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| **PROJECT ASSESSMENT REPORT** | | | |
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**New Package Design Application GB/4121 (R82)**

**Application for UK Competent Authority Package Design Approval of Transport flask R82 as a Type B(U)F Package**

Project Assessment Report ONR-TD-PAR-22-010

Revision 0

12 September 2023

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**EXECUTIVE SUMMARY**

**Permission Requested**

ROBATEL Industries (Robatel), the Applicant, have applied to the Office for Nuclear Regulation (ONR) for approval of the R82 package design (GB/4121/B(U)F) for transport by road and rail. This report presents the basis of the regulatory decision by the ONR as Great Britain (GB) Competent Authority (CA) for the transport of Class 7 (radioactive material) dangerous goods. The statutory duty is given to ONR through The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (CDG).

**Background**

The NDA’s strategy for fuels that were irradiated in the Dounreay Prototype Fast Reactor (PFR) is to consolidate them at Sellafield Ltd (SL). A suitable package was not available for irradiated PFR fuel assemblies and Dounreay Site Restoration Ltd (DSRL) produced a justification to commission a new package design.

The package design is a 46.6 t, 4.6 m cylindrical stainless-steel design including a ‘multiple high standard water barrier’ to support the criticality safety case. The material for consolidation consists of irradiated mixed oxide (MOX) fuel sub-assemblies (SA’s), carbide fuel SA’s, breeder SA’s and MIF (miscellaneous irradiated fuel) items such as loose. These items will be loaded into welded stainless-steel Irradiated Fuel Containers (IFCs). A basket within the multi-element bottle (MEB) accommodates up to nine IFCs per package.

DSRL have adopted a progressive strategy for approval. The current package design safety report (PDSR) considers a subset of the material to be transported throughout the consolidation campaign (Irradiated Oxide PFR Core Fuel Sub-Assemblies / Radial Breeder Sub-Assemblies and Oxide PFR Loose Pins). This approval is restricted to the content described above in the PDSR and Certificate of Approval. Additional contents will be added to the PDSR and submitted to ONR for approval as the consolidation transport programme develops.

**Assessment work carried out by ONR in consideration of this request**

ONR has considered the engineering, criticality, radiation shielding and safety case requirements (SCR) aspects of the safety submission in respect of compliance with the International Atomic Energy Agency (IAEA) Regulations for the Safe Transport of Radioactive Material (SSR-6 2018 edition). Targeted and proportionate ONR assessments were undertaken in accordance with ONR guidance for new package designs. The engineering assessment focused on adequacy of the package containment system, thermal safety assessment and impact assessment. The criticality assessment focused on the fissile payload, geometry and material specification, criticality safety criterion, temperature effects and independent cross-checking of criticality calculations. The radiation shielding assessment targeted the contents specification, source term generation and general radiation shielding calculation methodology. The SCR assessment considered the non-engineering means of assuring compliance with the relevant transport regulations.

Several regulatory queries were raised and adequately closed during the ONR assessment. ONR assessments of all four aspects of the safety submission recommended approval of the package design.

**Matters arising from ONR's work**

During the ONR engineering and SCR assessments, four recommendations were made with respect to operational use, manufacturing arrangements and the adequacy of finite element analysis used to support the engineering safety case. The ONR assessment reports that make the recommendations do not contest the safety or compliance of the package design. The ONR project inspector has judged that any requirement for further assessment and / or inspection will be considered during routine engagement between the ONR Transport Competent Authority and the relevant dutyholder and will be undertaken, if required, prior to first use of the package.

**Conclusions**

The safety submission from the Applicant, together with supporting documentation provided to ONR throughout the assessment process, is adequate to meet applicable regulatory requirements and the package design is judged to be safe.

**Recommendation**

It is recommended that the ONR Transport Competent Authority approve the R82 design by issuing GB approval certificate GB/4121/B(U)F (Rev.0), to be valid for a period of five years.

