Transport Permissioning (SVC4354984)

Amendment of Approval GB/5108A/AF-96 (Rev.0) and GB/5108A/IF-96 (Rev.3) for the TNF-XI Package to Increase the Permitted Uranium Oxide Density

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EXECUTIVE SUMMARY

Amendment of Approval GB/5108A/AF-96 (Rev.0) and GB/5108A/IF-96 (Rev.3) for the TNF-XI Package to Increase the Permitted Uranium Oxide Density

This report presents the basis of the regulatory decision by the Office for Nuclear Regulation (ONR) as Great Britain (GB) Competent Authority (CA) for the transport of Class 7 (radioactive material) dangerous goods, to issue revised certificates of approval to allow continued use of TNF-XI transport package (CA identification marks: GB/5108A/AF-96 and GB/5108A/IF-96) for transport by road, rail and sea in the United Kingdom (UK).

Permission Requested

The Applicant, AREVA TN International (AREVA TN) has requested an amendment to the GB CA approval of the TNF-XI package, for transport by road, rail and sea in the UK (GB/5108A/AF-96 (Rev.0) and GB/5108A/IF-96 (Rev.3)). AREVA TN would like to increase the permitted density of uranium oxide to 10.96 g/cm^3.

This request is made under the United Nations Economic Commission for Europe (UNECE) modal regulations ADR 2017 and RID 2017 (published by the Intergovernmental Organisation for International Carriage by Rail (OTIF)) for the transport of dangerous goods by road and rail and the International Maritime Dangerous Goods Code (IMDG) 2014 (or IMDG 2017). ADR and RID are implemented in GB law via 'The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009' (CDG) while IMDG is implemented in the UK by 'The Merchant Shipping (Dangerous Goods and Marine Pollutants) Regulations 1997'. The modal regulations (ADR/ RID / IMDG) are based on the International Atomic Energy Agency (IAEA) Regulations for the Safe Transport of Radioactive Material, currently SSR-6 (2012 Edition) supported by advisory material in SSG-26.

Background

AREVA TN, based in France, is the design authority for the TNF-XI transport package for the transport of fissile radioactive material. The package is used to transport uranium oxides (UO_2, UO_3 or U_3O_8) with a ^{235}U enrichment of no more than 5 weight percent ^{235}U in total U. The uranium oxides are in the form of powder, pellets or scraps and may be contaminated by residues consisting of incinerator ashes or earth, sand and residues from dissolution. There are two package variations, a Type A (carrying content n°4) and an Industrial Package Type 2 (carrying content n°2 or n°7), both of which are fissile packages. Both package variants have been approved for use in France by the French CA, Autorité De Sûreté Nucléaire (ASN) under certificates of approval F/381/AF-96 (Di) and F/381/IF-96 (Dj).

The TNF-XI transport package is used by a UK based dutyholder and is currently approved for transport via road, rail and sea in the UK under certificates of approval, GB/5108A/AF-96 (Rev.0) and GB/5108A/IF-96 (Rev.3), which were issued in January 2017.

The Safety Analysis Report (SAR), DOS-06-00037028-000 Revision 7 that was previously submitted to ONR and resulted in the issue of the current certificates of approval already assumed a uranium oxide density of 10.96 g/cm^3, and the French certificates already permit a density of 10.96 g/cm^3. However, for criticality safety reasons ONR was not satisfied that at a density of 10.96 g/cm^3, all regulatory requirements had been met. These reasons were:

- The safety case assumed a criticality safety criterion of $k_{eff} + 3\sigma \leq 0.98$ for arrays of TNF-XI packages. This is in excess of the generally accepted worldwide criterion of $k_{eff} + 3\sigma \leq 0.95$ (as recommended in IAEA SSG-26) which should not be exceeded unless adequately justified.

- The safety case had not taken into account the effect of temperature variations on the system neutron multiplication.

