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**Transport of Type 30B Cylinders Containing a Heel of
Uranium Hexafluoride without a Protective Shipping Package
GB/3518A/AF-85 [Validation of USA/0411/AF-85 Revision 11]**

**Multilateral Approval of the USA Competent Authority Certification
USA/0411/AF-85 Revision 11**

Project Assessment Report ONR-SDFW-PAR-19-019
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EXECUTIVE SUMMARY

Multilateral Approval of the USA Competent Authority Certification - USA/0411/AF-85 Revision 11

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 a Certificate of Approval (CoA) for Type 30B cylinders containing a heel of uranium hexafluoride (UF₆) without a protective shipping package, CA Identification Mark: GB/3518A/AF-85 (Validation of USA/0411/AF-85 Revision 11).

Permission Requested

ONR has received an application from URENCO UK Limited (UUK) for renewal of the competent authority package approval for the GB/3518A/AF-85 transport package design (Type 30B Cylinders Containing a Heel of Uranium Hexafluoride without Protective Shipping Package e.g. UX-30 Over-packs). It is a USA design fissile package (USA/0411/AF-85) which was most recently approved by the USA competent authority (US DOT) in May 2016.

This validation request was made under the following modal regulations to allow transport by road, rail and sea:

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

The modal regulations 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.

Approval is required by ONR in addition to the USA approval (i.e. multilateral approval) for two reasons:

- It is a fissile package (6.4.22.4 of ADR, RID and IMDG);
- The packaging is manufactured to a package design approved by the competent authority under the provisions of the 1985 Edition of the International Atomic Energy Agency (IAEA) Regulations for the Safe Transport of Radioactive Material (1.6.6.2.1 (b) of ADR/RID and 6.4.22.2 of IMDG).

Approval may be by validation of the original certificate issued by the CA of the country of origin of the package design or shipment, or the issue of a separate certificate of approval.

Background

The GB/3518A/AF-85 package design has been approved for use in the UK a number of times before, which involved detailed review of the safety case. The most recent UK approval was granted in September 2011 which expired September 2016.

The US approved design is based on a Criticality Safety Index (CSI) of zero, meaning there would be no limitation on the number of packages per conveyance. During previous ONR assessment, ONR identified this as unacceptable and did not meet our expectations for package criticality control within the UK. Accordingly, this multi-lateral approval was previously effected by the issue of a GB certificate of approval (GB/3518A/AF-85) that lists

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supplementary controls for use of the package within the UK i.e. specifying a CSI for packages which limits the number of packages permitted on a conveyance.

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

ONR carried out a programme of work in consideration of this request which involved assessment of the Applicant's safety case, its claims, arguments, supporting documentation and evidence.

The main changes since the previous approval (in September 2011) are:

- Completely revised criticality assessment, although it uses a very similar methodology to that used in the previously approved case. The new case contains calculations using a more modern version of the criticality code (MONK) and includes assessment of temperature effects.
- A shielding assessment has been included. This is the same shielding assessment as was supplied in support of the GB/5121 (USA/9196).
- Applicant is now UUK whereas previously it was International Nuclear Services (INS).

The revised assessment resulted in a reduction in the permitted consignment mass limits compared to that which has been approved previously. The ONR assessment of this application therefore focussed on the changes in the safety case that has been made since the previous CoA was granted.

Some detailed consideration was also given to ensure compliance with the uranium mass limits (which also requires accurate determination of enrichment) which is fundamental to criticality safety of the package / consignment.

No inspection work was conducted explicitly in support of this application. Regulatory confidence is drawn from recent inspection history of the UK based duty-holder, 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

The USA approval is based on the 1985 regulations i.e. the 'Grandfathering' option permitted under IAEA SSR-6 para. 820 is being utilised. The '-85' certificate is only valid for packages manufactured prior to 31 December 2006 (see para 817 of TS-R-1 2009 Edition). This restriction will be captured on the certificate of approval, GB/3518A/AF-85 (Rev.9), issued to the applicant. For packages manufacture after 31 December 2006, UUK will have to submit a separate application which demonstrates full compliance with the regulations as it is not permissible to use the Grandfathering provisions for packages manufactured after 31 December 2006.

