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 B(U)F FISSILE RADIOACTIVE MATERIALS PACKAGE DESIGN CERTIFICATE USA/0492/B(U)F-96, REVISION 20

REVALIDATION OF FRENCH COMPETENT AUTHORITY CERTIFICATE F/313/B(U)F-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 B(U)F package as prescribed in the regulations of the International Atomic Energy Agency[1] and the United States of America[2].

1. Package Identification - TN-BGC1.

2. Package Description and Authorized Radioactive Contents - as described in French Certificate of Competent Authority F/313/B(U)F-96, Revision Lbj (attached). Contents are restricted to:

   a. Solid non-irradiated uranium bearing materials contained within a TN-90 secondary conditioning container as described in French Certificate of Approval No. F/313/B(U)F-96(Lbj), Appendix 11, Content No. 11 (attached), except that Content 11h is not authorized.

   b. Non-irradiated TRIGA fuel elements as described in French Certificate of Approval No. F/313/B(U)F-96(Lbj), Appendix 26, Content No. 26 (attached).

3. Criticality - The minimum criticality safety index is 1.0 for Content No. 11 and 0 for Content No. 26. The maximum number of packages per conveyance is determined in accordance with Table 11 of the IAEA regulations cited in this certificate.

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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.

CERTIFICATE USA/0492/B(U)F-96, REVISION 20

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. This certificate provides no relief from the limitations for transportation of plutonium by air in the United States as cited in the regulations of the U.S. Nuclear Regulatory Commission 10 CFR 71.88.

e. 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. Content No. 11h is prohibited.

b. For Content Nos. 11a thru 11g transported by land, the maximum mass of uranium, the maximum enrichment in uranium-235, the allowable containment diameter and the presence of hydrogen-bearing materials having a hydrogen content greater than water shall be as allowed in French Package Design Certificate No. F/313/B(U)F-96.

c. For Content Nos. 11a thru 11g, the transport of reprocessed uranium is prohibited.

d. For Content Nos. 11a thru 11g, the transport of uranium carbides and uranium nitrides is prohibited.

CERTIFICATE USA/0492/B(U)F-96, REVISION 20

e. For Content Nos. 11a thru 11g, the mass of water and the equivalent mass of other hydrogenous materials must not exceed 2000 grams per package.

f. For Content Nos. 11a thru 11g, the maximum allowable fissile mass is 5 kg when transported by air.

g. For Content No. 26, the maximum number of TRIGA fuel elements per package is not to exceed 5 standard elements or 23 thin elements, where standard and thin elements are defined in F/313/B(U)F-96 26bj, Appendix 26, Content No. 26. The total mass of cardboard must not exceed 1200 grams, the moisture content of the wood components must not exceed 10 percent, and the total water content (including moisture content of the wood and water equivalent in the form of cardboard) must not exceed 2900 grams per package. No other hydrogenous packaging materials are permitted within the package containment vessel.

6. Marking and Labeling - The package shall bear the marking USA/0492/B(U)F-96 in addition to other required markings and labeling.

7. Expiration Date - This certificate expires on March 1, 2024. Previous editions which have not reached their expiration date may continue to be used.

This certificate is issued in accordance with paragraph(s) 810 and 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 May 23, 2019 petition by TN Americas LLC, Columbia, MD, and in consideration of other information on file in this Office.

Certified By:

for William Schoonover
Associate Administrator for Hazardous Materials Safety

June 13, 2019
(DATE)

CERTIFICATE USA/0492/B(U)F-96, REVISION 20

Revision 20 - Issued to revalidate French Certificate of Competent Authority F/313/B(U)F-96, Revision Lbj, restricted to contents 11a, 11b, 11c, 11d, 11e, 11f, 11g and 26, subject to special conditions listed in paragraph 5.

