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| ONR Technical Assessment Guide  Transport Engineering Assessment |



ONR Technical Assessment Guide (TAG)

**Transport Engineering Assessment**

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# INTRODUCTION

1. The Office for Nuclear Regulations (ONR) Technical Assessment Guides (TAG) assist inspectors’ assessments. The guides also support inspectors make regulatory judgements and decisions. The existing guides support the ONR’s Safety Assessment Principles (SAPs), which are used to assess safety cases for nuclear facilities.
2. The range of guides has been extended to cover ONR’s other regulatory responsibilities. This TAG is one of these guides, which covers radioactive materials transport.

# PURPOSE AND SCOPE

1. This TAG guides ONR inspectors’ mechanical assessment of the safety of package designs that are being assessed for approval under the transport regulations. It also covers the adequacy of the regulatory tests completed on packages. These tests are detailed in Package Design Safety Reports (PDSRs) that are submitted to support requests for design approvals. The scope of this guidance is governed by two primary ONR Transport guidance documents: TRA-PER-GD-014 [1] and TRA-PER-GD-001 [2].
2. The TAG is limited to the aspects of the transport regulations relevant to the mechanical safety of package designs, specifically:

* containment of radioactive contents; and
* prevention of damage caused by heat.

1. This TAG excludes the following safety attributes as they are addressed in other guidance:

* preventing criticality; and
* controlling external radiation hazards.

1. This TAG contains guidance to advise and inform ONR staff in the exercise of their regulatory judgment.
2. Research into topics relevant to the assessment of transport packages has been carried out, this TAG includes short summaries of these research activities as Annexes.

# RELATIONSHIP TO LICENCE CONDITIONS AND OTHER RELEVANT LEGISLATION

1. Licence conditions, that apply to the nuclear safety aspects on licensed sites, are not directly applicable to the assessment of package designs for off-site use. However, aspects of transport activity do overlap with on-site activity. These aspects apply to licence conditions, which link to management arrangements, packing/unpacking and loading/unloading. In these cases, the activities identified within the PDSR should also satisfy applicable licence conditions. If packages are also used on-site, i.e. for storage/transport, their use is covered by the licence conditions, the assessment should consider if there is any conflict between on-site and off-site use requirements and how these are addressed in the PDSR.
2. Legislation governing intra-national and international transport of radioactive materials is based on IAEA Regulations for the Safe Transport of Radioactive Materials, currently Specific Safety Requirements No. SSR-6 (SSR-6) [4]. These regulations are translated into European modal regulations (e.g. ADR [5] and RID [6] for road and rail transport respectively). Within these modal requirements, radioactive materials are referred to as Class 7 (out of 9 classes) Dangerous Goods. The modal regulations are given legal effect in GB via the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (CDG) [7], which are Nuclear Regulations under The Energy Act (2013).
3. ONR approves packages for Air and Sea transport, on behalf of the relevant competent authority, under a series of agency agreements. The modal requirements for these modes of transport are also based on SSR-6 [4]. All ONR’s assessment work should clearly identify the modes of transport the approval is required for. This enables the correct requirements to be identified within the assessment. ONR also approves packages for use within Northern Ireland by road where ADR [5] is the applicable modal requirement.
4. In this TAG, safety requirements reference the relevant paragraphs in SSR-6 [4] unless a specific modal requirement differs, then the specific modal reference is used. Any formal communications with duty holders, or regulatory enforcement action being considered by ONR inspectors, should reference the appropriate legal provisions that is relevant to the mode of transport in question.
5. IAEA document “Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material” - SSG-26 [8] supports the requirements of SSR-6 [4]. The contents of SSG-26 are considered to be relevant good practice for the purposes of interpreting the regulatory requirements. SSG-33 [11] is a useful guide to identify what requirements are applicable to each package type via the appropriate UN number.