AREVA TN provided supplementary calculations which demonstrated that by restricting the uranium oxide density of content n°2 and n°4 to 7.0 g/cm^3, the criticality safety criterion normally adopted in the UK of $k_{eff} + 3\sigma \leq 0.95$ is met even when temperature variations are accounted for.

ONR therefore restricted the uranium oxide density to 7.0 g/cm^3 for UK transport on GB/5108A/AF-96 (Rev.0) and GB/5108A/IF-96 (Rev.3), which was sufficient to permit powder shipments as an interim solution.

AREVA TN would now like to increase the maximum permitted density of uranium oxide from 7.0 g/cm^3, as currently approved in the UK, to 10.96 g/cm^3. Thus, AREVA TN has produced some additional criticality analysis NTC-17-00194972-000 in order to demonstrate that the previously identified criticality safety issues are resolved and that the oxide density can be increased to 10.96 g/cm^3. This new analysis for material at 10.96 g/cm^3 requires that the mass of oxide permitted per package is reduced to less than permitted on the French certificates.

Assessment and inspection work carried out by ONR in consideration of this request

ONR carried out a programme of assessment of the Applicant's transport safety case, its claims, arguments, supporting documentation and evidence. ONR also assessed the mechanisms for implementation of the requirements of the transport safety case and certificate of approval via the relevant management systems. The assessment has been carried out by sampling a number of key areas of the transport safety case. These areas were chosen based on ONR inspector's judgement of their importance to safety, changes since the last approval and any findings and outcomes from previous ONR assessments.

The package designs under assessment are Type A and Industrial Package Type 2, both of which are fissile packages, hence the designations GB/5108A/AF-96 and GB/5108A/IF-96 respectively. In accordance with paragraph 802 and Annex I of SSR-6, CA approval is only required owing to the fissile aspects (potential criticality hazards) of the package. Consequently, ONR's assessment was focused mainly on the criticality analysis and any engineering/ administrative aspects which influence the criticality assessment. The assessment targeted the change in contents (increased uranium oxide density) and the results of the neutron multiplication calculations and associated analysis in NTC-17-00194972-000.

No inspection work was conducted explicitly in support of this application. Regulatory confidence is drawn from recent inspection history of the GB based duty-holder (who act as both consignor and consignee) including a recent inspection in March 2017 which focused on packing and load arrangements of the TNF-XI package, approval from the originating CA, and written correspondence from the Applicant to establish specific details relevant to this application.

Matters arising from ONR's work

ONR identified supplementary controls in addition to those on the certificates of approval issued by the French CA that are necessary to meet regulatory expectations for package criticality control within the UK. Accordingly, this multilateral approval is effected by the issue of a GB certificate of approval that lists these supplementary controls to highlight these safety requirements to users of the package. These supplementary controls are summarised as follows:

- An underpinning assumption in the package criticality safety case relating to the maximum hydrogen density of package contents has not been captured on the certificate of approval issued by the French CA. In order to emphasise this to users of the package, it is considered necessary to explicitly capture this on the GB certificates of approval.

- The Applicant has used a criticality safety criterion which, although accepted by the French CA, does not meet internationally recognised relevant good practice and is not acceptable to ONR without further justification. Therefore, ONR cannot approve the package design without further restriction. Consequently, the Applicant has supplied supporting documentation which shows that ONR's regulatory expectations are satisfied if the following additional restriction is imposed on the GB certificates of approval: For content n°2 and n°4, the maximum allowable mass of uranium oxide in each cavity (shared out in three pails) of the package is limited as a function of uranium enrichment and uranium oxide density as follows:

Mass enrichment ($e = {}^{235}U/U_{tot}$)	UO_2, UO_3, U_3O_8 (powder, pellets or scraps of pellets)*	
≤ 4.15%	75.0 kg	49.0 kg
≤ 4.45%	64.5 kg	
≤ 4.65%	58.5 kg	39.5 kg
≤ 4.85%	53.5 kg	
≤ 4.95%	51.5 kg	
≤ 5.00%	50.0 kg	
Density	≤ 7.0 g/cm^3	≤ 10.96 g/cm^3

Conclusions

Subject to the imposition of supplementary controls for use of the package design within the UK, the SAR together with supporting documentation provided to ONR (including NTC-17-00194972-000) is considered to be adequate to meet applicable regulatory requirements and the design is judged to be safe.