AUTORITÉ DE SÛRETÉ NUCLÉAIRE

DEPARTMENT OF INDUSTRIAL ACTIVITIES AND TRANSPORT

APPROVAL CERTIFICATE FOR A PACKAGE DESIGN

La traduction du français vers l'anglais a été réalisée et contrôlée par la société de traduction et d'interprétation Caupenne & Co
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The French Governing Authority,

Considering the request presented by the **Commissariat for Atomic Energy and Alternative Energies** by the letter CEA DPSN DIR 2017-437 of November 20, 2017, and the letter CEA DSSN/DIR/2018/632 of November 30, 2018;

and in light of safety analysis report CEA DSN/STMR/LEPE/TNBGC1 DSEM 0600 Ed. 05 dated 16 November 2018,

Certifies that the package model constituted by the **TN-BGC 1** packaging described below in appendix 0, index bj, and loaded with one of the following contents:

- rods or sections of rods or pellets of uranium oxide, as described in Appendix 7, index bj;
- solid uranium materials, as described in Appendix 11, index bj;
- TRIGA fuel, as described in Appendix 26, index bj;
- an aqueous solution of uranyl nitrate, as described in Appendix 40, index bj;
- fuel element or plates U_3Si_2Al, as described in Appendix 50, index bj;
- FSV fuel, as described in Appendix 52, index bj,

is compliant, as a type B(U) package design loaded with fissile materials, with the requirements of the regulations and agreements listed below:

- International Atomic Energy Agency, Regulations for the Safe Transport of Radioactive Material, Safety Standards Series, No. SSR-6, 2012 Edition;
- European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR);
- Technical Instructions for the safe air transport of hazardous goods (ICAO-TI),
- amended Order of May 29, 2009, relating to the carriage of dangerous goods by land (known as the "TDG Order");
- Instruction of June 26 2008 regarding the technical rules and administrative procedures applicable to commercial transport by aircraft and EU regulation no. 859/2008 of August 20 2008 (EU-OPS1).

However, only contents 11, 26 and 52 are allowed for air transport.

This certificate does not relieve the shipper from complying with the requirements established by the authorities of the countries through or into whose territory the parcel will be transported.

The validity of this certificate expires on March **1, 2024.**

Registration number: **CODEP-DTS-2019-010485**

Done at Montrouge on March 1, 2019

For the President of the ASN, and on the authority of,
the Director Industrial Activities and Transport

