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Transport Engineering Assessment			
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1. INTRODUCTION

1.1 The Office for Nuclear Regulations (ONR) has prepared a suite of Technical Assessment Guides (TAG) to assist its inspectors in their technical assessment work in support of making regulatory judgements and decisions. The guides were originally prepared to support ONR's Safety Assessment Principles, which apply to the assessment by ONR specialist inspectors of safety cases for nuclear facilities. More recently the scope of this suite of guides has been extended to other areas of ONR's regulatory responsibility including radioactive materials transport. This TAG is one of these latter guides.

2. PURPOSE AND SCOPE

2.1 ONR is the Competent Authority (CA) for Great Britain (GB) with responsibility for the civil inland surface transport of radioactive materials (Class 7 dangerous goods).

2.2 ONR regulates the higher hazards via a permissioning regime in which certain transport designs and activities require CA approval. This requires safety submissions ("applications") to the CA in which duty-holders explain how their designs and/or activities are compliant with the relevant safety regulations. Most of these different types of safety submissions, but not all, require engineering assessment.

2.3 The safety submissions which require engineering assessment are covered in this guidance and are those involving:

- material designs (special form, low dispersal radioactive material, fissile exception);
- package designs which require CA approval, such as Types B and C packages (which carry radioactive material whose activity exceed a specified limit), and any package carrying fissile materials and UF6);
- modifications (usually related to an approved package design);
- validation of foreign package designs for use in GB; and
- shipment, including special arrangements.

2.4 This guidance document describes the methodology and focus required to achieve an effective and efficient assessment. In order to provide a common baseline to all prospective users, it is pitched at the level that would be required by an inspector ("engineering assessor") who is new to Transport engineering assessment; it nevertheless provides necessary *aide-memoire* to more experienced assessors who may not need all of the guidance.

2.5 This Transport Engineering TAG contains guidance to advise and inform ONR staff in the exercise of their regulatory judgment.

2.6 Generic aspects of the guidance may also be used for independent peer review of a safety submission on behalf of Transport duty-holders, prior to such submissions being presented to the regulator for assessment/approval.

2.7 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].

2.8 Ref. 1 describes:

- In Section 1, the legal basis and scope of ONR's powers as GB Competent Authority (CA). The section also summarises the legislative framework in which those powers are exercised; this framework is described in Section 3 of this guidance.
- In Section 2, ONR's regulatory expectations in respect of application contents, structure and desirable qualities. In turn, Ref. 1 refers to the ONR generic guidance, NS-TAST-GD-51, on the purpose, scope and contents of a safety case.

2.9 Ref. 2 describes ONR internal process for Transport Permissioning (TP); engineering assessment is a sub-process of this TP process. Ref. 2 describes the purpose and scope of TP (in Section 2), the roles and responsibilities within the TP process (in Section 3), the required inputs and desired outputs/outcomes of the TP process, as well as general assessment principles (in Section 5).

2.10 The TP process diagram is on HOW2 [3] and refers out to other guidance documents relating to the TP process.

2.11 This guidance assumes that a prospective engineering assessor is aware of the context provided by Refs. 1 to 3.

2.12 Engineering assessment should only be started on an application that has passed the 'Q0' completeness check and after a Pre-Job Brief has been conducted (see Paragraph 5.7 of Ref. 2). This ensures that the engineering assessor is fully aware of the programmatic, regulatory and strategic context within which their particular piece of work is to be undertaken. It also prevents nugatory work being undertaken.

3. RELATIONSHIP TO LICENCE CONDITIONS AND OTHER RELEVANT LEGISLATION

3.1 Licence conditions, which govern nuclear safety on licensed sites, do not apply to the offsite transport of radioactive materials, which are based on a similar, but parallel, set of safety regulations.

3.2 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 which 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 Applicable Provisions of The Energy Act (2013).

3.3 In this guide, safety requirements are discussed by reference to the relevant paragraphs in SSR-6. Clearly, any formal communications with duty holders or enforcement action being considered by ONR inspectors should make reference to the appropriate UK legal provisions for the mode of transport in question

3.4 Supporting guidance for the requirements of SSR-6 [4] is provided by the IAEA document SSG-26 [8]. It should be noted that guidance in SSG-26 has no legal status, unlike the requirements in SSR-6.

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

SAPs

4.1 This TAG does not directly address or support any of the ONR Safety Assessment Principles (SAPs) [9], given that the SAPs apply to assessments of the safety of existing or proposed nuclear facilities.

Western European Nuclear Regulators Association (WENRA) Reference levels

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

IAEA Safety Standards

4.3 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.