Conclusions

Based on the sampling undertaken I am satisfied with the claims, arguments and evidence within the safety case documentation and conclude that it is safe and meets the requirements for a Type AF-85 transport package design detailed within ADR, RID and IMDG (and also SSR-6).

Recommendation

It is recommended that the package design approval is issued for the Type 30B cylinders containing a heel of uranium hexafluoride without protective shipping package USA/0411/AF-

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85 for carriage by road, rail and sea. However, due to deficiency in terms of CSI as identified under previous approvals, it is not possible to validate the revised US certificate, USA/0411/AF-85 Revision 11 in full. For this reason it is recommend that this multilateral approval is effected by the issue of GB certificate of approval GB/3518A/AF-85 (Rev.9) which adds additional controls.

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LIST OF ABBREVIATIONS

ADR	European Agreement Concerning the International Carriage of Dangerous Goods by Road
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
CA	Competent Authority
CDG	Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009
CM9	ONR Document Record System
CoA	Certificate of Approval
CSI	Criticality Safety Index
DCI	Deputy Chief Inspector
DMG	Delivery Management Group
DOT	(US) Department of Transportation
GB	Great Britain
IAEA	International Atomic Energy Agency
IMDG	International Maritime Dangerous Goods
INS	International Nuclear Services
ISO	International Organization for Standardization
MONK	Monte Carlo Criticality Code
ONR	Office for Nuclear Regulation
OTIF	Intergovernmental Organisation for International Carriage by Rail
PAR	Project Assessment Report
Q1AR	Assessment Record with regulatory question set
RID	Intergovernmental Organisation for International Carriage by Rail, Regulations Concerning the International Carriage of Dangerous Goods by Rail
SDFW	Sellafield Decommissioning Fuel & Waste
SSG	(IAEA) Specific Safety Guide
SSR	(IAEA) Specific Safety Requirements
UK	United Kingdom
UNECE	United Nations Economic Commission for Europe
UF ₂₆	Uranium Hexafluoride
US	United States
USA	United States of America
UUK	URENCO UK Limited

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Figure 1: Schematic of Cylinder Model 30B

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1 PERMISSION REQUESTED

1. The Applicant, URENCO UK Limited (UUK) requested Competent Authority (CA) approval of the USA/0411/AF-85 package (Type 30B cylinders containing a heel of uranium hexafluoride (UF_6) without a protective shipping package), for transport by road, rail and sea.

2 BACKGROUND

2. There are certain transport package designs carrying Class 7 (radioactive material) dangerous goods that require Competent Authority (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 Great Britain (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) [1]. In accordance with Agency Agreements (legal documents used to transfer statutory responsibilities between bodies) [2] ONR also acts on behalf of other civilian United Kingdom (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. ONR has received an application [3] from URENCO UK Limited (UUK) for renewal of the competent authority package approval for the GB/3518A/AF-85 transport package design (Type 30B Cylinders Containing a Heel of Uranium Hexafluoride without Protective Shipping Package e.g. UX-30 Over-packs).
5. Type 30B cylinders designed to American National Standards Institute (ANSI) N14.1 or International Organization for Standardization (ISO) 7196 are used to store and transport UF_6 . They comprise a carbon steel pressure vessel with a nominal 30 inch diameter. Type 30B cylinders have a 1 inch valve which is protected by a valve cover during transport. A schematic of the Type 30B cylinder is provided in Figure 1.
6. For significant inventories of UF_6 , the package design used for transport is a UX-30 (USA/9196) which requires the Type 30B cylinder to be held within a protective over pack and the number of packages on a conveyance is limited to a small number. However, for Type 30B cylinders limited to a very low mass 'heel' (residual material that remains in the cylinder after emptying), the cylinders are transported without a protective over pack and can allow more packages per conveyance.
7. The US package design for Type 30B cylinders limited to a low mass heel, without a protective over pack is USA/0411/AF which was most recently approved by the USA competent authority (US Department of Transportation (US DOT)) in May 2016 [4].

