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ONR's Expectations of Shielding Design in package Design Safety Reports

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Abstract

Background:

This paper communicates ONR's expectations of package designs, following changes to IAEA regulations. GB legislation for land transport requires from July 2015, all new package designs, modifications and renewals meet the shielding requirements in SSR-6 2012.

Change to the Regulations:

ONR historically required operational controls to ensure dose limits will be met for routine conditions of transport. This is now a design requirement following the introduction in SSR-6 of Paragraph 617, which ensures packages are designed to carry maximum contents without exceeding statutory radiation levels. Package and conveyance dose rates must be demonstrated within the design process and by operational controls. Requirements for compliance with normal/ accident conditions are unchanged.

Demonstration of Shielding Design:

The compliance demonstration should be commensurate with the hazard and safety margin.

Routine Conditions: Compliance with radiation dose levels for the intended content. Also consider conveyance (vehicle) dose rates.

Normal Conditions: As RCT, and designs for IP-2, IP-3, Type A, B and C packages should prevent external surface dose rates increasing by >20% following NCT tests.

Accident Conditions: As RCT and NCT, and designs for Type B and C packages should prevent dose rates at 1m from a package from exceeding 10mSv/h following ACT testing.

Competent Authority Approved Designs:

For existing approvals, any periodic renewal or modification must address the requirements of SSR-6. ONR will conclude either:

The package is compliant with SSR-6: Five year certificate, possibly with advice.

The application contains some minor shortfalls, however ONR is confident that the design meets the regulations: Short term certificate, possibly with operational limits. This permits transport for a limited period whilst evidence of compliance is prepared.

The application contains safety significant shortfalls: ONR is not confident the design meets regulations. The application will be declined.

Self-Approved Packages:

This approach applies for self-approved packages, commensurate with the hazard. ONR expects self-approved packages under TS-R-1, intended for use post-June 2015, to be approved under SSR-6 at the next renewal (<5 years). Consignors are responsible for ensuring all regulatory requirements are met.

Introduction

The purpose of this paper is to communicate ONR's expectations with regards to package designs, renewals and modifications following a recent change to the assessment of doses under routine conditions of transport in the IAEA regulations, for self-approved and competent authority approved packages which have now been incorporated into GB and UK law, via the Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations 2009 (1). These regulations require carriage to be in accordance with the requirements of ADR (2) and/ or RID (3), which themselves are based on UN Recommendations that include provisions based on the IAEA's SSR-6 2012 Edition (4).

Although this paper refers to SSR-6 and various paragraphs within SSR-6 and its associated guidance material, duty-holders are reminded that the legal requirements are contained in the modal regulatory texts: European Agreement concerning the International Carriage of Dangerous Goods by Road (ADR) 2015 Edition, Regulations concerning the International Carriage of Dangerous Goods by Rail (RID) 2015 Edition, International Maritime Dangerous Goods (IMDG) Code 2014 Edition incorporating Amendment 37-14 and the Technical Instructions for the Safe Transport of Dangerous Goods by Air 2015-2016 Edition.

Timing

GB legislation for transport by road and rail requires that from 1st July 2015, all new package designs, design modifications and renewals demonstrate that a package will meet the shielding requirements set out in SSR-6, the 2012 edition of the IAEA Transport regulations.

Scope

These expectations are applicable to new designs, modifications and periodic renewals of all package designs i.e. Excepted, Industrial, Type A, Type B and Type C packages.

Change to the Regulations

ONR's advice in the "Guide to an application for UK competent authority approval of radioactive

material in transport” (5) states that applications should demonstrate that radiation dose rate limits will be met for routine as well as for normal and accident conditions of transport (although superseded by a revised Applicant’s Guide (6), much of the advice remains valid). Demonstration of dose rate compliance under Routine Conditions of Transport has now become a legal requirement as a consequence of a change in the IAEA Regulations for the Safe Transport of Radioactive Material 2012 Edition (SSR-6) (which forms the basis of UK and GB law) from the previous edition (TS-R-1, 2009 (7)).

Paragraph 617 of SSR-6 states: *“A package shall be so designed that it provides sufficient shielding to ensure that, under routine conditions of transport and with the maximum radioactive contents that the package is designed to contain, the radiation level at any point on the external surface of the package would not exceed the values specified in paras 516, 527 and 528, as applicable, with account taken of paras 566(b) and 573.”*

The IAEA’s guidance material [SSG-26 (8) para 617.1] states: *“The intention of para. 617 is to demonstrate by calculation or other methods that the package is correctly designed to transport the maximum permitted contents without exceeding the radiation level limits specified in the Transport Regulations.”*

This change was brought about to ensure that packages are correctly designed to carry the maximum contents without exceeding statutory radiation dose levels. The change effectively extends the package and vehicle (or conveyance) dose rate levels to be demonstrated within the design process in addition to those required by the transport controls. The requirements for demonstrating compliance with Normal and Accident Conditions of Transport are unchanged.