SUMMARY OF CERTIFICATE VERSIONS

Issued	Expiry	Type of version and modifications	Authority	Certificate Ref. No.	Revision index								
					Body	t	0	1	2	3	4	5	6
25/08/2008	15/11/2010	extension: contents 2, 4, 7, 11 and 26	ASN	F/313/B(U)F-96	Iak	-	ak	-	ak	-	ak	-	-
25/08/2008	31/08/2013	extension: contents 5, 6 and 15	ASN	F/313/B(M)F-96 T	Ial	al	al	-	-	-	-	al	al
12/02/2009	31/08/2013	extension: inclusion of contents 1 and 3	ASN	F/313/B(M)F-96 T	Iao	ao	ao	ao	-	ao	-	-	-
10/04/2009	31/08/2013	extension: modification of contents 1 and 3	ASN	F/313/B(M)F-96 T	Iap	ao	ao	ap	-	ap	-	-	-
04/11/2009	31/08/2013	extension: modification of contents 1, 3, 5, 6 and 15; inclusion of contents 8, 9, 10, 18, 19, 20 and 23	ASN	F/313/B(M)F-96 T	Iaq	aq	aq	aq	-	aq	-	aq	aq
28/04/2010	31/08/2013	extension: inclusion of content 39	ASN	F/313/B(M)F-96 T	Ias	as	as	-	-	-	-	-	-
04/06/2010	31/08/2013	extension: cancels and replaces certificate F/313/B(U)F-96 (Iak)	ASN	F/313/B(U)F-96	Iat	-	at	-	at	-	at	-	-
04/08/2010	31/08/2013	extension: inclusion of content 42	ASN	F/313/B(U)F-96	Iav	-	av	-	-	-	-	-	-
10/11/2010	31/08/2013	extension: inclusion of content 40	ASN	F/313/B(U)F-96	Iax	-	ax	-	-	-	-	-	-
10/05/2011	31/08/2013	extension: modification of content 40	ASN	F/313/B(U)F-96	Iay	-	ay	-	-	-	-	-	-
17/08/2011	31/08/2013	Extension: inclusion of CH_2	ASN	F/313/B(U)F-96	Iaz	-	az	-	az	-	az	-	-
20/04/2012	31/08/2013	extension: inclusion of content 46	ASN	F/313/B(M)F-96 T	Iba	ba	ba	-	-	-	-	-	-
10/10/213	30/06/2018	extension: contents 2, 4, 7, 11, 26, 40, 41 and 42	ASN	F/313/B(U)F-96	Jbb	-	bb	-	bb		bb	-	-
01/10/2014	30/06/2018	extension: contents 1, 3, 5, 8 - 10 18-20, 23 and 46	ASN	F/313/B(M)F-96 T	Jbc	bc	bc	bc	-	bc	-	bc	-
01/07/2016	30/06/2018	extension: content 11i	ASN	F/313/B(U)F-96	Jbd	-	bd	-	-	-	-	-	-
28/09/2017	30/06/2018	extension: modification of content 40	ASN	F/313/B(U)F-96	Jbe	-	be	-	-	-	-	-	-
28/09/2017	30/06/2018	extension: content 48	ASN	F/313/B(U)F-96	Jbf	-	bf	-	-	-	-	-	-
27/06/2018	31/12/2018	administrative extension: contents 2, 4, 7, 11, 26, 40, 41 and 42	ASN	F/313/B(U)F-96	Kbh	-	bh	-	bh		bh	-	-
27/06/2018	31/12/2018	extension: contents 1, 3, 5, 8 to 10, 18 - 20, 23 and 46	ASN	F/313/B(M)F-96 T	Kbi	bi	bi	bi	-	bi	-	bi	bi
01/03/2019	01/03/2024	extension: contents 2, 7, 11, 26 and 40 extension: contents 5, 50 and 52	ASN	F/313/B(U)F-96	Lbj	-	bj	-	-	-	-	-	-
01/03/2019	01/03/2024	extension: contents 1, 3, 5, 8 to 10, 18 to 20, 23 and 46	ASN	F/313/B(M)F-96 T	Lbk	bk	bk	-	-	-	-	-	-

01/03/2019	01/03/2024	extension: contents 5, 51 and 53	ASN	F/313/B(U)F-96	Lbl	-	bl	-	-	-	-	-	-

Revision index																											
Body	7	8	9	10	11	15	16	17	18	19	20	21	22	23	24	25	26	27	39	40	41	42	46	48	50	51	52	53
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Ial	-	-	-	-	-	al	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iao	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iap	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Iaq	-	aq	aq	aq	-	aq	-	-	aq	aq	aq	-	-	aq	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ias	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	as	-	-	-	-	-	-	-	-	-
Iat	at	-	-	-	at	-	-	-	-	-	-	-	-	-	-	-	at	-	-	-	-	-	-	-	-	-	-	-
Iav	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	av	-	-	-	-	-	-
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Iba	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	ba	-	-	-	-	-
Jbb	bb	-	-	-	bb	-	-	-	-	-	-	-	-	-	-	-	bb	-	-	bb	bb	bb	-	-	-	-	-	-
Jbc	-	bc	bc	bc	-	-	-	-	bc	bc	bc	-	-	bc	-	-	-	-	-	-	-	-	bc	-	-	-	-	-
Jbd	-	-	-	-	bd	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
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Kbh	bh	-	-	-	bh	-	-	-	-	-	-	-	-	-	-	-	bh	-	-	bh	bh	bh	-	-	-	-	-	-
Kbi	-	bi	bi	bi	-	-	-	-	bi	bi	bi	-	-	bi	-	-	-	-	-	-	-	-	bi	-	-	-	-	-
Lbj	bj	-	-	-	bj	-	-	-	-	-	-	-	-	-	-	-	bj	-	-	bj	-	-	-	-	bj	-	bj	-
Lbk	-	bk	bk	bk	-	-	-	-	bk	bk	bk	-	-	bk	-	-	-	-	-	-	-	-	bk	-	-	-	-	-
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APPENDIX 0

TN-BGC 1 PACKAGING

1. PACKAGING DEFINITION

The packaging is designed, manufactured, inspected, tested, maintained and used in compliance with safety analysis report CEA DSN/STMR/LEPE/TNBGC1 DSEM 0600 Ed. November 2018.