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8. The Type 30B cylinders limited to a low mass heel, without a protective over pack design has been approved for use in the UK a number of times before (under separate competent authority ID GB/3518A/AF-85), which involved detailed review of the safety case. The most recent UK approval was granted in September 2011 [5] which expired September 2016.
9. The reason that the package design is given a UK competent authority ID mark GB/3518A/AF-85 in addition to USA/0411/AF-85 was because after previous assessment ONR were of the opinion that there were some deficiencies in the case approved by the US competent authority. This was because the US approved design is based on a Criticality Safety Index (CSI) of zero, meaning there would be no limitation on the number of packages per conveyance. ONR identified this as unacceptable and did not meet our expectations for package criticality control within the UK and so it was not possible to fully validate the US approval. Instead the GB certificate GB/3518A/AF-85 was issued which included additional restrictions to ensure the package design complies with the regulations. This approach is explained further in Section 3 of TRA-PER-GD-009 and Section 4 of TRA-PER-GD-009 [6].
10. As it is intended to use the GB/3518A/AF-85 package to transport fissile content in the UK, UUK have submitted an application [3] requesting package design approval from ONR (the CA) as required under the following modal regulations to allow transport by road, rail and sea:
 - European Agreement Concerning the International Carriage of Dangerous Goods by Road, ADR [7] – provisions 1.6.6.2.1 (b) and 6.4.22.4;
 - Regulations concerning the International Carriage of Dangerous Goods by Rail, RID [8] - provisions 1.6.6.2.1 (b) and 6.4.22.4;
 - International Maritime Dangerous Goods Code, IMDG [9] - provisions 6.4.22.2 and 6.4.22.4.¹
11. Since the package design was approved by ONR in September 2011, the Safety Assessment Report (SAR) has been updated from INS Report Number 80 Issue 4 [10] to UUK6116800.1 Issue 1 [3]. Prior to UUK updating the SAR, ONR met with UUK to outline ONR's expectations for the revision [11].
12. Previous regulatory assessment was focussed on Criticality Safety Case. No shielding assessment was carried out. Engineering assessment was limited to confirming package performance under NCT in support of criticality assessment.
13. The main changes since the previous approval are:
 - Completely revised criticality assessment, although it uses a very similar methodology to that used in the previously approved case. The new case contains calculations using a more modern version of the criticality code (MONK) and includes assessment of temperature effects.
 - A shielding assessment has been included. This is the same shielding assessment as was supplied in support of the GB/5121 (USA/9196).
 - Applicant is now UUK whereas previously it was International Nuclear Services (INS).
14. The revised criticality assessment resulted in a reduction in the permitted consignment mass limits compared to that which has been approved previously. The packaging and claims on packaging performance are unchanged.

¹ 6.4.22.4 of ADR, RID and IMDG apply as it is a fissile package and 1.6.6.2.1 (b) of ADR/RID and 6.4.22.2 of IMDG apply as the packaging is manufactured to a package design approved by the competent authority under the provisions of the 1985 Edition.

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15. The ONR assessment of this application therefore focussed on the changes in the safety case that has been made since the previous CoA was granted.
16. This ONR Project Assessment Report (PAR) presents the findings of the assessment of the application for package design approval of the Type 30B Cylinders Containing a Heel of Uranium Hexafluoride without Protective Shipping Package, GB/3518A/AF-85 [3].

