LESSONS FROM THE PREPARATION OF PACKAGE DESIGN SAFETY REPORTS

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INTRODUCTION

The IAEA Transport Regulations [1] require that compliance assurance be carried out by competent authorities. The specific requirement is set out as follows in Paragraph 311 of ST-1 [1]. "The competent authority is responsible for assuring compliance with these Regulations. Means to discharge this responsibility include the establishment and execution of a programme for monitoring the design, manufacture, testing, inspection and maintenance of packaging, special form radioactive material and low dispersible radioactive material, and the preparation, documentation, handling and stowage of packages by consignors and carriers, to provide evidence that the provisions of these Regulations are being met in practice."

According to the draft advisory material to the IAEA Transport Regulations [2], amongst the measures that should be part of a competent authority's compliance assurance programme are review and assessment, including the issue of approval certificates. A specific requirement relating to this is identified in Paragraph 311.6 of [2]. This states that "in order to ensure the adequacy of special form material and certain package designs, the competent authority is required to assess these designs. In this way, the competent authority can ensure that the designs meet the regulatory requirements and that the requirements are applied in a consistent manner by different users. When required by the Regulations, shipments are also subject to review and approval in order to ensure that adequate safety arrangements are made for"

Consignors are required to make the following or equivalent declaration in the transport documents (Paragraph 550 of [2]). "I hereby declare that the contents of this consignment are fully and accurately described above by the proper shipping name and are classified, packed, marked and labelled, and are in all respects in proper condition for transport by (insert mode(s) of transport involved) according to the applicable international and national governmental regulations." Unless the contents and the packaging together form a package that complies with the IAEA Transport Regulations [1], the declaration cannot be signed.

From these requirements, it can be concluded that a package designer needs to be able to demonstrate that the package meets the relevant requirements of the IAEA Transport Regulations [1] in order that the competent authority can carry out its role of compliance assurance and also so that the consignor can sign the consignor's declaration prior to transport. The Package Design Safety Report (DSR) is a key document in achieving this, and this paper reviews aspects of the structure and production of DSRs.

PACKAGE DESIGN SAFETY REPORTS

The primary purpose of DSRs is generally seen as demonstrating to the competent authority that the package design complies with all the relevant requirements of the IAEA Transport Regulations [1].

However, although DSRs do not usually get passed on to the consignors, their production is, in effect, a hold point such that until the DSR is approved, the package cannot be released to the consignor for operations to commence.

The DSR also enables the package designer to ensure that there is sufficient data to demonstrate that all the relevant requirements of the IAEA Transport Regulations [1] and to act as a vehicle for the collation of information and the interaction of data. Typically during the development of a package design, the overall substantiation work is broken down into various work packages, with specialists being responsible for each work package. This is consistent with ensuring that each element of the work is carried out by suitably qualified and experienced personnel (SQEP). The main elements of the development of the design substantiation are shown in Figure 1.

It is important, for example, to be able to show that the external dose rate at 1 m from the external surface of a Type B package meets the regulatory limit of 10 mSv/h following the tests to represent accident conditions of transport (see paragraph 656 of ST-1 [1]). For this to be done, the configuration of the package after the drop tests, including that from 9 m, must be established. This would typically be done by drop tests of a scale model of the package. The thermal test, a fully engulfing fire at 800°C for 30 minutes, is then applied to the impact-damaged package. This is often carried out by thermal analysis, rather than carrying out an actual fire test. Having established the configuration of the damaged package, the external dose rate can be determined, typically by shielding calculations, except for situation where a reasoned argument can be made that there would no significant increase in the external dose rate following the accident conditions tests.

APPLICANTS GUIDE

As part of its compliance assurance programme, the UK competent authority, the Department of Transport, Local Government and the Regions (DTLR) (previously known as Department of the Environment, Transport and the Regions) has produced Applicants Guide [4], [5] for the 1985 and 1996 Editions of the IAEA Transport Regulations, for use by users wishing to obtain approval of special form radioactive material, certain packages and shipments.

DSRs prepared by UK users are frequently written using the structure of the Applicants Guide [4], [5] as the basis for the DSR structure. The basis for this is that it enables the competent authority to receive DSRs that have a structure that is consistent with their own Applicants Guide, thereby enabling the competent authority to assimilate and review the DSR more efficiently than if a structure derived by the applicant were used. Furthermore, although non-fissile industrial packages do not require design approval for the competent authority, the structure of the Applicants Guide has also been used as the basis of the structure for the DSR for industrial packages. This is for two reasons. Firstly, users of transport packages that require competent authority approval have become familiar with the structure of the Applicants Guide and so there is sense in having commonality in DSR structure for all package types within a single organisation. Secondly, as the requirements for packages such as industrial packages are less extensive than for Type B packages, the Applicants Guide has the strength of covering all the requirements that need to be addressed in a DSR.