Demonstration of Shielding Design

For both competent authority approved and self-approved packages (where the design does not require competent authority approval), in general, the method of demonstrating the shielding element of the package design should be commensurate with the level of hazard and the safety margin derived from the design. ONR expects the package design safety case to address the following, as applicable:

- Routine Conditions of Transport (RCT):

Designs for all packages should demonstrate compliance with radiation dose rate levels for the contents they are designed for (SSR-6, paras 516, 527, 528 and 566). Designs should also take account of conveyance (vehicle) dose rates (paras 573b and c);

- Normal Conditions of Transport (NCT):

In addition to RCT, designs for IP-2, IP-3, Type A, Type B and Type C packages should prevent the

external surface dose rate increasing by >20% (para 648) following NCT testing (paras 719 to 724);

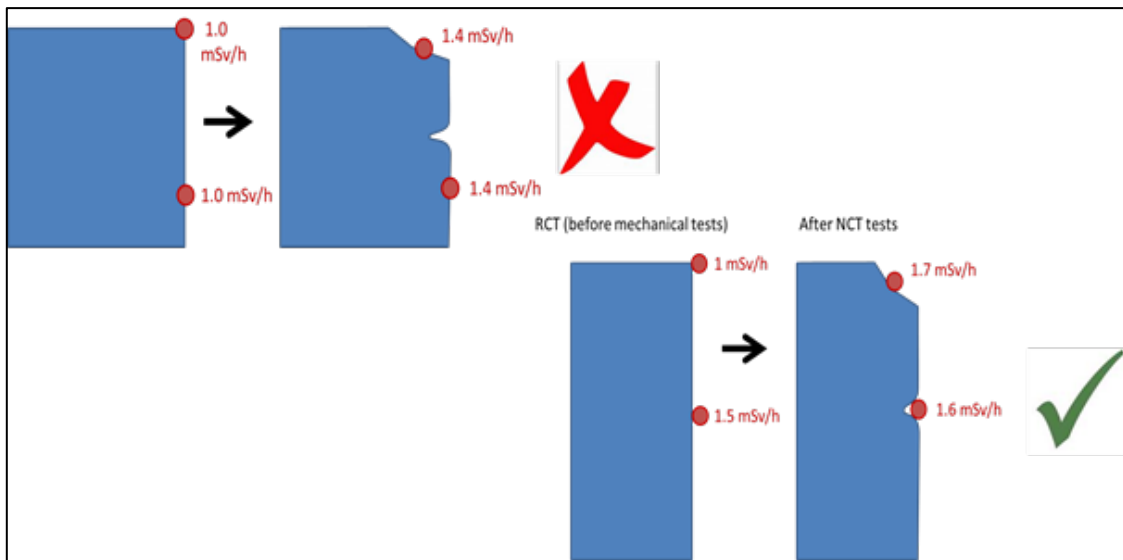


Figure 1: Assessment of external dose rates following NCT. The pre- and post-test maximum radiation levels may be at different positions on the package.

- Accident Conditions of Transport (ACT):

In addition to RCT and NCT, designs for Type B and Type C packages should demonstrate that the dose rate at 1m from a package does not exceed 10mSv/h (para 659) following ACT testing (paras 727, 728 and 729).

Importance of NCT

The Normal Conditions of Transport (NCT) 20% criterion was introduced to prevent dose rates exterior to the package reaching Accident Conditions of Transport (ACT) levels following minor mishaps during transport. At the package surface, the dose rate could potentially increase by a factor of 50 (accounting for distance fall-off next to an unshielded 0.5m x 0.5m box) following ACT testing. Without the NCT 20% criterion (SSR6-para. 648), there is essentially no regulation that would prevent this increase from occurring following a minor incident.

Ways to demonstrate compliance with NCT:

ONR has well established regulatory assessment criteria that have been applied successfully to assessments over many years. The preferred approach for making a safety case is set out in ONR's guidance (6), and required applicants to identify the safety claims being made, which are then supported by string technical arguments, underpinned by appropriate evidence. Recognised methods of making the technical arguments include:

- **Inspection and operational measurement** together with reasoned argument (this is appropriate for simple cases only, where it is evident that there is little change/movement to

package (noting that under transport regulations, the package comprises of the packaging and the contents, including any internal furniture necessary to positively locate the content.))

- pre/post-drop **measurements** following inspection of a dummy source and replacement of a real source, taking into account measurement uncertainty, and realistically it may be difficult to replace the source if there has been movement to the furniture
- **FEA or other numerical analysis**
- **calculation**
- **Comparison with analytical or test data from another package**, and robust justification for why it is applicable, including an analysis of differences between the designs and an assessment of their significance and any allowance made accordingly in the subsequent case.
- **any combination** of the above, or other method acceptable to the Competent Authority.