**LIST OF ABBREVIATIONS**

ACT Accident Conditions of Transport

ADR European Agreement concerning the International Carriage of Dangerous Goods by Road

CA Competent Authority

CDG The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations

GB Great Britain

IAEA The International Atomic Energy Agency IMDG International Maritime Dangerous Goods Code

IFC Irradiated Fuel Container

MEB Multi Element Bottle

MIF Miscellaneous Irradiated Fuel

MOX Mixed Oxide

NDA Nuclear Decommissioning Authority

NCT Normal Conditions of Transport

ONR Office for Nuclear Regulation

PAR Project Assessment Report

PDSR Package Design Safety Report

PFR Prototype Fast Reactor

RCT Routine Conditions of Transport

RID Regulations concerning the International Carriage of Dangerous Goods by Rail

SA Sub-assembly

SCR Safety Case Requirements (Assessment)

SL Sellafield Ltd

SSG (IAEA) Specific Safety Guide

SSR (IAEA) Specific Safety Requirements

TAG Technical Assessment Guide (ONR)

TCA Transport Competent Authority

UK United Kingdom

UNECE United Nations Economic Commission for Europe

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1. PERMISSION REQUESTED
2. ROBATEL Industries (Robatel), the Applicant, have applied [1] to the Office for Nuclear Regulation (ONR) for approval of the R82 package design for transport by road and rail.
3. BACKGROUND
   1. Legislation
4. This report presents the basis of the regulatory decision by the ONR as Great Britain (GB) Competent Authority (CA) for the transport of Class 7 (radioactive material) dangerous goods, to grant an approval of the R82 package design. The GB CA number assigned to this design is GB/4121/B(U)F.
5. This statutory duty is given to ONR through The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (CDG) [2].
6. The following modal regulations apply to allow transport by road and rail:

* European Agreement Concerning the International Carriage of Dangerous Goods by Road (ADR) 2021 Edition [3];
* Regulations concerning the International Carriage of Dangerous Goods by Rail (RID) 2021 Edition [4].

1. The above modal regulations are based on the International Atomic Energy Agency (IAEA) Regulations for the Safe Transport of Radioactive Material, currently SSR-6 2018 [5] supported by advisory material in SSG-26 [6].
   1. Package Design
2. The Nuclear Decommissioning Authority’s (NDA) strategy for fuels that were irradiated in the Dounreay Prototype Fast Reactor (PFR) is to consolidate them at the Sellafield nuclear licensed site. Following the closure of reprocessing plants at SL, there is a requirement to dry-ship the remaining irradiated material and as a suitable package was not available for irradiated PFR fuel assemblies, Dounreay Site Restoration Ltd (DSRL) produced a justification to commission a new package design. DSRL specified that the new package was required to meet transport regulations and the NDA’s target date for consolidation at SL. DSRL tendered for a package design to meet its specifications and commissioned Robatel to design and submit an application for GB CA approval of the package design.
3. The package design is a 46.6 t (loaded), 4.6 m cylindrical stainless-steel design. Within the stainless-steel outer body is the shielding, thermal and mechanical protection (lead shielding, ROBATEL PNT7TM neutron and thermal shielding and structural stainless steel) and a closure lid made of stainless steel which is bolted to the flask’s body. The internal furniture consists of a self-contained stainless-steel Multi Element Bottle (MEB) with its own bolted lid. Stainless-steel / wood shock absorbers are fitted front and rear to provide impact and thermal protection (see Figure 1).
4. In accordance with SSR-6 para. 680, the package design includes a ‘multiple high standard water barrier’. The multiple high standard water barriers are in the outer flask closure system and the MEB. As such, for packages in isolation it is not a requirement for the criticality case to assume water ingress past the secondary barrier into the MEB void spaces, resulting in an increased fissile payload.
   1. Contents
5. All material to be consolidated at SL has been in a DSRL pond at some time but has been dry stored for over 20 years. Due to the ageing time and irradiation, the maximum heat output is less than 1000 W per package, calculated at approximately 200 W for core fuel sub-assemblies (SA) and external dose rates are expected to be relatively benign in comparison to other irradiated fuel.
6. The material for consolidation consists of irradiated mixed oxide (MOX) SA’s, carbide fuel SA’s, breeder SA’s and MIF (miscellaneous irradiated fuel) items such as loose pins which will be loaded into various cans. These items will be loaded into welded stainless-steel Irradiated Fuel Containers (IFC). A basket within the MEB accommodates up to 9 IFCs.
7. DSRL have adopted a progressive strategy for approval. The current package design safety report (PDSR) [7] considers a subset of the material to be transported throughout the consolidation campaign. PDSR content modifications are expected to be submitted to ONR for approval as the consolidation transport programme develops. The contents to be transported throughout this campaign and under the current PDSR are:

* Content No. 1 – Irradiated Oxide PFR Core Fuel Sub-Assemblies and Irradiated Oxide PFR Radial Breeder Sub-Assemblies
* Content No. 2 – Oxide PFR Loose Pins
  1. Applicant

1. ONR has no regulatory history or intelligence of Robatel, however Robatel have designed and manufactured multiple Type B Competent Authority approved packages in France. ONR considered the recent inspection history of Robatel in the Safety Case Requirements assessment [8].
2. ONR engaged with the Applicant prior to submission and advised of our regulatory expectations [9] [10] [11].
3. ASSESSMENT AND INSPECTION WORK CARRIED OUT BY ONR IN CONSIDERATION OF THIS REQUEST
4. The PDSR [7] submitted to ONR is a self-contained document, with the content based on the ONR Applicants Guide [12] which in turn is based on the IAEA transport package application guidance.
5. ONR carried out a targeted and proportionate programme of assessment of the Applicant’s PDSR, its claims, arguments, supporting documentation and evidence. The engineering, criticality, radiation shielding and safety case requirements (SCR) aspects of the safety submission has been assessed in respect of compliance withSSR-6 [5] and SSG-26 [6]**.**
6. The key findings and conclusions for each assessment are summarised in sections 3.1 to 3.4 below. Further details that underpin the summaries are provided in the ONR assessment reports that are referenced in the relevant sections.
   1. Criticality Assessment [13]
7. A criticality assessment was carried out in accordance with ONR guidance [14]. The scope of the assessment includes inspection of the Applicant’s criticality safety analysis (Part 2, Chapter 16 of the PDSR) and various supplementary documentation provided by the Applicant during the ONR assessment.
8. The ONR criticality assessor agreed with the Applicant’s statement that routine conditions of transport (RCT) and normal conditions of transport (NCT) conditions would be bounded by the accident conditions of transport (ACT) criticality assessment. Various criticality technical questions were asked, focusing on the fissile payload, geometry and material specification, criticality safety criterion, temperature effects and independent cross-checking of criticality calculations. The Applicant provided adequate responses to these questions and included independent cross-check calculations that provided the ONR criticality inspector with further confidence that the package will remain sub-critical in all conditions of transport with the specified payload.
9. Fundamental to the criticality safety case is the claim that the R82 package containment systems (the MEB and R82 flask) present two high standard multiple water barriers. If this is the case, the criticality assessment is not required to consider water ingress into the package voids (in and around the fuel pins in particular) in accordance with SSR-6. This provides the opportunity to transport higher fissile quantities in the R82 package. The adequacy of the multiple water barrier, a feature that is imperative to the criticality safety case, is considered in the ONR engineering assessment.
10. 8 technical questions were raised with the Applicant during the ONR criticality assessment and acceptable responses were provided.
11. Based on the claims, arguments and evidence contained in the Applicant’s safety documentation, the ONR criticality assessor is satisfied that this package meets the criticality safety requirements of the IAEA SSR-6 [5] as implemented in UK law for routine, normal and accident conditions of transport.
12. The ONR criticality assessor recommended that the ONR Transport Competent Authority (TCA) approve the GB/4121/B(U)F package design.
13. The criticality recommendation for approval is contingent on the ONR engineering assessment report confirming that the R82 transport package meets the IAEA requirements for claiming high standard multiple water barriers, specifically that the water barriers must remain watertight following the SSR-6 ACT tests (see paragraph 27).
    1. Engineering Assessment [15]
14. An engineering assessment was carried out in accordance with ONR guidance [16]. The engineering assessment considered the adequacy of the package containment system, thermal safety assessment and impact assessment (finite element analysis / physical testing).
15. 16 technical questions were raised with the Applicant during the ONR engineering assessment relating to containment, thermal safety and impact assessment, and acceptable responses were provided.
16. It was confirmed that the seal performance, thermal analysis and physical / finite element testing were adequate and demonstrated compliance with IAEA SSR-6 design requirements.