Recommendation

It is recommended that the application is approved under GB certificates GB/5108A/AF-96 (Rev.1) and GB/5108A/IF-96 (Rev.4) subject to inclusion of the supplementary controls as conditions of approval.

LIST OF ABBREVIATIONS

ADR	European Agreement concerning the International Carriage of Dangerous Goods by Road
ASN	Autorité De Sûreté Nucléaire
CA	Competent Authority
DCI	Deputy Chief Inspector
DGSA	Dangerous Goods Safety Advisor
DL	Delivery Lead
GB	Great Britain
HOW2	(Office for Nuclear Regulation) Business Management System
IAEA	International Atomic Energy Agency
IMDG	International Maritime Dangerous Goods Code
IP2	Industrial Package Type 2
k_{eff}	Effective Neutron Multiplication Factor
MoU	Memorandum of Understanding
ONR	Office for Nuclear Regulation
PAR	Project Assessment Report
PD	Programme Director
PL	Professional Lead
RID	Regulations concerning the International Carriage of Dangerous Goods by Rail
SAR	Safety Analysis Report
SDFW	Sellafield Decommissioning Fuel & Waste
SI	Superintending Inspector
SSG	(IAEA) Specific Safety Guide
SSR	(IAEA) Specific Safety Requirements
UK	United Kingdom
UNECE	United Nations Economic Commission for Europe
σ	Standard Deviation

TABLE OF CONTENTS

Tables

1 PERMISSION REQUESTED

1. The Applicant, AREVA TN International (AREVA TN) has requested an amendment to the Great Britain (GB) Competent Authority (CA) approval of the TNF-XI package, for transport by road, rail and sea in the United Kingdom (UK) [1]. The current certificates of approval, which were issued in January 2017, are GB/5108A/AF-96 (Rev.0) and GB/5108A/IF-96 (Rev.3) [2, 3]. The amendment requested is to increase the permitted density of uranium oxide to 10.96 g/cm^3.

2 BACKGROUND

2. There are certain transport package designs carrying Class 7 (radioactive material) dangerous goods that require CA approval. For example, all packages containing fissile material (that are not classed as fissile excepted) require multilateral approval, i.e. approval by the relevant CA of the country of origin of the design, and also, where the consignment is to be transported through or into any other country, approval by the CA of that country.

3. The Office for Nuclear Regulation (ONR) is the GB CA for the civil inland surface transport of Class 7 (radioactive material) dangerous goods. This statutory duty is given to ONR through The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (CDG) [4]. ONR also acts on behalf of other civilian UK CAs in cases where CA approval of a package design is required; namely:

   - The Competent Authority of the United Kingdom of Great Britain and Northern Ireland in respect of sea transport, being the Secretary of State for Transport including the Maritime and Coastguard Agency;
   - The Competent Authority of the United Kingdom of Great Britain and Northern Ireland in respect of air transport, being the Civil Aviation Authority; and
   - The Competent Authority of Northern Ireland in respect of road transport, being the Department of Agriculture, Environment and Rural Affairs - Northern Ireland.

4. AREVA TN, based in France, is the design authority for the TNF-XI transport package for the transport of fissile radioactive material. The package is used to transport uranium oxides (UO_2, UO_3 or U_3O_8) with a ^{235}U enrichment of no more than 5 weight percent ^{235}U in total U. The uranium oxides are in the form of powder, pellets or scraps and may be contaminated by residues consisting of incinerator ashes or earth, sand and residues from dissolution. There are two package variations, a Type A (carrying content n°4) and an Industrial Package Type 2 (carrying content n°2 or n°7), both of which are fissile packages. Both package variants have been approved for use in France by the French CA under certificates of approval F/381/AF-96 (Di) and F/381/IF-96 (Dj) [5, 6] (English translation [7, 8]).