Issues with Demonstration

Recent assessment work in ONR has identified a number of repeated challenges faced by applicants when making the shielding safety case. The predominant issue is that commonly there is little knowledge of what sources will be transported in the package at the design stage, often because the package is intended for flexible deployment to carry a range of different content, or because the content itself is unknown, for example for decommissioning purposes. Some characterisation of contents will always be necessary, as it is unacceptable to not know the extent of the hazard being transported. Poor definition of the contents could cause concerns with other aspects of the safety case, for example with respect to containment: if the internal furniture and sources are not characterised, sharps or friction could puncture containment, and radiolysis or hydrolysis could occur.

An optioneering process may be required to determine:

- a) bounding case(s) and/ or
- b) solution(s) for ensuring and demonstrating that there won't be movement of, or damage to, sources.

The outcome of the optioneering process needs to be documented with calculations/reasoned argument supporting the judgements made. If the content changes later, there may be a need to update the safety case, or consider modifications to the package through the Competent Authority modifications process, or potentially using a different package altogether.

Competent Authority Approved Designs

For existing competent authority approved packages, any periodic renewal or modification of a design must address the requirements of SSR-6 in the next application. ONR will take one of the following positions:

- *The package is compliant with SSR-6 design requirements*

ONR is satisfied that the package design has been demonstrated to meet regulatory requirements. A five year certificate with Tier 2¹ advice (where appropriate) will be issued.

- *The application contains shortfalls, i.e. the justification is missing /incomplete, but the ONR is confident that the package design has been demonstrated to meet regulatory requirements.*

Supporting evidence is not documented, incorrect assumptions in calculations, etc. but ONR is confident that the actual package design meets the transport regulations, (i.e. self-evident safety margins, calculations supported by empirical data, confirmatory calculations done by ONR, etc.). All other requirements of the regulations are demonstrably met. A short term, typically one year certificate (possibly with additional limits on the package's use) will be issued. The purpose of the short term certificate is to provide an enabling regulatory approach which allows continued transport operations for a limited period whilst the applicant provides documentary evidence of compliance with RCT, NCT, ACT in the Package Design Safety Report.

- *The application contains safety significant shortfalls and ONR is not confident that package design meets regulatory requirements.*

Supporting evidence is not documented, incorrect assumptions may outweigh safety margins, lack of safety margins, ONR calculations do not demonstrate compliance. In this case, ONR will consider the assessment in line with the published Enforcement Policy Statement (11) and Enforcement Management Model (12), in order to assess the risk gap between the application and regulatory compliance. Dependent on this assessment, various options will be considered, such as the applicant being asked to redesign that package, resubmit the application, the application of additional controls through the certificate of approval, or consideration of the possible use of a Special Arrangement.

Self-Approved Packages

The same approach to demonstrating safety should be evident in the safety case for self-approved packages (where the design does not require competent authority approval) as would be required for competent authority approved packages, although the level of hazard posed by the package should be taken into account in the extent to which safety is demonstrated. The ONR expectation for packages approved by the duty holder's design authority under TS-R-1, with the intention to use the package post-June 2015 (when TS-R-1 based regulations cease to apply), is that the safety case should be approved under SSR-6 at the next renewal, so long as that renewal period is equal to or less than the competent authority approved renewal period of 5 years. ONR may ask to view duty holders' processes that stipulate the package renewal period. ONR as Competent Authority may also request necessary safety documentation for inspection under the Carriage of Dangerous Goods regulations (1) Regulation 26 and applicable modal provisions, such as ADR section 1.8.1 and 5.1.5.2.3, particularly if ONR considers that there may be shortfalls in the package safety case.

¹ "Tier 1" questions are considered to be essential to the safety case being made in the submission, and must be answered satisfactorily before the requested Competent Authority approval is granted. "Tier 2" questions, while still being safety-related, are not considered to be essential to the safety case being made in the submission, and can be answered in a longer timeframe.

If a self-approved package is acquired from a design authority (domestic or foreign), then it is the responsibility of duty holders (normally the consignor) to ensure:

- compliance with design regulations,
- that the package is operated in accordance with the package design requirements, and;
- compliance with any government requirement of any country that the package may be transported through or into.

Further Information

Package designers should refer to the Guide to an application for UK competent authority approval of radioactive material in transport and the European Package Design Safety Reports for the Transport of Radioactive Material for details of the regulatory expectations on demonstrating compliance with design requirements.

A presentation was given at ONR's recent Transport's 2015 Stakeholder Event that explains the recent changes to the regulations with regard to shielding and ONR's expectations.

Conclusions

Recent changes to the transport regulations now require shielding performance to be assessed as part of the design in addition to operational dose measurements. This paper explains the ONR's expectations in this regard to ensure regulatory compliance and to maintain the high standards of safety required for transport of radioactive materials.

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