The Applicants Guide is structured quite differently from ST-1 [1] and is split into the following parts:

Part I, General Information;

Part II, Package Design Approval;

Part III, Additional Design Information Required for Fissile Materials;

Part IV, Shipment Approval;

Part V, Special Form Radioactive Material;

Part VI, Special Arrangement Transport Operation;

Part VII, Validation Application;

Part VIII, Modification Procedure.

As an example, the headings and sub-headings of Part II, Package Design Approval, are set out in Table 1.

The Applicants Guide consists of a series of headings, under each of which is specified the information required by the competent authority and the specific questions that must be answered.

POTENTIAL CHANGES TO THE DSR STRUCTURE

Experience of using this structure has shown that it is generally sound and ensures that all aspects of the design, operation and maintenance of the package are covered, which is crucial in respect in enabling the UK competent authority to carry out its role of compliance assurance.

However, in preparing DSRs, there have been areas where strictly following the structure has resulted in the DSR being less well-structured than could be the case. These are essentially related to the location of the assessments that are required to substantiate the performance of the package. It would be expected that Section 6, Design, would be where all aspects of the package design would be covered.

However, some aspects are required to be covered in other sections, such that it becomes necessary for significant cross-referencing between Section 6 and other sections. It is considered that it should be possible to include all aspects of the design assessment in Section 6, thereby reducing the extent of cross-referencing and enabling the complete design assessment to be seen as a comprehensive whole.

The areas where text would need to be moved from are as follows:

- the part of Section 4.1 that deals with the design substantiation of package handling;
- the text within Section 4.2 that covers the design substantiation of package tie -down;
- the requirement in Section 4.3 to determine the maximum heat flux on the package surface;

- the entirety of Section 5.1, Regulatory Compliance Testing of Package Design, which requires an explanation of whether the evidence for compliance with the regulatory test requirements is from actual tests, extrapolation from other designs, calculation or by reasoned argument and the provision of the evidence and/or justification for compliance with regulatory requirements.

If this approach were adopted, Sections 4.1 and 4.2 would be focussed upon the design and operation of the handling and tie-down systems. The substantiation of these systems against design criteria, such as AECP(TCSC) 1006 [6] for the tie-down system, should then be included in Section 6, which would cover substantiation of all aspects of the design against the relevant requirements of the IAEA Transport Regulations [1]. Furthermore the calculation of the maximum surface heat flux would become an integral part of the thermal considerations in sub-section 6.5.

Similarly, the approach to demonstrating compliance with the regulatory requirements that is required to be addressed in Section 5, Testing, would become an integral part of Section 6, Design. In particular, the overall approach to demonstration of compliance of the design with the regulatory requirements could be described at the start of Section 6, with the details of how compliance is shown being dealt with under each of the areas of design to be covered, i.e. structural evaluation, radiation shielding, etc.

Finally, it is becoming the practice in a number of safety cases for fixed nuclear installations in the UK to include a summary safety argument. This sets out in one or two pages the key arguments for the overall safety of the installation. It is considered that there is benefit in including this at the front of the DSR, which would result in the following advantages:

- it ensures that the individual responsible for the package design properly understands the key safety features and arguments for the package;

- it enables the competent authority to understand the key safety arguments and to assess the package design against the detailed requirements of the IAEA Transport Regulations [1] in the context of knowing the basic safety approach for the package;

- it enables a summary safety argument to be passed on to those who will be consigning and operating the package, thereby assisting them to understand how their activities relate to ensuring the overall safety of the package.

In the latter case, it is quite conceivable that a particular operation may appear to an operator to have little benefit to the safety of the package, which could lead to the operation being given less attention that it should. However, if the operator were to be given a better understanding of the overall safety argument, the operators are less likely to give the most important operation less attention.

OPTIONS FOR PREPARATION PROCESS FOR DSRs

There are two fundamental questions to be addressed when planning the preparation of a DSR:

- who should carry out the preparation?

- when should the preparation be started?

The DSR could be prepared by a number of people, but it is considered that there are advantages to using an individual. This ensures a consistency of style, and helps to avoid the possibility of there being gaps, with each co-author believing that the other was dealing with a particular detail, and contributing to managing the interfaces between parts of the DSR.

The author must be a suitably qualified and experienced person (SQEP), who has a broad understanding of all aspects of transport package design and operation, although they do not need to be a specialist in any of these areas. In particular, it is important to be able to appreciate how changes in one area affect other areas, e.g. revisions to the temperatures arising during accident conditions may impact upon internal pressure, and the areas of structural, shielding, leak-tightness and criticality performance. However, they do need to be able to rely upon specialists to carry out the necessary design and assessment work to provide the outputs from that work to enable the DSR to be written.