# RELATIONSHIP TO SAPS, WENRA REFERENCE LEVELS AND IAEA SAFETY STANDARDS ADDRESSED

## SAPs

1. This TAG does not directly address or support any of the ONR Safety Assessment Principles (SAPs) [9]. This is because the ONR SAPs apply to assessments of the safety of existing or proposed nuclear facilities.
2. However, where aspects of package use interact with nuclear facilities, i.e. storage, packing and/or loading, then using the ONR SAPs may be appropriate during assessment. Particularly, if there is no other directly relevant guidance available.

## WENRA Reference levels

1. There are no specific WENRA reference levels [10] relevant to this TAG.

## IAEA Safety Standards

1. The applicable IAEA Safety Standard is SSR-6 [4] which, along with its supporting guidance document, SSG-26 [8], has been discussed above in Section 3.

# ASSESSMENT STRATEGY

## Overview

1. The purpose of an engineering assessment is to examine a transport safety case against the requirements of the transport regulations. The regulations are based on SSR-6 [4].
2. SSR-6 [4] is structured so that

* section II defines the terms that are used;
* section III specifies the general provisions relating to radiation protection emergency response, management system, training etc;
* section IV specifies the applicable activity limits and material restrictions used;
* section V specifies requirements and controls for transport;
* section VI specifies the performance standards required for radioactive material and for packagings and packages;
* section VII specifies the test procedures for demonstrating compliance with the performance standards specified in Section VI, and
* section VIII specifies the requirements for approvals and administration.

1. Engineering assessment focuses on whether the transport safety case meets the specific requirements in Section VI of SSR-6[4]. SSR-6 [4] Section VI links to Section VII, which specifies the test procedures for demonstrating compliance with the requirements.
2. SSR-6 [4] Section VI prescribes the following safety requirements for radioactive material design, packagings and packages:

* requirements for radioactive material (601–605);
* requirements for material excepted from fissile classification (606);
* general requirements for all packagings and packages (607–618);
* additional requirements for packages transported by air (619–621);
* requirements for excepted packages (622);
* requirements for industrial packages (623–630);
* requirements for packages containing uranium hexafluoride (631–634);
* requirements for Type A packages (635–651);
* requirements for Type B(U) packages (652–666);
* requirements for Type B(M) packages (667–668);
* requirements for Type C packages (669–672); and
* requirements for packages containing fissile material (673–686).

1. SSG-33 [11] provides a simple method of identifying which of these requirements apply to each package type via the associated UN number.
2. The initial assessment approach should be to conduct a high level “thin slice” review of the PDSR. The aim should be to determine whether the applicant has provided evidence against each of the applicable requirements. The PDSR should be in a format that allows this review to be completed with minimal effort ([1] para 2.5).
3. This high level review should ensure that the safety case claims and arguments are complete. The safety case should also provide links to suitable evidence of compliance.
4. Based on the design, use and/or other risk factors a more detailed assessment of specific topic areas should be completed. These “deep dives” should consider the methods used, and evidence provided, to determine whether the claims and arguments can be supported. A deep dive against all requirements is normally unnecessary. The initial assessment scope should identify the areas proposed, although this can change based on findings.
5. Designs may include novel use of materials or a high reliance on metal structural withstand/weld strength. Hence, it may be appropriate to request advice and guidance from a Structural Integrity specialist. Similarly, if manufacturing and supply chain aspects are critical to the design compliance, it may be appropriate to request support from the Human and Organisational Capability specialism.

## Thin Slice Assessment Approach

1. The purpose of a thin slice PDSR assessment is to consider whether compliance with the relevant prescribed parts of SSR-6 Section VI [4], is adequately presented.
2. To succeed, the assessment should consider whether the safety case has:

* Dealt with all the relevant safety performance requirements. There should be no obvious omissions ([11] and [12] provide useful guidance.
* Identified, and described, all the engineering components and processes that are provided to meet these safety performance requirements. This should specifically cover containment, shielding, criticality and temperature effects.
* Substantiated the safety performance requirements for these components and processes for all the relevant transport conditions. Such a substantiation requires that:

1. The correct engineering loads have been applied to all the relevant components, including the radioactive contents. For example, the following have been addressed:
   * the whole relevant range of loads (for routine, normal and accident conditions of transport) have been applied; any drop tests have been conducted “in the most damaging orientation” (SSR-6 para 630b [4]);
   * targets used for drop tests are essentially unyielding (SSR-6 para 717 [4]);
   * test loads for accident conditions of transport have been applied cumulatively (SSR-6 para 726 [4]) and impact drops have been conducted in the order that would result in maximum damage during the thermal test that follows (SSR-6 para 727 [4]).
2. Consequential loads, particularly resulting from normal and accident conditions of transport, have been addressed, for example:
   * e.g. pressurisation from material decomposition due to thermal and radiation effects;
   * combustion of flammable gases released from such decomposition; and
   * fatigue and fracture as a result of cyclic loading).
3. All the relevant failure modes and sequences for the given design have been considered, for example:
   * damage to shielding, moderator or radioactive material resulting in burn-off, melting or slumping;
   * relocation or re-arrangement of the radioactive material contents;
   * water ingress; and
   * low temperature brittle failure or high temperature creep failure of containment components, particularly the seals (see Annex A2).
4. All the relevant performance requirements prescribed in SSR-6 Section VI have been correctly interpreted for the given design and complied with. This may require the engineering inspector to interact with the shielding and criticality inspectors; the interaction also serves to ascertain the validity of the engineering damage assumptions made in the shielding/criticality modelling.
5. In addition, the safety case story must be internally consistent. There must be a clear link between the referenced documents, supporting evidence and the main safety case documentation (golden thread).

## Deep Dive Assessment Approach

1. Dependant on the application, i.e. new, renewal, validation, modification etc, and the specific technical aspects of the design; different aspects of the PDSR may be sampled at a more in-depth level. These deep dive assessments should target PDSR aspects that address higher risk and/or where the claims of compliance require significant amounts or complexity of evidence to support them.
2. The deep dive assessment approach is similar to that addressed in para 25 above but with additional depth of review. To support these deep dive assessments, more detailed supporting guidance to the requirements in SSR-6 [4] is provided in SSG-26 [8].
3. The assessment also needs to ascertain that the PDSR supporting evidence is complete and supports the claims of compliance. This means:
4. Where analytical substantiation is provided:
   * the calculation methods have good provenance and pedigree,
   * are verified and validated (see paragraphs 2.24 to 2.29 of [1]), and
   * use valid and verified input data.

Note : Certain calculations will require specialist assessment by a subject matter expert. Examples include, those involving new/non-standard/untested technology, or are based on bespoke or in-house models. The requirement for a specialist assessment should be determined by the Project Inspector in consultation with the Professional Lead and/or Programme Delivery Lead. The need for a specialist assessment can be minimised if the calculation methods in question has been validated and verified.

1. Where substantiation by means of physical testing, the test specimen must be demonstrated to be sufficiently similar to the production or approved module, and test procedures must be as prescribed in SSR-6 [4] Sections VI and VII (see Para 26 for examples of issues that should be considered).

## Guidance for Specific Application Types

1. Guidance on the appropriate levels of permissioning assessment required for the different types of applications is provided in Table 1 of the permissioning guide [2]

## Use of this TAG by Technical Support Contractors

1. Either the engineering assessment or its peer review may be carried out under a Technical Support Contract (TSC). TSC use is however subject to approval of the Programme Delivery Lead. The general guidance in Section 3 applies whether the engineering assessment is carried out by ONR staff or a TSC. Where TSCs carry out the majority of the assessment activity an engineering inspector should still provide intelligent customer oversight and confirm the scope and output meet the expectations of this TAG. This will also enable the inspector to liaise effectively with the applicant for the rest of the transport permissioning process.
2. The guidance in para 32 above only applies where the TSC substitute for ONR staff in the role of engineering inspector or peer reviewer. When the whole of a package design assessment is being undertaken by a TSC the processes and interfaces will be defined by the terms of the particular contract. Further guidance on the use of TSCs is in TRA-PER-GD-004 [13].