5. The TNF-XI transport package is used by a UK based dutyholder to facilitate transfer of nuclear materials from the UK in support of fuel production programmes. It can also be used to facilitate transfer of nuclear materials to the UK to allow recovery of uranium from residues. The TNF-XI package is currently approved for transport via road, rail and sea in the UK under certificates of approval, GB/5108A/AF-96 (Rev.0) and GB/5108A/IF-96 (Rev.3) [2, 3], which were issued in January 2017.

6. The Safety Analysis Report (SAR), DOS-06-00037028-000 Revision 7 [9] that was previously submitted to ONR and resulted in the issue of the current certificates of approval already assumed a uranium oxide density of 10.96 g/cm^3, and the French certificates already permit a density of 10.96 g/cm^3. However, for criticality safety

reasons ONR was not satisfied that at a density of 10.96 g/cm^3, all regulatory requirements had been met [10]. These reasons were:

- The safety case assumed a criticality safety criterion of $k_{eff} + 3\sigma \leq 0.98$ for arrays of TNF-XI packages. This is in excess of the internationally recognised relevant good practice (as recommended in IAEA SSG-26 [11]) which suggests a criterion of $k_{eff} + 3\sigma \leq 0.95$ should not be exceeded unless adequately justified.
- The safety case had not taken into account the effect of temperature variations on the system neutron multiplication.

7. AREVA TN provided supplementary calculations which demonstrated that by restricting the uranium oxide density of content n°2 and n°4 to 7.0 g/cm^3, the criticality safety criterion normally adopted in the UK of $k_{eff} + 3\sigma \leq 0.95$ is met even when temperature variations are accounted for.

8. ONR therefore restricted the density to 7.0 g/cm^3 in the UK via certificates of approval GB/5108A/AF-96 (Rev.0) and GB/5108A/IF-96 (Rev.3) [2, 3], which was sufficient to permit powder shipments as an interim solution.

9. AREVA TN would now like to increase the maximum permitted density of uranium oxide from 7.0 g/cm^3, as currently approved in the UK, to 10.96 g/cm^3. Thus, AREVA TN has produced some additional criticality analysis NTC-17-00194972-000 [12] in order to demonstrate that that the previously identified criticality safety issues are resolved and that the oxide density can be increased to 10.96 g/cm^3. This new analysis for material at 10.96 g/cm^3 requires that the mass of oxide permitted per package is reduced to less than permitted on the French certificates.

10. Accordingly, AREVA TN has written to ONR [1] to request CA approval of this modification as required under provision 6.4.22.4 of the following modal regulations:

- European Agreement Concerning the International Carriage of Dangerous Goods by Road, ADR [13];
- Regulations concerning the International Carriage of Dangerous Goods by Rail, RID [14];
- International Maritime Dangerous Goods Code, IMDG [15].

3 ASSESSMENT AND INSPECTION WORK CARRIED OUT BY ONR IN CONSIDERATION OF THIS REQUEST

11. This current application has been considered in accordance with ONR's assessment processes [16]. ONR carried out a detailed programme of work [17 – 23] that involved the assessment of the applicant's transport safety case, supporting documentation and evidence, and the mechanisms for its implementation via the relevant management systems.

12. The package designs under assessment are Type A and Industrial Package Type 2 (IP2), both of which are fissile packages, hence the designations GB/5108A/AF-96 and GB/5108A/IF-96 respectively. In accordance with para 802 and Annex I of SSR-6 [11], CA approval is only required owing to the fissile aspect of the package, i.e. CA approval is not required for Type A or IP2 package designs containing non fissile material. Thus, multilateral approval is only required because the packages are fissile packages (potential criticality hazard).