The packaging, which consists of a parallelepiped cage inside which a generally cylindrical body equipped with a closure system and a cover are fixed, is presented in figure 0.1.

The packaging design drawings are as follows:

- design drawings for the set : TN 9990-65 (C),
- cage : TN 9990-118 (B),
- fitted plug : TN 9990-117 (B),
- cover : EMB TNBGC PBC PDC CA 010001 A.

The main dimensions of the packaging are as follows:

- cage cross-section : 600 × 600 mm;
- overall height of the cage : 1,821 mm;
- diameter of the body - uninterrupted section : 295 mm;
- cover diameter : 466 mm;
- overall body height with cover : 1,808 mm

The maximum permissible mass of the packaging, loaded for transport, is 396 kg; its mass when empty is 280 kg.

Given the tolerances on the dimensions and densities of balsa and poplar contained in the packaging (shock absorbing cover and bottom of the body), the total mass of water in these elements does not exceed 1,670 grams.

The packaging consists of the main subsets specified below.

1.1 Packaging body

The cavity, with a useful internal diameter 178 mm and useful length 1475 mm, is formed of a stainless steel shell, 6 mm thick, and a bottom of thickness 8 mm, also in stainless steel.

A second stainless steel shell, 1.5 mm thick, and with an internal diameter 292 mm delimits, with the first shell, a space filled with resin which acts as a neutron absorbent and active thermal insulation.

The bottom is completed, from the inside of the package to the outside, by a distribution plate of 25 mm high tensile steel, a layer of 24 mm resin, an intermediate bottom, a wooden damper disc and a stainless steel sheet.

In the upper part, a machined stainless steel flange is welded to the two shells to host the closure system described below.

1.2 Cage

The cage is a structure in aluminium tubes of 30 × 30 mm section and 2 mm thick.

Angle-reinforced passageways are provided at two levels on the cage to allow for the forks of a forklift and thereby for packaging handling.

Inside the cage, frames are provided to connect the cage to the body of the packaging. They are welded to the vertical struts of the cage and drilled to allow the body's mounting bolts to be inserted.

1.3 Closing system

The body cavity is closed using a system consisting of 3 main parts: a plug, a clamp ring and a bayonet ring.

The plug is held against the body by the clamping ring. This component is screwed into the bayonet ring, which is itself pressed against the body flange.

In the centre of the cap, a bore hole equipped with a quick coupling can be used to reduce the pressure inside the packaging before shipment and to re-establish atmospheric pressure before unloading at the destination. This orifice is closed off by a cap.

The plug on the body and the quick-connect cap are sealed by two pairs of O-rings. The spaces between the seals both communicate with a common control port which can be used to check the tightness of the closure system.

1.4 Shock absorption system

In the event of a fall, a leaktight shock absorbing cover over the head of the body and the closing system will absorb impact forces.

The shock absorbing cover consists of two stainless steel sheeting boxes filled, for the one that is closest to the body, by resin and, for the second, by wood (balsa and poplar).

The lid is fixed on the body by two bent rods which are housed in lugs integral with the body and, secondly two latches whose ends are screwed on the lid and welded to the body of the packaging.

1.5 Handling and tie-down components

The cage is used to handle and tie-down the packaging.
The tie-down of the packaging is in particular carried out in accordance with the instruction referenced DSN / STMR / LEPE / TN-BGC 1 PCD 0007 Ind. 01 of 15/10/2018.

1.6 Safety functions

Containment is ensured by the packaging enclosure, made up of the inner shell, the base of the body and their circumferential welds, the plug and the quick-connect cap, which are fitted with silicone internal gaskets.

Radiological protection is provided mainly by:

- the lateral stainless steel shielding of the inner and outer shells against gamma radiation and the resin against neutron radiation;
- the stainless steel bottom shield of the bottom of the cavity and the two closure plates as well as the carbon steel of the distribution plate against the gamma radiation and by the resin and the wood against the neutron radiation;

- the stainless steel head shielding of the plug and the sheets of the lid against gamma radiation and by the resin and the wood against the neutron radiation.