## Engineering Assessment Outputs

1. The engineering assessment outputs are:
2. The Q1 Question Set, which:

* Lists the set of issues raised with the Transport duty-holder during the course of the assessment.
* Provides a means of recording the interaction history with the duty-holder to resolve the issues as well as the inspector’s final sentencing of the issues.

Note: Guidance on producing a Q1 Question Set is provided in HOW2 [3].

1. The Assessment Report, which:

* Records their assessment, including a definite statement of whether (or not) the regulatory requirements in respect of engineering have been met by the safety case.
* Records the reasons for that statement.

Note: Guidance on the different levels of report by application type is provided in TRA-PER-GD-001 [2].

# ADVICE TO INSPECTORS

1. The assessment advice that follows provides additional guidance on specific aspects of the package performance requirements. This advice should be considered in combination with the requirements and guidance given in SSR-6 [4] and SSG-26[8].

## Key definitions

1. The requirements within SSR-6[4] include reference to aspects of the design which have specific meaning, which affect the interpretation. Words with specific definitions within SSR-6 [4] are written in italics and defined in Section II. Inspectors should be familiar with all the definitions. Those with specific importance to mechanical engineering assessment are detailed below:

* Containment system - Containment system shall mean the assembly of components of the packaging specified by the designer as intended to retain the radioactive material during transport.
* Maximum normal operating pressure – Maximum normal operating pressure shall mean the maximum pressure above atmospheric pressure at mean sea level that would develop in the containment system in a period of one year under the conditions of temperature and solar radiation corresponding to the environmental conditions in the absence of venting, external cooling by an ancillary system, or operational controls during transport.
* Package - Package shall mean the complete product of the packing operation, consisting of the packaging and its contents prepared for transport.
* Packaging - Packaging shall mean one or more receptacles and any other components or materials necessary for the receptacles to perform containment and other safety functions.

## General requirements for all packagings and packages

1. SSR-6 paras 607 to 618 [4], detailed below, identify the general requirements applicable to all packages.

* Para 607: requires that packages should be designed that they can be “properly secured” in or on the conveyance during transport. ADR para 7.5.7.1 identifies that this requirement is met for road transport if the securing system meets the requirements of EN 12195-1:2010. Appendix IV of SSR-6 provides additional guidance on other methods of demonstrating compliance to this requirement.
* Para 608: requires suitable design of the lifting attachments. SSG-26 identifies ISO 10276:2010 as an appropriate standard for trunnion design for radioactive packages.
* Para 612: This requirement includes, for example, packages that are transported on a pallet or in a frame where the pallet/frame has not been assessed as part of the package design. The inspector should ensure that the method of transport clearly identifies these additional features.
* Para 613: The requirement to withstand acceleration and vibration during routine conditions is not demonstrated by read across from any of the tests for more onerous impact conditions. The requirement should be specifically addressed in the PDSR and suitably justified.
* Para 613A: This requirement was added in the 2018 edition of SSR-6 and read into the modal requirements in 2021. The PDSR should include a management system that details how the package will be managed through life, addressing likely degradation, inspection and replacement of parts required. Where appropriate it should include aspects of long term storage (full or empty) with consideration of demonstration of suitability to transport when left in a filled condition for periods before transport. SSG-26 2019 includes guidance on this topic, the draft version should be used until it is formally issued.
* Para 616: This requires the package to withstand the ambient conditions it may see during transport. SSG-26 regards the ambient temperatures to be -40°C to +38°C. These values are consistent with the requirements in paras 639, 653 and 666, therefore the demonstration of these temperature requirements may be based on a bounding case.
* Para 618: radioactive material with a significant secondary hazard is unusual but this should be confirmed within the PDSR. In the case of Uranium Hexafluoride (UF6) see para 43 below.