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

17. This current application has been considered in accordance with ONR's assessment processes [6].
18. The package design under assessment is Type A Fissile, hence the designations USA/0411/AF-85 (and GB/3518A/AF-85). In accordance with para 802 and Annex I of the International Atomic Energy Agency (IAEA) Regulations for the Safe Transport of Radioactive Material, currently SSR-6 (2012 Edition) [12], CA approval is only required owing to the fissile aspect of the package, i.e. CA approval is not required for Type A package design containing non-fissile material. Thus, multilateral approval is only required because the package is a fissile package (potential criticality hazard).
19. In accordance with ONR's transport process, a pre-job brief and assessment scope decision record have been compiled, identifying potential areas of concern and agreeing the assessment strategy, scope, timescales and assessment output [13, 14].
20. ONR carried out a detailed programme of work [15 to 19] 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. A proportionate and targeted sampling assessment approach was adopted which focused mainly on:
 - the criticality assessment, as this is where the majority of modifications were since last approved by ONR in 2011, is the key reason why multilateral approval is required for this package, and has resulted in reduction in the permitted consignment mass limits compared to that which has been approved previously;
 - compliance with the uranium mass limits (which also requires accurate determination of enrichment) is fundamental to criticality safety of the package / consignment;
 - high level review of the new shielding assessment to ensure it contains expected information and any necessary operational controls are brought out in the operating instructions;
 - any engineering assumptions which underpin the criticality case;
 - clarify use of the package in the UK i.e. is UUK the only consignor, carrier and user in the UK or are there others and if so, how operating and maintenance requirements are communicated to other package users.
21. Assessments were undertaken for: criticality, engineering (accounting for the thermal and containment requirements), shielding and safety case requirements (the implementation of the safety case). Assessment reports were produced for each assessment undertaken [15 to 18]. An assessment record was kept to track ONR assessment questions and Applicant responses (Q1AR) [19]. Once the ONR assessment comments were closed out, the certificate was drafted and sent to the Applicant for comments on factual accuracy. Following approval of the assessment reports, this PAR was compiled.

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3.1 CRITICALITY ASSESSMENT [15]

22. ONR's criticality assessment [15] focussed on:

- Any changes to the modelling assumptions compared to the previously approved case;
- The derivation of the new uranium mass limits, taking into account the use of a more modern version of the MONK code and consideration of temperature effects;
- Compliance with the uranium mass limits (which also requires accurate determination of enrichment) which is fundamental to criticality safety of the package / consignment.

23. It was concluded that the derivation of the new uranium mass limits per consignment as well as derivation of CSI is adequate and meets the requirements of ADR [7], RID [8] IMDG [9] and IAEA SSR-6 and SSG-26 [12] for a fissile package.

24. Approval of the package was supported from a criticality safety perspective providing the ONR Engineering Specialist Inspector confirmed that the weigh scales and associated operating instructions are sufficiently adequate to allow the package / consignment mass limits to be complied with (see Section 3.3, which confirms this to be the case).

3.2 SHIELDING ASSESSMENT [16]

25. ONR's shielding assessment [16] carried out a review of the applicants shielding safety case UG-CTG-N-0-15-015129 [20] and UUK6116799 [21] including source terms, geometry, calculation methods and results. The applicants shielding assessment considered dose rates arising from Type 30B cylinders containing natural, depleted, enriched and reprocessed uranium heels. UUK has confirmed that they are not seeking permission to transport reprocessed uranium heels within the Type 30B cylinders without the PSP. This clarification means that dose rates for all cylinders containing un-reprocessed (natural, depleted and enriched) uranium will adequately meet package dose rate criteria provided they are not transported until 18 days after filling (as stated in [3]).

26. Neither the application (nor subsequent responses to Q1 questions [19]) provide specific consideration of the dose rates due to accumulations of heeled cylinders in a conveyance (e.g. on a flatbed trailer). However, peak dose rates from the heel material will be localised to the bases of the cylinders and fall-off rapidly with distance. Thus the dose rates from accumulations of cylinders are likely to be acceptable, as the physical dimensions of the cylinders should space them out such that the dose rate fall-off from the heels will result in dose rates that meet transport dose rates criteria for a conveyance. The monitoring regime provided in UUK/SHEQ/MON24 [22] should be sufficient to provide confirmation that dose rates around any package or conveyance will be compliant with the dose rate criteria prior to transport.

27. The ONR shielding assessment [16] (and subsequent clarification [23]) concludes that the claims, arguments and evidence within the safety case documentation are sufficient to meet the shielding and dose rate requirements of SSR-6 and recommends approval subject to the following conditions:

- Limiting the uranium-232 content per package to less than 1 A2.
- Pre-shipment measurement shall be used for empty / heeled cylinders to confirm that maximum dose rates are within regulatory limits.

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28. The above recommendations have been captured on the certificate of approval, GB/3518A/AF-85 (Rev.9).