S**ubcriticality is maintained** by the isolation system, which is composed of the elements described in the appendix to the contents and of:

- the packaging taking into account its geometry and its materials;
- the internal fittings given their geometries and materials. For these internal fittings, the parameters which are important for safety are recalled in the table below.

Internal fittings	Internal diameter (mm)	Thickness (mm)	Material
TN90	≤ 120	≥ 2	Z2 CN 18-10
AA 41 – AA 203 – AA 203c – AA 204	≤ 115	≥ 2	Z2 CN 18-10
E7	≤ 60	≥ 2	UA4G

The **dissipation of the internal thermal power** is ensured by radiation between the radioactive materials and the internal shell of the body, by conduction in the body and heat exchange between the body and the ambient air.

Impact protection is ensured by the shock-absorbing cover and the cage.

Fire protection is mainly provided by wood and resin. The body and the hood are equipped with fusible plugs which avoid the risk of overpressure due to the accumulation of steam.

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

The packaging is used according to procedures in accordance with the operating instructions of chapter 10 of the CEA safety reference file DSN/STMR/LEPE/TNBGC1 DSEM 0600 Ind. 05 of 16 November 2018.

In addition, when checking the tightness of the closure system through the test port, the sender ensures that the leakage rate is less than 6.65×10^{-4} Pa m^3 s^{-1} SLR.

3. MAINTENANCE PROGRAMME

The packaging is maintained according to the procedures in compliance with the instructions of chapter 10 of the safety analysis report with the reference CEA DSN/STMR/LEPE/TNBGC1 DSEM 0600 Ind. 05 of 16 November 2018.

4. NOTIFICATION AND RECORDING OF SERIAL NUMBERS

Any putting out of use or any change of ownership of a packaging is brought to the attention of the competent authorities. For this purpose, any owner passing on a packaging transmits the name of the new buyer.

5. MANAGEMENT SYSTEM

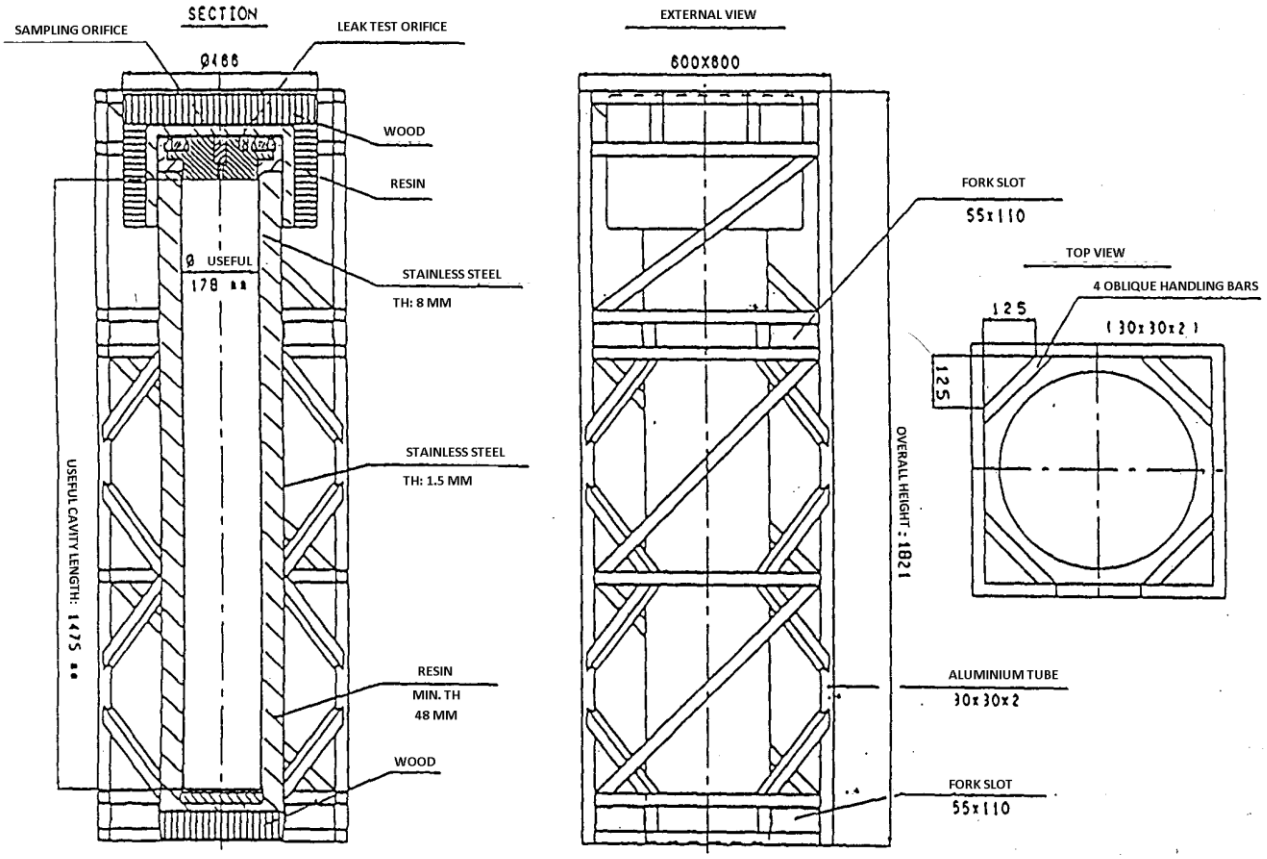
The principles of the management system to be applied during the design, manufacture, inspection, testing, maintenance and use of the package are in accordance with those described in chapter 11 of the CEA safety analysis report with the reference DSN/STMR/EMBAL/LEPE/DSEM 0600 ind. 05 of 16 November 2018.