5. ADVICE TO INSPECTORS

5.1 The overall purpose of an engineering assessment is to examine a transport safety case against the requirements of the transport regulations as specified in SSR-6 [4].

5.2 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.

5.3 The focus for an engineering assessment is to ascertain if the transport safety case meets the specific requirements in Section VI of SSR-6; these requirements in turn refer out to appropriate parts of Section VII where the test procedures for demonstrating compliance with the requirements are specified.

5.4 Within Section VI, specific paragraphs prescribe the different safety requirements for radioactive material design, packagings and packages, as outlined below:

- 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)
- Requirements for packages containing fissile material (673–686)

5.5 For the purposes of assessing a safety case, a useful analogy for a safety case is that of a classic temple structure comprising a head structure underpinned by pillars, which are in turn supported by a foundation. The head structure denotes the flow of claims and arguments and references to underpinning evidence which demonstrates why a package, material or shipment meets all the relevant safety requirements.

5.6 The pillars denote the more detailed underpinning documents which may involve some of the following specialist engineering disciplines: structural analysis; impact analysis; thermal analysis; fluid dynamics (including computational fluid dynamics); corrosion chemistry; seal performance; activity release calculations; maintenance; non-destructive testing; design and manufacture; material and package testing; management systems/capability audit (of duty-holder's contractors in respect of manufacturing, design, computational analysis, material and package testing etc.).

Assessment Strategy

5.7 The recommended assessment strategy is illustrated in Figure 2 and comprises two types of assessment:

- A "thin", horizontal slice assessment through the safety case head structure and
- A number of "deep", vertical slice assessments through selected pillars supporting the safety case.

5.8 The selection of which pillars to subject to deep slice assessment would be informed by the thin slice assessment and would depend on the type of safety case (see Sections 1.2 and 4), its complexity, and whether the safety case is to support a new approval or the renewal of an existing approval. The selection will also be informed by any available intelligence on the package or on the applicant, such as from a previous assessment, operational difficulties experienced in using the package, or from recent regulatory interventions/issues and incidents. The selected pillars should focus on areas of: greatest uncertainty (e.g. new or non-standard technology, bespoke or in-house calculation methods); highest risk and/or smallest safety margins; and where new or different arguments and methods are introduced in the safety case.

Thin Slice Assessment Checklist

5.9 The overall purpose of the thin slice assessment of the safety case head structure is to ascertain, without delving into details provided by the supporting pillars but taking the data references provided by the pillars at face-value, that compliance with all the relevant safety performance requirements, as prescribed in Section VI of SSR-6 [4], is adequately demonstrated.

5.10 In order to achieve this purpose, the thin slice assessment would need to consider, at a high level, whether the safety case has:

a) Addressed all the relevant safety performance requirements, i.e. no glaring omissions (Refs. 11 and 12 provide useful tick-lists);
b) Identified and described all the engineering components and processes provided to meet these safety requirements (specifically in respect of containment, shielding, criticality and temperature effects);
c) Substantiated, to the level and rigour prescribed in SSR-6 [4] Sections VI and VII, the performance requirements for these components and processes for all the relevant transport conditions. Such a substantiation requires that:

i) The correct engineering loads have been applied to all the relevant components, including the radioactive contents. This means that, for example,

the following have been addressed (the list is not exhaustive): 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); targets used for drop tests are essentially unyielding (SSR-6 para 717); test loads for accident conditions of transport have been applied cumulatively (SSR-6 para 726) 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).

ii) Consequential loads, particularly resulting from normal and accident conditions of transport, have been addressed (e.g. pressurisation from material decomposition due to thermal and radiation effects; combustion of flammable gases released from such decomposition; fatigue and fracture as a result of cyclic loading).

iii) 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; low temperature brittle failure or high temperature creep failure of containment components, particularly the seals.

iv) All the relevant performance requirements prescribed in SSR-6 Section VI have been correctly interpreted for the given design and complied with. This usually requires the engineering assessor to interact with the shielding and criticality assessors; the interaction also serves to ascertain the validity of the engineering damage assumptions made in the shielding/criticality modelling.

5.11 In addition, the safety case story must be internally consistent, and there must be consistent flow of data between the pillars and the head structure (the referenced pillar exists, is not obviously wrong, and actually supports the claim made of it).

Deep Slice Assessment Checklist

5.12 This requires consideration of the same items on the thin slice assessment checklist in Section 5.6(c), but at a greater level of detail that is dictated by the specialist area covered by the pillar in question. More detailed supporting guidance to the requirements in SSR-6 is provided SSG-26 [8].