## Requirement for Type A packages

1. Whilst Type A packages do not normally require assessment, these requirements also apply to Type B and C packages. Where a Type A package is required to transport fissile material, a Type AF assessment is required. This assessment may include a limited mechanical assessment of package performance against these requirements, to support the criticality assessment.
2. SSR-6 paras 636 to 649 [4] apply to Type B and C packages, however paras 650 and 651 do not:

* Para 636: requires a seal to demonstrate the package had not been opened during the transport activity. The seal should be placed in a location where it is not likely to become damaged through normal movement and be robust enough to withstand weather conditions. If a padlock is proposed as a solution then it should be of a robust standard and be attached in a way as to make removal difficult or that attempts to remove it will be noticeable.
* Para 638: SSG-26 para 638.1 [8] allows the use of “weak link” attachments to ensure that when forces exceed those of the restraint system the package is not damaged. The use of “weak links” should be demonstrated to still meet the requirements of para 608 with suitable margin before failure.
* Para 639: This requirement is specifically for the “components of the packaging”, the assessment should consider with general material properties of components within the package, including the material contents. The performance of the package as a whole is addressed in paras 616, 639, 653 and 666 although the PDSR may consider all within the same claim.
* Para 640: The design and manufacturing techniques should be clearly identified within the PDSR including the appropriate national/international standards.
* Para 641: The containment system should be clearly identified within the PDSR, a description is required to be included in the certificate of approval and therefore should be provided by the applicant. This should ideally be supported by a clear diagram detailing the outer boundary of the containment system.
* Para 648: The requirement is to “prevent loss or dispersal of the radioactive contents”. In the case of Type A packages this would generally be considered to be no loss of any amount. SSG-26 [8] however notes that the intent of the requirement is to minimise losses to levels below that which may create a radiological or contamination hazard. Therefore meeting the requirement in para 659 can be considered to have demonstrated compliance with para 648 without the need to specifically test at a lower drop height.

## Requirements for Type B(U) Packages

1. Paras 653 to 666 apply to Type B(U) packages, as well as those identified from the general and Type A requirements.

* Paras 654 and 655: The requirement only applies to “accessible” surfaces, the surface temperature of a package may exceed the requirement temperatures if they are not accessible.
* Para 656: the ambient temperature detailed in this para is only applicable to paragraphs that reference it directly.

## Requirements for Type B(M) Packages

1. SSR-6 [4] paras 667 and 668 permit Type B(M) packages to comply with less stringent conditions. This is reliant on approval by the competent authority of each country the package is to be transported through:

* Para 667: Although para 667 uses “As far as is practicable” and does not include “reasonably”, the assessment of practicability should still follow the general ALARP approach as defined in NS-TAST-GD-005 [15]. This is because, although the competent authority may approve a less stringent condition, the PDSR should demonstrate that the original requirements have been met as far as is practicable. For less stringent conditions relating to paras 639, 656 and 657 this is not required.

## Additional requirements for packages transported by Air

1. SSR-6 [4] paras 619 and 620 described below apply to all packages transported by air. Assessors should understand what modes of transport a package is to be approved for:

* Para 619: This requirement means that the “exclusive use” exception in para 654 does not apply. Hence, para 655 is not applicable to the package. The PDSR may define lower activity of contents for air transport to lower the surface temperature to meet this requirement; whilst allowing road/rail/sea transport at higher surface temperatures. In such cases, the approval certificate should clearly identify the contents limits for each mode of transport.
* Para 620: The higher upper temperature exceeds the paras 616 and 666 requirements. However, this only applies to the containment function of the package.

## Requirements for packages containing uranium hexaflouride

1. Although not specifically part of the requirements for the packaging, SSR-6 para 420 [4] includes three requirements for packages containing UF6. These conditions should be considered as part of the PDSR as design criteria for the requirements.
2. SSR-6 paras 631 to 634 [4] apply to all packages that are designed to transport UF6.