6. ADDITIONAL PRESCRIPTION FOR TRANSPORT IN A CONFINED ENVIRONMENT

The transport of the CB9 box package is authorised under exclusive use.

FIGURE 0.1

SCHEME OF PACKAGING



NB.: dimensions are in mm.

APPENDIX 11

UNIRRADIATED SOLID URANIFEROUS MATERIALS

1. DEFINITION OF AUTHORISED CONTENT

The safety analysis report justifying the authorised content is referenced CEA DSN/STMR/LEPE/TNBGC1 DSEM 0600 Ind. 05 of 16 November 2018.

The permitted radioactive content consists of uraniferous materials which have not been irradiated in solid form.

If the uranium comes from reprocessing, the material did not undergo irradiation subsequent to reprocessing.

The presence of neutron absorbents (Boron, Gadolinium, Erbium, Europium, Dysprosium, Hafnium and Cadmium) is permitted in any quantity.
The presence of materials other than those defined in this appendix (contents and internal fittings) is excluded. The presence of transuraniens, capped at one gram is, however, allowed.

Isotopic composition and masses

For transport by air, the maximum mass of uranium 235 transported by TN-BGC 1 package as a function of the mass of water and polymeric materials present in the package is set out in the following table.

Maximum mass authorised of 235U (kg)	Maximum mass of water and polymeric materials permitted (g)
7.7	0
5.4	500
3.2	1000

For all transport by land, the sub-contents, whose maximum masses and isotopic compositions are presented below, are described in the safety analysis report referenced CEA DSN/STMR/LEPE/TNBGC1 DSEM 0600 Ind. 05 of 16 November 2018. Mixing different sub-contents within the same packaging is prohibited.

1/ The enrichment of uranium is any:

Sub-content no.	Presence of materials with higher hydrogen content than water authorised	Containment diameter (mm)	Maximum mass of 235U (kg)	Maximum number of packages
11a	Yes	∅ ≤ 120	2	10
11b		∅ ≤ 100	19.5	5
11d (*)	No	100 < ∅ ≤ 120	7	50
11e		60 < ∅ ≤ 100	15	16
11f		∅ ≤ 60	40	50

*: For sub-content No. 11d, the presence of aluminium or carbon in any quantity is permitted in the cavity of the internal fitting if the mass of ^{235}U is less than or equal to 300 g.