17. The ONR engineering assessment considered the ONR criticality safety assessment requirement to confirm that the primary and secondary enclosures of the package would provide a high standard multiple water barrier during accident conditions of transport. The ONR engineering assessor confirmed that the Applicant has adequately demonstrated a high standard multiple water barrier, therefore validating the ONR criticality assessment (see paragraph 22).
18. Based on the claims, arguments and evidence contained in the Applicant’s safety documentation, the ONR engineering assessor is satisfied that this package meets the containment and thermal safety requirements of the IAEA SSR-6 [5] as implemented in UK law during RCT, NCT and ACT.
19. The ONR engineering assessor recommended that the ONR TCA approve the GB/4121/B(U)F package design.
20. The ONR engineering assessor made three further recommendations which are discussed further in Section 4.
    1. Radiation Shielding Assessment [17]
21. The ONR radiation shielding assessment was carried out in accordance with ONR guidance [18] and considered the radiation shielding safety submission by the Applicant and whether it met the applicable international transport requirements.
22. The ONR assessment focused on the contents specification, source term generation and general radiation shielding calculation methodology during RCT, NCT and ACT. The RCT contact dose rate is a factor of 30 lower than the exclusive use criterion for a pessimistically developed source term and model.
23. 11 technical questions were raised during the ONR radiation shielding assessment relating to the package modelling, code use, calculation methodology and source term derivation, all responses were assessed, and the supplementary evidence and arguments provided confidence that the package will be compliant with SSR-6 dose rate requirements under all conditions of transport.
24. Based on the claims, arguments and evidence contained in the Applicant’s safety documentation, the ONR radiation shielding assessor is satisfied that this package meets the dose rate requirements of the IAEA SSR-6 [5] as implemented in UK law during RCT, NCT and ACT.
25. The ONR radiation shielding assessor recommended that the ONR TCA approve the GB/4121/B(U)F package design.
    1. Safety Case Requirements (SCR) Assessment [8]
26. The SCR assessment considers the non-engineering means of assuring compliance with the relevant transport regulations, such as in the use, operation, and maintenance of the approved package design.
27. An SCR assessment often complements the engineering assessment of the package design by inspecting the manufacturing processes to ascertain that the manufactured package conforms to the design intent. However, at the time of approval the manufacturer had not been selected and as such, inspection or assessment of the manufacturing arrangements is out of scope. ONR may satisfy itself that the manufacturer has adequate arrangements by undertaking a future inspection (see paragraphs 50 to 52).
28. This ONR SCR assessment has been undertaken in accordance with the relevant ONR transport guidance.
29. The adequacy of Robatel management arrangements were judged based on certification, inspection evidence and the quality of the safety case. Robatel hold an extant ISO 9001 certificate covering nuclear design. ASN have undertaken several inspections of Robatel and in 2022 considered management systems during a manufacturing inspection in accordance with ADR Chapter 1.7.3. There were no significant findings or corrective actions. The quality of the PDSR was also considered as evidence that Robatel have adequate transport management arrangements. A compliance matrix was provided considering all relevant transport requirements and this, along with robust supporting arguments and evidence, demonstrated compliance with the relevant regulations.
30. The SCR assessment has confirmed that operating instructions, inspection, and maintenance arrangements have been documented.
31. 7 SCR questions relating to inspection and package approval history were raised during the assessment and these were all adequately resolved during the ONR assessment.
32. Based on the claims, arguments and evidence contained in the Applicant’s safety documentation, the ONR SCR assessor is satisfied that this package meets the dose rate requirements of the IAEA SSR-6 [5] as implemented in UK law during RCT, NCT and ACT.
33. The ONR SCR assessor recommended that the ONR TCA approve the GB/4121/B(U)F package design.
34. The ONR SCR assessment made one further recommendation that is considered in Section 4.
35. MATTERS ARISING FROM ONR’S WORK
36. During the ONR engineering and SCR assessments, four recommendations were made.