* Para 631: The ISO 7195: 2005 edition is referenced in SSR-6 [4]. The modal regulations also reference this specific edition.

Further Explanation

A new edition, ISO 7195:2020 has been issued. The IAEA Transport Safety Standards Committee states [14] that it considers ISO 7195:2020 to be within the scope of SSR-6 2018 [4]. Hence, for the purposes of para 631 [4], assessments undertaken against ISO 7195:2020 demonstrate compliance with ISO 7195:2005

The ANSI 14.1-2019 standard is also considered equivalent to ISO 7195:2020. Hence, analysis against ANSI 14.1 can be considered to demonstrate compliance against ISO 7195:2005 for the purposes of para 631 [4].

An exception to the above is the 30C cylinder has no equivalent in ISO 7195:2005 and therefore does not satisfy para 631 [4].

* Para 634: For the purposes of Para 634(a) [4] ISO 7195:2020 is considered to be an international standard with an equivalent level of safety with regards to the 30C cylinder. Hence, the 30C may be approved subject to multilateral approval through this route.

# DEMONSTRATION OF COMPLIANCE

1. Section VI of SSR-6 [4] states the demonstration of compliance to the requirements can be accomplished by a range of methods. Notably, the test criteria requirements state “shall be so designed that *if it were subjected* to the tests specified….”.
2. SSR-6 [4] Para 701 states the following range of options to demonstrate compliance:
3. Performance of the test with a suitable full size test item.
4. Read across from similar testing previously carried out, with justification.
5. Performance of the test with a suitable smaller scale item with justification.
6. Calculation or reasoned argument.
7. Calculation, or reasoned argument, can cover a wide range of options, including:

* FEA/CFD analysis with appropriate validation and verification
* Numerical analysis – with suitable discussion and justification of applicability.
* Statement of engineering reasoning – such as “use of X material demonstrates compliance with Y due to X’s material properties”.

1. Usually a mixture of approaches, using the strengths of each approach, provides the best demonstration of compliance.

## Preparation of a specimen for testing

1. SSR-6 Paras 713 to 715 [4] detail a set of criteria required before an item is tested to demonstrate compliance. Test preparation is key to ensuring that the test results can be assessed correctly. If there is early engagement with the applicant prior to testing being carried out these requirements should be highlighted.

## Target for drop tests

1. SSR-6 Para 717 [4] requires that the target for the drop tests meets a set criteria. This is generally known as an “unyielding” target. The guidance in SSG-26 para 717.2 [8] provides examples of what would be considered acceptable.

## Tests for demonstrating ability to withstand normal conditions.

1. SSR-6 Paras 720 and 721 [4] require specific water spray tests to be undertaken in advance of the free drop, stacking and penetration tests. The guidance in SSG-26 para 720 [8] allows the use of reasoned argument to demonstrate compliance with the water spray test for certain materials.

## Tests for demonstrating ability to withstand accident conditions.

1. SSR-6 Para 726 [4] requires that the effects of the testing in para 727 and 728 are cumulative and the tests must be carried out in that order. The test in para 729 is a standalone requirement.
2. SSR -6 Para 727 [4] – Mechanical test – usually this test will be the bounding case for a package with regards to drop/impact testing. Hence, the demonstration of compliance to para 727 may be used to demonstrate compliance with tests from paras 722 and 725[[1]](#footnote-2).
3. SSR-6 Para 733 [4] details the water leakage test conditions for fissile packages, and differs from the para 729 requirement

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# GLOSSARY AND ABBREVIATIONS

ALARP As Low As Reasonably Practicable

CA Competent Authority

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

GB Great Britain

IAEA International Atomic Energy Agency

ONR Office for Nuclear Regulation

PDSR Package Design Safety Report

SAP Safety Assessment Principle(s)

TAG Technical Assessment Guide(s)

TP Transport Permissioning

TSC Technical Support Contract(or)

WENRA Western European Nuclear Regulators’ Association

# ANNEXES

## Annex 1 – Dual Purpose Casks

A1.1 This annex aims to provide a high-level overview of the Dual Purpose Cask Technical Support report. The full report is publicly available on the ONR website [16].