2/ The enrichment of uranium in uranium 235 is less than or equal to 20%:

Sub-content no.	Presence of materials with higher hydrogen content than water authorised	Containment diameter (mm)	Maximum mass of U (kg)	Maximum number of packages
11c	Yes	∅ ≤ 120	40	10
11g	No	∅ ≤ 120	40	50

3/ Uranium enrichment in uranium 235 is less than or equal to 30%:

Sub-content no.	Presence of materials with higher hydrogen content than water authorised	Containment diameter (mm)	Maximum mass of U (kg)	Maximum number of packages
11h	Yes	∅ ≤ 115	40	25

Physical characteristics

The density of the material is arbitrary.

If metal powders are transported, the powder-conditioning boxes, the internal fitting used and the cavity of TN-BGC 1 are inerted.

Chemical form

The material is exclusively in one of the following chemical forms (or in the form of a mixture of these forms):

- Metallic Uranium,
- Uranium oxides: UO_2, UO_3, U_3O_8;
- Uranium tetrafluoride: UF_4 ;
- Uranium nitrides: UN, U_2N_3, UN_2;
- Uranium carbides: UC, UC_2 et U_2C_3;
- Uranium alloys with: aluminium, molybdenum, silicon, zirconium.

Special form

The material is not in a special form.

Special provisions

In the presence of polymer materials or water, the time between the closure of the internal fitting in the shipping facility and the arrival of the package at the destination facility is less than 1 year.

If transuraniens are present in the content, the sender verifies that the specific activity of the content does not exceed 25 A_2 / g.

2. INTERNAL FITTINGS AND PACKAGING

If the mass of the content is greater than or equal to 30 kg, the content is blocked in its internal fittings with shims.

The material is optionally placed in a primary packaging consisting of metal cans, bottles or polymer shells. Everything is placed in an internal fitting.

The permitted polymeric materials are polyethylene, polyurethane, polyvinyl chloride and tetrafluoroethylene.

For transport by land, the presence of polyethylene or polyurethane more hydrogenated than water:

- is not allowed in sub-contents 11d, 11e, 11f and 11g,
- is allowed in other sub-contents capped at 500 g for polyethylene and in any quantities for polyurethane.

For transport by air, the presence of polyethylene or polyurethane more hydrogenated than water is not allowed, whatever the sub-content.

The internal fittings that can be used are TN 90, AA 41, AA 203, AA 203c or AA 204.

If the required internal diameter is strictly less than 100 mm, the internal fitting used is of type TN 90 and E7 type spacers are used for positioning and the radial shim inside the TN 90.

The following spacers are used to position the internal fitting in the cavity of the packaging:

- for 1 TN 90 : spacers E1 and E2,
- for 1 AA 41 : spacers E1 and E11,
- for 2 AA 41 : spacers E1, E12 and E13,
- for 3 AA 41 : spacers E1, E9 and 2 × E13
- for 1 AA 203 : spacers E1 and E8,
- for 1 AA 203 : spacers E1 and E8,
- for 1 AA 204 : spacers E1 and E10 or E6.

The total mass of the entire load of internal fittings AA 41, AA 203, AA 204 and TN 90 (material + primary packaging) must not exceed 60 kg.

3. STUDY TO MAINTAIN SUB-CRITICITY

The sub critical maintenance study is the subject of chapter 8 CEA reference DSN/STMR/LEPE/TNBGC1 DSEM 0608 Ind. 03 of November 10, 2017, supplemented by CEA/SEC/T n°89-18 of 20/01/89 and NT 000 48,550.01 of October 30, 2018.

For the contents 11a, 11b, 11c and 11h, it admits the presence of polymeric materials of hydrogen concentration higher than that of the water in the enclosure.

For contents 11d, 11e, 11f and 11g it admits the presence of polymer substances with a hydrogen concentration equal to or lower than that of water in the enclosure.

Criticality Safety Index

For contents 11a and 11c	: CSI = 5 (where N = 10)
For content 11b	: CSI = 10 (where N = 5)
For content 11e	: CSI = 3,125 (where N = 16)
For contents 11d, 11f and 11g	: CSI = 1 (where N = 50)
For content 11h	: CSI = 2 (where N = 25)

APPENDIX 26

TRIGA FUEL

1. DEFINITION OF AUTHORISED CONTENT

The safety analysis report justifying the authorised content is referenced CEA DSN/STMR/LEPE/TNBGC1 DSEM 0600 Ind. 05 of 16 November 2018.