5.13 The assessment also needs to ascertain that the pillar stands on sound and secure foundations. This means:

a) For a pillar that provides substantiation by means of calculations, the calculation methods have good provenance and pedigree, are verified and validated (see paragraphs 2.24 to 2.29 of Ref. 1), and use valid and verified input data. Certain calculations will require specialist assessment by a subject matter expert, such as those involving new/non-standard/untested technology, or are based on bespoke or in-house models; the requirement for a specialist assessment would be determined by the Project Inspector in consultation with the Professional Lead and/or Programme Delivery Lead. The need for a specialist assessment would be minimised if the calculation methods in question has been validated and verified.

b) For a pillar that provides 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 Section 5.6(c)(i) for examples of issues that should have been considered).

Guidance for Specific Application Types

5.14 Guidance on the appropriate levels of permissioning assessment required for the different types of applications is provided in Table 1 of Ref. 2; the level of assessment referred to as “Enhanced Q0” and “Targeted Sampling” in Ref. 2 approximately corresponds to what has been referred to in this guide as “thin slice assessment” and “deep slice assessment” respectively.

Use of this TAG by Technical Support Contractors

5.15 Either the engineering assessment or its peer review may be carried out under a Technical Support Contract (TSC), subject to approval of the Programme Delivery Lead. The general guidance is the same as outlined in Section 3 whether the engineering assessment is carried out by ONR staff or a TSC. When the whole (thin and deep slice) engineering assessments are undertaken by the TSC, it would be prudent for ONR engineering assessor to undertake a separate thin slice assessment of the safety case in order to fulfil their intelligent customer role as well as to be able to liaise effectively with the applicant for the rest of the transport permissioning process.

5.16 The guidance in the previous paragraph only applies where the TSC is substituting for ONR staff in the role of engineering assessor or peer reviewer. When the whole of a package design assessment is being carried out 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.

Engineering Assessment Outputs

5.17 The two primary outputs from an engineering assessment are the Q1 Question Set and Assessment Report.

5.18 The Q1 Question Set is a compilation of the issues raised with the Transport duty-holder during the course of the assessment; it also provides a means of recording the history of interactions with the duty-holder to resolve the issues as well as the assessor’s final sentencing of the issues. Guidance on producing a Q1 Question Set is provided in HOW2 [3].

5.19 The Assessment Report is where the engineering assessor records his/her assessment, including a definite statement of whether (or not) the regulatory requirements in respect of engineering have been met by the safety case and the reasons for that statement. Guidance on the different levels of report by application type is provided in TRA-PER-GD-001 [2].

6. REFERENCES

1 *TRA-PER-GD-014 Revision 0. Guidance for Applications for UK Competent Authority Approval, April 2016 (*www.onr.org.uk*)*

2. *TRA-PER-GD-001 Revision 1. Transport Permissioning Process Guide - Transport Permissioning Assessment, October 2015.*

3. *ONR How2 Business Management System.*

4 *IAEA Regulations for the Safe Transport of Radioactive Material 2012 Edition. Specific Safety Requirements No. SSR-6.*

5 *United Nations Economic Commission for Europe (UNECE), European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR), New York and Geneva.*

6 *Intergovernmental Organisation for International Carriage by Rail (OTIF), Regulations concerning the International Carriage of Dangerous Goods by Rail (RID).*

7 *The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations*

8 *IAEA Advisory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition) IAEA Safety Standards Series No. SSG-26.*

9 *Safety Assessment Principles for Nuclear Facilities. 2014 Edition Revision 0. November 2014.* http://www.onr.org.uk/saps/index.htm

10 *Western European Nuclear Regulators' Association. Reactor Harmonization Group. WENRA Reactor Reference Safety Levels. WENRA. September 2014.* www.wenra.org.

11 *IAEA. Schedules of Provisions of the IAEA Regulations for the Safe Transport of Radioactive Material (2012 Edition), Specific Safety Guide No. SSG-33.*

12 *Technical Guide: Package Design Safety Reports for the Transport of Radioactive Materials. http://www.onr.org.uk/transport/guidance.htm.*

7. GLOSSARY AND ABBREVIATIONS

CA	Competent Authority
GB	Great Britain
IAEA	International Atomic Energy Agency
ONR	Office for Nuclear Regulation
SAP	Safety Assessment Principle(s)
TAG	Technical Assessment Guide(s)
TP	Transport Permissioning
TSC	Technical Support Contract(or)
WENRA	Western European Nuclear Regulators' Association