*Engineering Recommendation (i)*

1. Engineering recommendation (i) recommends that ONR complete an IFC loading and closure methodology compliance assessment against the design before package use.
2. The PDSR provides the specification for the radioactive content and IFC design, as well as operational instructions, to ensure that the package will be consigned and transported in accordance with transport regulations. The recommendation made in the engineering assessment does not contest the safety or compliance of the package and does not impact the engineering conclusion that the package design is compliant with SSR-6. There is no evidence to suggest that safety or compliance with the relevant regulations will be challenged during transport operations, provided that the package is manufactured and operated in accordance with the PDSR.
3. Engineering recommendation (i) relates to the safe use of the package by the consignor. It is not expected that this package will be used to transport material during the requested 5-year certification period (2023 – 2028). The consignor is expected to be Magnox Ltd (currently, consignment operations would be under DSRL arrangements) and based on recent inspections [19] [20], ONR has judged that both Magnox Ltd and DSRL have adequate transport management arrangements. There is no evidence to suggest that the consignor cannot adequately manufacture the package and translate the operational instructions to local working instructions and, as such, no reason to delay providing a package design certificate.
4. ONR has policies, procedures and guidance in place to deliver effective regulation of transport dutyholders. If there is a requirement to assess or inspect the IFC loading and / or closure methodology prior to first use, this will be captured and planned through normal regulatory interactions between the TCA and the appropriate dutyholder.

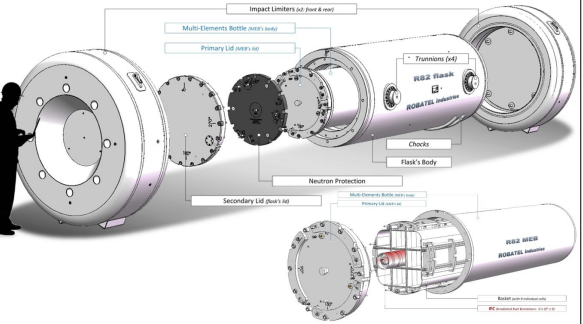
*Engineering Recommendation (ii) and SCR recommendation (i)*

1. These recommendations are related to the safety and compliance of the transport package by assuring that the package manufacturer produces a product in accordance with the PDSR specification. The recommendations are that package manufacturing quality is adequately controlled and that ONR have the opportunity to inspect the manufacturing arrangements and / or package, if necessary.
2. The application is for package design approval and neither the ONR engineering or SCR assessment claim that safety or compliance with the relevant regulations are challenged; the recommendations of TCA approval from both assessments are not contested.
3. It is expected that Magnox Ltd (potentially under DSRL arrangements) will tender for manufacture following design approval. For the same reasons stipulated in paragraphs 48 and 49, ONR will have the opportunity to inspect the manufacturing arrangements and / or package (and assure itself that the package manufacturing quality is adequately controlled) through normal regulatory interactions between the TCA and the appropriate dutyholder.