The authorised radioactive content consists of bars of non-irradiated TRIGA fuel elements. These bars are based on U-ZrH_x (with x between 0 and 2); they are cylindrical, and of two types, standard or fine, with the following geometric characteristics:

- standard : diameter = 3.63 cm; length = 12.7 cm,
- end : diameter = 1.29 cm; length = 18.6 cm.

The uranium does not come from reprocessing.

The presence of other materials than those defined in the certificate of approval is prohibited.

Isotopic composition and masses

The maximum 235U enrichment level is 20%. The mass content of uranium varies between 8 and 47%, depending on the type of element:

Element type	U (% by maximum mass)	ZrH_X (% by maximum mass)	Maximum U-Zr mass (g/cm³)	Mass of U-ZrH_2 maximal (g/cm³)
Composition of standard TRIGA elements				
103	8	92	6.9	6.04
105	12	88	7.1	6.22
107	12	88	7.1	6.22
117	21	79	7.4	6.64
119	31	69	8.1	7.24
Composition of thin TRIGA fuel elements				
424	47	53	9.3	8.40

Mixing different sub-contents within the same packaging is prohibited.

Maximum transportable quantities

The maximum transportable quantities are specified in the following tables.

– for **transport by air**: the maximum mass of uranium transported by TN-BGC 1 package depends on the type of element, according to the table below:

Element type	Maximum mass of U (kg)
103	1.1
105	1.7
107	1.7
117	3.3
119	5.3
424	6.6

– for **overland transport**, the maximum mass of uranium transported by TN-BGC 1 package is a function of the type of element, according to the table below, subject, however, to the maximum mass indicated in paragraph 2, for the loading of internal fittings:

Element type	Maximum mass of U (kg)
103	9
105	14
107	14
117	27
119	43
424	76

Chemical form

Metal.

Special form

The material is not in a special form.

Special provisions

In the case of air transport, the mass of water present with the fissile material, irrespective of that contained in the hydrogenated materials of the packaging, does not exceed 1,200 g or 1,937 g, depending on whether standard or fine elements are present respectively.

The time between closing the internal fitting in the shipping facility and opening the package at the receiving facility is less than 365 days.

2. INTERNAL FITTINGS AND PACKAGING

If the mass of the content is greater than or equal to 30 kg, the content is blocked in its internal fittings with shims.

The TRIGA bars are placed in cardboard protective cases placed in an internal fitting. The presence of polyvinyl chloride and polyurethane is permitted. If polyurethane is used, it is less hydrogenated than water.

The internal fittings, equipped with silicone gaskets, are of the TN 90, AA 41, AA 203 or AA 204 type.

A type E7 primary packaging container can be used with TN 90 for the conditioning of uranium material.

The following spacers are used to wedge the internal fitting in the cavity of the packaging:

- for the TN 90 : shims E1 + shim E2,
- for 1 AA 41 : shims E1 + shim E11,
- for 2 AA 41 : shims E1 + shim E12 + shim E13,
- for 3 AA 41 : shims E1 + shim E9 + 2 shims E13,
- for the AA 203 : shims E1 + shim E8,
- with one AA 204 : shims E1 + shim E11.

The total mass of the entire load of internal fittings AA 41, AA 203, AA 204 and TN 90 (material + primary packaging) must not exceed 60 kg.

3. STUDY TO MAINTAIN SUB-CRITICITY

The sub critical maintenance study is the subject of chapter 8 CEA reference DSN/STMR/LEPE/TNBGC1 DSEM 0608 Ind. 03 of 10 November 2017.

It allows for the presence of polymer materials with a hydrogen concentration lower than or equal to that of water in the enclosure.

Criticality Safety Index: CSI = 0 (where N = infinity),

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U.S. Department of
Transportation

**Pipeline and
Hazardous Materials
Safety Administration**

**East Building, PHH-23
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CERTIFICATE NUMBER: USA/0492/B(U)F-96

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