13. In addition, in relation to multilateral approval of certificates of approval, para 840.1 of SSG-26 [11] states 'Competent authorities, other than that of the country of origin,

have the option of either performing a separate safety assessment and evaluation or making use of the assessment already made by the original competent authority, thus limiting the scope and extent of their own assessment'. Cognisance was taken that:

- the package with higher payloads has been accepted by the French CA (with whom, until recently we maintained a Memorandum of Understanding which allowed ONR to give multilateral approval of cases approved by the French without detailed assessment by ONR);
- there is confidence in the applicant's process for producing transport safety cases and their track record;
- the package is not novel or complex, and is a recently approved design (which included detailed criticality assessment by ONR which was subject to peer and acceptance review) with a relatively straight-forward change to the contents.

14. Therefore, a proportionate assessment approach was adopted which focused mainly on the criticality analysis (as this is the reason that CA approval is required) and any engineering/ administrative aspects which influence the criticality assessment, as well as changes since the last approval and any findings and outcomes from previous ONR assessments.

15. From ONR's initial review of the proposed modification it was judged that from an engineering, shielding and Safety Case Requirements (SCR) perspective, the Applicant's proposed change does not have a significant impact [18, 19]. The previous assessments supporting the certificates of approval issued in January 2017 were based on the content permitted by the French certificates. The proposed change simply means that the maximum permitted mass of the uranium oxide will be reduced compared to the French certificates. From ONR's review of the additional criticality analysis, it is apparent that the Applicant's criticality assessment does not place any addition claims on engineering aspects compared to the case we assessed previously.

16. Thus, the assessment by ONR targeted the additional criticality analysis and no further shielding, engineering or SCR assessment was warranted. This was confirmed with the ONR inspectors who assessed the previous application who agreed no further consideration is required from their respective disciplines [22, 23].

17. ONR's criticality assessment [21] confirmed that the package design is structurally the same and the proposed changes relate only to the contents to address issues previously identified by ONR. The assessment then focused on the new package contents (increased uranium oxide density) and the results of the neutron multiplication calculations and associated analysis in NTC-17-00194972-000 [12]. The conclusion of ONR's criticality assessment was that the package will remain sub-critical (meeting the criticality safety criterion of $k_{eff} + 3\sigma \leq 0.95$, which is internationally recognised relevant good practice) under routine, normal and accident conditions of transport and all regulatory relevant requirements relating to fissile material transport are met. However, this requires the following restrictions which supplement those on the CoA issued by the French CA, F/381/AF-96 (Di) and F/381/IF-96 (Dj) [5, 6] (English translation [7, 8]):

- substances having a hydrogen density greater than 0.137 g/cm^3 at 20°C shall not be carried[1];

[1] The is an existing restriction which is captured on the GB certificates GB/5108A/AF-96 (Rev.0) and GB/5108A/IF-96 (Rev.3) [2, 3], which were issued in January 2017. This remains equally applicable for the proposed modification.

- for content n°2 and n°4, the maximum allowable mass of uranium oxide in each cavity (shared out in three pails) of the package is limited as a function of uranium enrichment and uranium oxide density as shown in Table 1.

18. These additional restrictions are necessary to ensure safety of the package and meet regulatory expectations in the UK.

19. No inspection work was conducted explicitly in support of this application. Regulatory confidence is drawn from the recent inspection history of the GB based dutyholder (who act as both consigno

20. r and consignee) including a recent inspection in March 2017 [24] which focused on packing and load arrangements of the TNF-XI package. The proposed change will affect permitted mass / density / enrichment limits. At the recent inspection in March [24], the UK based dutyholder demonstrated they have adequate arrangements in place in these respects. They also demonstrated they understood the implications of having different restrictions on certificates issued by each of the CA's from countries through which the package will travel. To deal with this, the Dangerous Goods Safety Advisor (DGSA) reviews the various transport approvals and creates a compliance matrix which shows the most restrictive factors from each of the countries the package will travel though.