A1.2 ONR Research Project 086 was commissioned to consider the feasibility of Dual Purpose Casks (DPC) in relation to the transportation of RAM between licenced sites, and storage for an extended period without modification or waste repackaging. The outcome from the research project is the ‘Dual Purpose Cask Technical Support’ report, which considers the relevant information regarding storage, transportation, and the proposed ALARP argument for a DPC transport system.

A1.4 The report uses the 2013 Inventory for Geological Disposal (IGD), which comprises of UK Radioactive Waste Inventory (UKRWI) data and the inclusion of materials not-yet-classified as waste (spent fuel, stocks of uranium). The 2016 data was not published until the DPC report was already complete. Differences between the inventories should not affect the report conclusions.

A1.5 The DPC report is based upon the IAEA SSR-6 (2012 edition) transport regulations. The updated IAEA SSR-6 Rev.1 (2018) includes two relevant additions relating directly to DPCs which state the package design should account for ageing mechanisms, and packages intended for shipment after storage should be maintained in a manner that meets the relevant provisions of the regulations and the applicable certificates of approval have been fulfilled.

A1.6 The methods of transporting DPC’s are only considered viable for road or rail, as sea transport was not deemed cost, or nuclear-safety affective. Limitations for transport by rail include the number of sites with functioning railheads and the route / gauge availability. It is therefore assumed road transport will be the default method, which is primarily limited to HGV/STGO cat 1 and STGO cat 3 vehicles.

A1.7 A section of the report is dedicated to review the ALARP considerations around the justifications of implementing a DPC system, which include: handling systems and repackaging; containment barriers; the fuel assembly capacity of a DPC; the benefits of DPCs for failed fuel assemblies; the importance of ageing management and monitoring of DPCs during interim storage; and also the vulnerability of ALARP justifications to future changes to both regulation and the GDF design

## Annex 2 – Guidance Applicable to Seals for use in RAM Transport Packages

A2.1 This annex discusses the ‘Overview of Current Practices and Guidance Applicable to Seals for use in Radioactive Materials Transport Packages and other Nuclear Safety Applications’ technical report. The full report is publicly available on the ONR website [17].

A2.2 ONR Research Project 083 was required as existing guidance on the application of seals in RAM transport and other nuclear safety applications had not been reviewed in 15 years, and was limited in scope and application.

A2.3 The use of seals covers a large range of functions, and equally, there are a large choice of seal types and materials available for nuclear applications. The technical report provides an overall description of the different sealing arrangements that are available, with recommendations for seal types and materials for different nuclear applications. However, an overriding consideration in seal material selection and use is the choice of suitable tests to indicate that the sealing arrangement can perform reliably and safely for its intended service lifetime.

A2.4 The technical report provides an overview of the seal response to specific ageing conditions (ionising radiation, elevated temperatures, pressure harsh chemical environments and low temperatures) discussed in terms of long-term ageing effects and functionality. The properties of different types of polymeric seal materials have been compared and contrasted in terms of their use across the range of conditions experienced across the UK nuclear industry.

A2.5 A major consideration associated with the reliability of polymeric seals is the assessment of ‘service lifetime’ or ‘qualified life’. The technical report provides an overview of the qualification process for nuclear applications, interpreting international standards and best practice. The qualification process is discussed in terms of the implementation of test programmes that are representative of nuclear environmental conditions.

A2.6 A table comparing ONR SAP requirements to the report content is included in the technical report. It is intended to assist with inspections and the judgements that relate to the adequacy and suitability of any proposed sealing arrangements in a safety related nuclear application. The information in the table is intended to be neither exclusive or exhaustive and is subject to change.

1. Paragraph 6.5 above refers to SSR-6 Para 648 with regards to this. [↑](#footnote-ref-2)