3.3 ENGINEERING ASSESSMENT [17]

29. The engineering assessment [17] confirmed:

- The cylinder is designed and manufactured in accordance with ANSI N14.1 which is historically an acceptable alternative to ISO 7195 – called for under ADR 6.4.6.
- The design of the cylinder has not changed since the previous approval.
- The supporting evidence for drop and thermal testing are dated 2004/2005 and are the same provided for the previous approval.
- The regulatory expectations of ADR (and associated standard ISO 7195) have not changed since the previous approval.

30. As part of the criticality assessment, the ONR Criticality Specialist Inspector requested the ONR Engineering Inspector review the adequacy of the weigh scales and associated operating instructions to confirm that they are sufficiently adequate to allow the package / consignment mass limits to be complied with. Through review of documentation, meetings / discussions with the applicant resulting in updates to processes to account for uncertainties, the Engineering Inspector confirmed that they are content that the arrangements are now adequate (see [19], [24] and [25]).

3.4 SAFETY CASE REQUIREMENTS ASSESSMENT [18]

31. ONR assessed the arrangements for implementation of the safety case requirements and certificate of approval [18].
32. UUK is expected to be the only UK based consignor. The GB/3518A package will also be sent from foreign consignors to the UUK Capenhurst site and will involve foreign based carriers. UUK and its customers use third party Approved Carriers for transport within the UK and abroad. For URENCO, this could be Framatome US, GNF US and Westinghouse US as consignors or consignees as well as UUK's dedicated freight forwarders (DAHER, TAM and RSB) and their subcontractors. Within the UK, Westinghouse may be a consignee if UUK chooses to use the cylinder wash and recertification service at Springfields.
33. The focus of the assessment was on UUK as the applicant and the GB based consignor and gaining confidence in its competence and capability to implement the requirements of the safety case / certificate. No inspection work was conducted explicitly in support of this application. Regulatory confidence is drawn from the recent inspection history of UUK including a recent inspection in February 2018 [26]. Based on the outcome of these regulatory activities, ONR is content that the safety management arrangements at UUK are suitable and sufficient to comply with the regulatory requirements for transport of radioactive material and an ONR package design Certificate of Approval.

4 MATTERS ARISING FROM ONR'S WORK

34. The USA approval is based on the 1985 regulations i.e. the 'Grandfathering' option permitted under IAEA SSR-6 para. 820 [12] is being utilised, hence the '-85' suffix. The '-85' certificate is only valid for packages manufactured prior to 31 December 2006 (see para 817 of TS-R-1 2009 Edition) [12]. This restriction will be captured on the certificate of approval, GB/3518A/AF-85 (Rev.9), issued to the applicant. UUK have been informed that for packages manufactured after 31 December 2006, UUK will

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have to submit a separate application which demonstrates full compliance with the regulations as it is not permissible to use the Grandfathering provisions for packages manufactured after 31 December 2006.

5 CONCLUSIONS

35. This report presents the findings of the ONR assessment of the adequacy of UUK's application for the Type 30B Cylinders Containing a Heel of Uranium Hexafluoride without Protective Shipping Package, USA/0411/AF-85, for carriage by road, rail and sea. This has been judged against the requirements for a Type AF-85 transport package design of the IAEA Regulations for the Safe Transport of Radioactive Material, SSR-6, 2012 Edition [12], as implemented in UK law via ADR, RID and IMDG [7, 8, 9] for carriage by road, rail and sea respectively.
36. Based on the sampling undertaken [13 to 19] I am satisfied with the claims, arguments and evidence within the safety case documentation and conclude that it is safe and meets the requirements for a Type AF-85 transport package design detailed within ADR, RID and IMDG (and also SSR-6).

6 RECOMMENDATIONS

37. It is recommended that the package design approval is issued for the Type 30B cylinders containing a heel of uranium hexafluoride without protective shipping package, USA/0411/AF-85, for carriage by road, rail and sea. However, due to deficiency in terms of CSI as identified under previous approvals, it is not possible to validate the revised US certificate, USA/0411/AF-85 Revision 11 in full. For this reason it is recommend that this multilateral approval is effected by the issue of GB certificate of approval GB/3518A/AF-85 (Rev.9) which adds additional controls.

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Figure 1
Schematic of Cylinder Model 30B