4 MATTERS ARISING FROM ONR'S WORK

21. ONR identified supplementary controls in addition to those on the certificates of approval issued by the French CA [5, 6] (English translation [7, 8])] that are necessary to meet regulatory expectations for package criticality control within the UK. These include: limiting the maximum permitted hydrogen density of contents and imposing more restrictive uranium oxide mass / enrichment / density limits (see Table 1) than permitted by the certificates issued by the French CA.

22. The applicant has been made aware and has accepted these additional restrictions. The UK based dutyholders arrangements to ensure compliance against the maximum permitted hydrogen density of contents was inspected and judged to be adequate by ONR during the inspection in March 2017 [24]. As the more restrictive uranium oxide mass / enrichment / density limits than permitted by the certificates issued by the French CA are new restrictions, it is not possible to check compliance. However, based on the inspection in March 2017 [24], the consignor's management system arrangements are considered adequate and there is no reason to believe compliance will not be achieved.

5 CONCLUSIONS

23. This report presents the findings and basis of ONR's regulatory decision following our assessment of the TNF-XI transport package (CA identification marks: GB/5108A/AF-96 and GB/5108A/IF-96).

24. ONR is satisfied with the claims, arguments and evidence presented within the original submission supported by subsequent correspondence / evidence provided in response to our assessment findings. Subject to the imposition of the identified supplementary controls for use of the package design within GB, the design is judged to be safe and meet applicable regulatory requirements. Criticality safety is enhanced through the inclusion of safety case assumptions as supplementary controls within the GB certificates of approval to highlight these additional safety features to all users of the package, specifically:

- the maximum permitted hydrogen density of contents;
- more restrictive uranium oxide mass / enrichment / density limits (see Table 1) than permitted by the certificates issued by the French CA.

6 RECOMMENDATIONS

25. The project assessment report recommends that the TNF-XI package design (CA identification marks: GB/5108A/AF-96 and GB/5108A/IF-96) is approved for use in the UK by road, rail and sea by issue of GB certificates of approval GB/5108A/AF-96 (Rev. 1) and GB/5108A/IF-96 (Rev. 4), which include additional supplementary controls as discussed above.

7 REFERENCES

1. CEX-17-00194663-002: 'Transport of Radioactive Material Package model F/381/AF-96 and F/381/IF-96 - TNF-XI Package Application for French certificates of approval F/381/AF-96 (Di) and F/381/IF-96 (Dj)', 6 July 2017. TRIM Record: 2017/272506.

2. GB/5108A/AF-96(Rev.0), 'Certificate of Approval of Package Design for the Carriage of Radioactive Material', January 2017. TRIM Record: 2016/465166.

3. GB/5108A/IF-96(Rev.3), 'Certificate of Approval of Package Design for the Carriage of Radioactive Material', January 2017. TRIM Record: 2016/467120.

4. The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (CDG) 2009, (SI 2009 No. 1348). www.legislation.gov.uk

5. F/381/AF-96 (Di): 'Certificat D'Agrement D'Un Modele De Colis' Autorité De Sûreté Nucléaire, 6 September 2016. Attachment to TRIM Record: 2016/363389.

6. F/381/IF-96 (Dj): 'Certificat D'Agrement D'Un Modele De Colis' Autorité De Sûreté Nucléaire, 6 September 2016. Attachment to TRIM Record: 2016/363389.

7. F/381/AF-96 (Di): 'Certificate of Approval of a Package Model', Autorité De Sûreté Nucléaire. Attached to TRIM Record: 2016/431067.

8. F/381/IF-96 (Dj): 'Certificate of Approval of a Package Model', Autorité De Sûreté Nucléaire. Attached to TRIM Record: 2016/431067.

9. DOS-06-00037028-000 Revision 7: 'Safety Analysis Report TNF-XI', AREVA TN International, 21 July 2016. TRIM Record: 2016/446429.