*Engineering Recommendation (iii)*

1. The final engineering recommendation was that the Applicant should submit adequate finite element analysis validation evidence to support future package applications.
2. Mechanical testing has been undertaken on a 1/3 scale model with further finite element analysis of the full-scale package. The ONR engineering assessor has undertaken a programme of work to ensure that in this application, the full-scale finite element analysis that substantiates the claims of compliance following the regulatory accident tests, is adequately validated.
3. This ONR engineering recommendation does not contest the safety or compliance of the package but puts a requirement on the ONR TCA to provide general guidance to the Applicant for future package applications.
4. Robatel will be notified that future transport package applications should include adequate finite element analysis validation when the R82 certificate is distributed.
5. CONCLUSIONS
6. The safety submission from the Applicant, together with supporting documentation provided to ONR throughout the assessment process, meets the applicable regulatory requirements and the package design is judged to be safe and compliant with the relevant transport regulations.
7. RECOMMENDATIONS
8. It is recommended that the ONR TCA grants approval of the R82 transport package design by issuing GB certificate of approval GB/4121/B(U)F (Rev.0), to be valid for a period of five years.
9. REFERENCES

|  |  |
| --- | --- |
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| [3] | United Nations Economic Commission for Europe (UNECE), European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) 2021 Edition. www.unece.org. |
| [4] | Intergovernmental Organisation for International Carriage by Rail (OTIF), Regulations concerning the International Carriage of Dangerous Goods by Rail (RID) 2021 Edition. www.otif.org. |
| [5] | IAEA Safety Standards: SSR 6, ‘Regulations for the Safe Transport of Radioactive Material (2018 Edition)’, IAEA, Vienna, 2018. www.iaea.org. |
| [6] | IAEA Safety Standards: SSG 26, ‘Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition)’, IAEA, Vienna, 2012. www.iaea.org. |
| [7] | ANS 0001 ‘PACKAGE DESIGN SAFETY REPORT R82 TRANSPORTATION FLASK Rev B’, dated 18 November 2021. |
| [8] | GB/4121 (SVC4366668) - Assessment Report - GB/4121/B(U)F R82 Safety Case Requirements SCR CM9: 2023/3932. |
| [9] | Transport Permissioning - R82 Early Engagement (SVC4366668) - Contact Record ONR-SDFW-CR-18-348 - Drop Test Programme - A Smith - 04 July 2018 CM9: 2018/233763. |
| [10] | Transport Permissioning - R82 Early Engagement (SVC4366668) - Contact Record ONR-SDFW-CR-19-601 Package Design Safety Report Submission - 9 October 2019 - A Smith CM9: 2019/314077.. |
| [11] | Transport Permissioning - R82 Early Engagement (SVC4366668) - Contact Record ONR-SDFW-CR-17-979 Rev 0 - 31st January 2018 CM9: 2020/62028.. |
| [12] | TRA-PER-GD-014 Revision 3, ‘Guidance For Applications For UK Competent Authority Approval’ November 2019.. |
| [13] | ONR-TD-AR-22-010 - (SVC4366668) - Criticality Safety Assessment for the UK Validation of R82 CM9:2022/43995. |
| [14] | NS-TAST-GD-097 Revision 2 'Criticality Safety Assessment of Transport Packages'. |
| [15] | ONRW-2126615823-615, Mechanical Engineering Assessment of Robatel Industries Transport Package R82 (GB/4121/B(U)F-96) Application. |
| [16] | NS-TAST-GD-099 Issue 2.1 'Transport Engineering Assessment'. |
| [17] | GB/4121 (SVC4366668) - Assessment Report - GB/4121/B(U)F R82 Shielding AR CM9: 2023/1456. |
| [18] | NS-TAST-GD-100 Revision 2 'Shielding and Dose Rate Assessment of Transport Packages'. |
| [19] | ONR-SDFW-IR-21-051, Dounreay: Annual Review of Safety, Security & Safeguards, LC11, LC26, CDM, LOLER & CDG Compliance Inspections and IIS 100 Inspection Activities CM9: 2021/56072. |
| [20] | ONR-TD-IR-22-015, Magnox Ltd: Corporate Inspection of Magnox Ltd Transport Management Arrangements, Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 and IRR 2017 (including LC17 and LC25) CM9: 2022/55886. |

**Figure 1:** R82 Package Assembly