHORISED CONTENT

The authorised radioactive content is described in the Orano NPS Safety Analysis Report DOS-19-022728-000 Version 3.0 dated 06 December 2021.

1.1 Physical form:

The radioactive content is made up of uranium oxides (UO_2, UO_3 or U_3O_8) in powder, pellet or fragment form.

1.2 Isotopic composition and maximum permissible masses

The radioactive content may contain gadolinium and erbium in unlimited quantities.

1.2.1 Uranium oxides, additives and impurities

The maximum permissible mass of uranium oxides per cavity (divided into three pails) of the packaging is defined by the maximum enrichment rate of the ^{235}U, its physical form and its density, as shown in one of the scenarios (A and B) below:

Scenario A:

Physical form		**UO_2, UO_3, U_3O_8 (no pellets allowed)**	**UO_2, UO_3, U_3O_8 (pellets allowed)**
Maximum density		4 g/cm³	10.96 g/cm³
Maximum enrichment by mass of the cavity ($e = {}^{235}U/U_{tot}$)	4.15%	75.0 kg	60.0 kg
	4.45%	64.5 kg	39.5 kg
	4.65%	58.5 kg	
	4.85%	53.5 kg	
	4.95%	51.5 kg	
	5%	50.0 kg	

The content may contain additives. The mass of additives with a greater hydrogen content than water does not exceed 390 g.

The powder may contain impurities. The impurities do not exceed the limits below:

Impurity	**Maximum content (ppm)**
Aluminium	5,000
Carbon	10,000
Sum of C, Al, Ca, Mg, Cl, Co, Cu, F, N, P, Si, Ta, Sn, V, Fe, Cr, Ni impurities	30,000

Other impurities do not exceed the limits in table 1 of standard ASTM C753 – 16.a published on 01/04/2016.

Scenario B:

Physical form		**UO_2, UO_3, U_3O_8 (no pellets allowed)**
Maximum density		4 g/cm³
Maximum enrichment by mass of the cavity ($e = {}^{235}U/U_{tot}$)	4.15%	75.0 kg
	4.55%	66.0 kg
	5%	46.0 kg

The content may contain additives. The mass of additives with a greater hydrogen content than water is limited to 1,620 g.

The powder may contain impurities. The impurities do not exceed the limits below.

Impurity	**Maximum content (ppm)**
Aluminium	5,000
Carbon	17,000
Zinc	5,000
Sum of C, Al, Ca, Mg, Cl, Co, Cu, F, N, P, Si, Ta, Sn, V, Fe, Cr and Ni impurities	30,000

Other impurities do not exceed the limits in table 1 of standard ASTM C753 – 16.a published on 01/04/2016.

In both Scenario A and Scenario B, the radioactive content meets the definition of "*unirradiated uranium*" given in Article 246 of the above-mentioned Regulations for the Safe Transport of Radioactive Material No. SSR-6.

1.2.2 Consideration of the nature of the material used to make the bags

If the plastic bags (see 2. below) are made of a plastic with a greater hydrogen content than water, their mass must be included in the verification of the criterion described in §1.2.1 for the mass of materials with a greater hydrogen content than water.

1.2.3 Mass per internal enclosure

The total mass of the content (pails, shimming system, bags and radioactive material) in all the cavities does not exceed 386 kg, without causing the maximum permissible mass of the packaging loaded for transport, laid down in Appendix 0, to be exceeded.

2. PACKING

The material is placed in two bags (one inside the other) made of materials that may have a greater hydrogen content than water. Each bag is closed. The bagged material is placed in internal primary containers, which are the pails (three for each of the four cavities) meeting the criteria in the table below.

Each pail is fitted with a ring, the characteristics of which are set out in the table below.

Part	Position in packaging	Material	Nominal external diameter (mm)	Nominal height (mm)	Minimum thickness (mm)
Pail	Vertical	Stainless steel	287.4	Internal: 205	1
Ring	/	Borated steel (minimum boron concentration by mass: 1%)	$280 \leq x \leq 285$	≥ 180	2

From 1 December 2022 at the latest, each cavity shall have a shimming system consisting of:

- a centring shim placed at the bottom of the cavity,
- one or more top shim(s) placed on top of the three pails to provide less than 10 mm of clearance between the content and the closing system of the packaging.

3. SUB-CRITICALITY CONTINUITY STUDY

The sub-criticality continuity study is covered in Chapters 5A, 5A-4 and 5A-7 of the Safety Analysis Report.

The isolation system used is described in Chapter 5A of the Safety Analysis Report.

The criticality safety index (CSI) is 0.

U.S. Department of
Transportation

**Pipeline and
Hazardous Materials
Safety Administration**

**East Building, PHH-23
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CERTIFICATE NUMBER: USA/0653/AF-96

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