10. ONR-COP-AR-16-019 Revision 0: 'Transport Permissioning Criticality Assessment Report - Application for the Validation of French Certificates of Approval F/381/AF-96(Di) and F/381/IF-96(Dj)', 09 January 2017. TRIM Record: 2016/338695.

11. IAEA Safety Standards:
SSR 6: 'Regulations for the Safe Transport of Radioactive Material (2012 Edition)', IAEA, Vienna, 2012.
SSG 26: 'Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition)', IAEA, Vienna, 2012.
www.iaea.org.

12. NTC-17-00194972-000 Rev.0: 'Criticality safety analysis of TNF-XI packaging loaded with uranium oxide – density 10.96 g/cm^3 – in the range of temperature [-40^{o}C ; 100^{o}C]', 5 July 2017. TRIM Record: 2017/272506.

13. United Nations Economic Commission for Europe (UNECE), European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) 2017 Edition. www.unece.org

14. Intergovernmental Organisation for International Carriage by Rail (OTIF), Regulations concerning the International Carriage of Dangerous Goods by Rail (RID) 2017 Edition. www.otif.org

15. International Maritime Dangerous Goods Code (IMDG) 2014 Edition incorporating Amendment 37-14 (until end of December 2017) or IMDG 2016 Edition incorporating Amendment 38-16.

16. ONR Transport Permissioning Process Guides:
TRA PER GD 001 Revision 1, 'Transport Permissioning Assessment'.
ONR Transport Permissioning Assessment Guides on How2

17. GB/5108 (SVC4354984) - Q0 Check - TNF-XI request for modification of GB/5108A/IF-96 & GB/5108A/AF-96 – 19 July 2017. TRIM Record: 2017/277256.

18. GB/5108 (SVC4354984) - Pre-Job Brief - Modification of certificates GB/5108A/IF-96 & GB/5108A/AF-96 for the TNF-XI Package - Areva TN International – 9 August 2017. TRIM Record: 2017/307372.

19. GB/5108 (SVC4354984) - Decision Record - Modification of certificates GB/5108A/IF-96 & GB/5108A/AF-96 for the TNF-XI Package - Areva TN International – 8 November 2017. TRIM Record: 2017/414387.

20. GB/5108 (SVC4354984) - Q1AR - Multilateral approval of GB/5108A/IF-96 & GB/5108A/AF-96, TNF-XI - AREVA TN – 07 September 2017. TRIM Record: 2017/341086.

21. ONR-SDFW-AR-17-100 Revision 0: 'Criticality Safety Assessment for the UK Approval for the TNF-XI Package, GB/5108A/AF-96 and GB/5108A/IF-96', 8 December 2017. TRIM Record: 2017/341587.

22. GB/5108 (SVC4354984) - Email - Engineering assessment response from [redacted] for modification 1 September 2017. TRIM Record: 2017/334300.

23. GB/5108 (SVC4354984) - Email - Shielding assessment for multilateral approval of GB/5108A/IF-96 & GB/5108A/AF-96, TNF-XI - AREVA TN – 08 September 2017. TRIM Record: 2017/342820.

24. ONR-COP-IR-16-067 Revision 0: 'Compliance Inspection of Consignor/Carrier of Radioactive Material', March 2017. TRIM Record: 2017/111471.

Table 1
Maximum mass of uranium oxide in each cavity of the package as a function of uranium enrichment and uranium oxide density for content n°2 and n°4

Mass enrichment ($e = {}^{235}U/U_{tot}$)	UO_2, UO_3, U_3O_8 (powder, pellets or scraps of pellets)*	
≤ 4.15%	75.0 kg	49.0 kg
≤ 4.45%	64.5 kg	
≤ 4.65%	58.5 kg	39.5 kg
≤ 4.85%	53.5 kg	
≤ 4.95%	51.5 kg	
≤ 5.00%	50.0 kg	
Density	≤ 7.0 g/cm^3	≤ 10.96 g/cm^3