DSRs have been written by both in-project staff and individuals external either to the package deign project or to the design organisation itself, i.e. expert consultants. There is no perfect situation, although having someone external to the project can bring a fresh pair of eyes to the design and its assessment whilst preparing the DSR, thereby acting to a degree to an independent peer reviewer, which should enhance the quality of the package design, assessment and DSR.

There are differing views as to when the preparation of a DSR should be started. Some take the view that it should not be started until all the package design and assessment work is complete, thereby enabling the DSR to be prepared in a single, continuous process. An alternative view is that the DSR should be started partway through the design and assessment process, with gaps left for when the required information becomes available. This can have the advantage of acting as a check to see that the production of all the necessary information is planned by holding reviews to check that individuals have responsibility for producing such information. This latter approach would be expected to show a higher total cost for the DSR production, simply because it is carried out in a series of steps. However, it does have the potential to save overall programme time and costs by identifying where information production is not planned, and such savings typically outweigh any small increases in DSR production costs.

CONCLUSIONS

The UK competent authority's Applicants Guide forms a good basis for the structure of DSRs, although some improvements have been identified. These are:

- the introduction of a summary safety argument;
- incorporation of all design substantiation, including that of handling and tie-down, into the package design section;
- including all aspects of testing that is used to substantiate the package design into the package design section.

Careful planning of the DSR production process, with a sound understanding of the role and benefits of the DSR, can bring significant benefits to the package development process and to the safe operation of the approved package.

REFERENCES

[1] IAEA, *Regulations for the Safe Transport of Radioactive Material, 1996 Edition.* Safety Standards Series No. ST-1.

[2] IAEA, *Advisory Material for the Regulations for the Safe Transport of Radioactive Material (1996 Edition)*, IAEA Safety Standards Series No. ST-2, Draft for TRANSSAC dated 3 February 1997.

[3] IAEA, *Explanatory Material for the IAEA Regulations for the Safe Transport of Radioactive Material (1985 Edition) Second Edition (As Amended 1990)*, Safety Series No. 7.

[4] Department of the Environment, Transport and the Regions, Radioactive Materials Transport Division, *Guide to Applications for Competent Authority Approval of Package Designs, Shipments, Special Form Materials and Special Arrangements*, DETR/RMTD/0001, June 2000.

[5] Department of the Environment, Transport and the Regions, Radioactive Materials Transport Division, *Guide to an Application for UK Competent Authority Approval of Radioactive Material in Transport (IAEA 1996 Regulations)*, DETR/RMTD/0003, January 2001.

[6] Atomic Energy Code of Practice, *Transport of Radioactive Material, The Securing/Retention of Radioactive Material Packages on Conveyances*, AECP (TCSC) 1006, December 1997.

TABLE 1 HEADINGS IN PART II OF THE APPLICANTS GUIDE

1 Administrative Details
2 Specification of Radioactive Contents
- 2.1 General Nature of Contents
- 2.2 Radionuclides, Physical and Chemical State, Enrichment and Maximum Activity
- 2.3 Determination of Any A_1/A_2 Values Used That are not in Table 1 of the Regulations
- 2.4 Nature of Radiations Emitted
- 2.5 Materials that Affect the Nature of Radiations Emitted
- 2.6 Additional Hazards from Daughter Products
- 2.7 Details of Irradiated Fuel
- 2.8 Maximum Heat Load to be Carried
- 2.9 Physical and Chemical Effects on the Contents of Normal and Accident Transport Conditions
- 2.10 Details of Other Dangerous Properties

3 Specification of Packaging
- 3.1 Specification
- 3.2 Packaging Make-up
- 3.3 Drawings
- 3.4 Method to Demonstrate that the Package has not been Opened During Transport

4 Transport Operations
- 4.1 Handling
- 4.2 Tie-down (or Retention) System
- 4.3 Stowage Provisions
- 4.4 Action Required by Consignor Before Each Shipment
- 4.5 Action Required During Shipment
- 4.6 Emergency Instructions
- 4.7 Exclusive Use Conditions

5 Testing
- 5.1 Regulatory Compliance Testing of Package Design
- 5.2 Performance Tests Before First Shipment

6 Design
- 6.1 Structural Evaluation
- 6.2 Radiation Shielding
- 6.3 Containment System
- 6.4 Leak-tightness
- 6.5 Thermal Considerations
- 6.6 Pressure Considerations
- 6.7 Impact Evaluation
- 6.8 Type B(M) Packages Only
- 6.9 Type B(U) and Type B(M) Packages

7 Quality Assurance
- 7.1 Quality Assurance Programmes
- 7.2 Quality Control in Manufacture and Construction
- 7.3 Maintenance
- 7.4 Control of Use and Care of Packages

FIGURE 1 MAIN STEPS IN SUBSTANTIATING A PACKAGE DESIGN