INTERNATIONAL GUIDANCE ON TRANSPORT SAFETY RADIATION PROTECTION PROGRAMMES

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ABSTRACT
This paper provides a status report on the development of a guidance document for a transport safety radiation protection programme. Such guidance is needed to facilitate a new requirement arising from the 1996 edition of the IAEA Transport Regulations which are going into force during 2001 at the international modal level.

INTRODUCTION

The International Atomic Energy Agency (IAEA) periodically issues a set of Transport Regulations that serve as the model for countries and international organizations to use in developing and implementing their individual transport regulations. The latest major edition of these was published in 1996[1] in 1996 in English, French, Russian and Spanish as ST-1, and since re-issued in English in 2000 with minor editorial corrections as TS-R-1 (ST-1, Revised)[2].

A number of new requirements have been included in the new, 1996 edition of the Transport Regulations. One of the most significant among those is a new requirement for a radiation protection programme (RPP) for the transport of radioactive material, which "*shall be established for the transport of radioactive material*", and "*the nature and extent of the measures employed in the programme shall be related to the magnitude and likelihood of radiation exposures*". The responsibility for implementing the programme basically resides with consignors and carriers. In addition, the "*programme documents shall be available, on request, for inspection by the relevant competent authority*".

The IAEA, working with a body of experts during the latter part of 2000 developed a draft of a guidance document on RPPs for radioactive material transport. Those involved in the preparation of the draft were transport regulators, advisors and operators. The draft that was produced underwent detailed review by Member State and IAEA experts during the first part of 2001 and a number of the comments have been incorporated into the draft. However, there are still outstanding major issues that must be resolved before the document can be approved for publication. Key among the outstanding issues is that it does not refer to or reflect all of the principles set forth in the IAEA's Safety Guide on *Occupational Radiation Protection* (RS-G-1.1)[3]. These differences must be adequately addressed before the draft guidance document can be published. In addition, the manner in which this guidance is to be published is also an issue that must be resolved.

This paper outlines the structure of the draft document, summarizes some key aspects of the draft guidance document on the new requirements for a transport RPP, defines areas where the draft guidance is consistent with and areas where its not consistent with RS-G-1.1, and highlights areas where actions are needed before the guidance document can be made final.

STRUCTURE OF DRAFT GUIDANCE DOCUMENT

The draft transport RPP guidance document is currently structured as follows:

INTRODUCTION

OBJECTIVES

BASIC ELEMENTS OF A RADIATION PROTECTION PROGRAMME AS A FUNCTION OF OCCUPATIONAL DOSE CATEGORY

THE NEED AND SCOPE FOR RADIATION PROTECTION PROGRAMMES IN TRANSPORT

ASSIGNMENT OF THE ROLES AND RESPONSIBILITIES FOR THE ESTABLISHMENT OF A RADIATION PROTECTION PROGRAMME
- THE OPERATOR'S RESPONSIBILITIES
- COMPETENT AUTHORITY RESPONSIBILITIES

DOSE ASSESSMENT AND OPTIMIZATION
- DOSE ASSESSMENT PRINCIPLES
- EXTERNAL DOSE ASSESSEMENT METHODS
- DOSE LIMITS, DOSE CONSTRAINTS AND OPTIMIZATION

SURFACE CONTAMINATION

SEGREGATION AND OTHER PROTECTIVE MEASURES

EMERGENCY RESPONSE

TRAINING

QUALITY ASSURANCE

OUTLINE EXAMPLES OF RADIATION PROTECTION PROGRAMMES
- EXAMPLE OF AN RPP FOR AIR TRANSPORT
- EXAMPLE OF AN RPP FOR ROAD CARRIER
- EXAMPLE OF AN RPP FOR A CONSIGNOR
- EXAMPLE OF AN RPP FOR A SEA CARRIER

ANNEXES
- ANNEX I – EXCERPTS FROM IAEA TRANSPORT REGULATIONS
- ANNEX II – EXAMPLES OF COLLECTIVE DOSE PER TRANSPORT INDEX
- ANNEX III – SEGREGATION REQUIREMENTS FOR MARITIME TRANSPORT RADIATION PROTECTION
- ANNEX IV - EXAMPLE CHECKLIST FOR DRIVERS OF ROAD VEHICLES
- ANNEX V - EXAMPLE RADIATION PROTECTION/EMERGENCY RESPONSE INSTRUCTIONS FOR VEHICLE OPERATOR

KEY ASPECTS OF THE DRAFT GUIDANCE DOCUMENT

The following discusses a few of the key aspects of the draft guidance document and, as appropriate, compares them with guidance from RS-G-1.1

The draft guidance document emphasizes that an RPP for the transport of radioactive material:

- should have an objective of providing and documenting, in a systematic and structured way the framework of controls applied by a transport organization to satisfy the radiation protection principles and provisions embodied in the Transport Regulations, i.e. it should be designed to limit both normal and potential exposures of workers and members of the public.
- should define the radiation protection objectives of a transport organization and describe the operator's response contributing to meeting these safety objectives.

It notes that, specifically, the objectives of an RPP for the transport of radioactive material are to:

- provide for adequate consideration of radiation protection measures,
- ensure that the system of radiological protection is adequately applied,
- enhance the safety culture, and
- provide practical measures to meet these objectives.

The objectives of an RPP specified in RS-G-1.1 are similar, including the need to "*reflect the application of management structures, policies, procedures and organizational arrangements that are commensurate with the nature and extent of the risks*".

The draft guidance document indicates that an RPP for transport needs to incorporate all of the radiation protection general provisions set forth in Section III of the Transport Regulations, that it may consist of one or several documents and that it may be a part of the Operator's general quality assurance programme.

The draft guidance document indicates that

- operational radiation protection objectives incorporated in an RPP may be diverse in nature and may reflect, for example, regulatory, managerial or operational requirements and criteria concerning radiation protection in transport;
- the nature and extent of control measures to be employed in an RPP should be related to the magnitude and likelihood of radiation exposures, i.e. the control measures employed are expected to be commensurate to the level of hazards arising from the radioactive material to be transported (i.e., it follows a 'graded approach');
- an RPP needs to cover all stages of transport, but the main emphasis needs to be placed on those stages of transport operations likely to give rise to exposure to radiation;
- small operations involving only a limited number of insignificant package shipments may require a small programme while more significant operations with very diverse radioactive materials and packages being handled and shipped in the public domain need to have a well trained workforce, a well managed programme in place and a significantly larger programme, and
- RPPs need to cover all aspects of transport and associated conditions including routine transport conditions and transport and handling incidents and accidents.

This philosophy is similar to that specified in para 5.3 of RS-G-1.1, which states that "*it is important to ensure that the RPP is well adapted to the situation"*.

Regarding the need for an RPP, the draft guidance document specifies that a transport RPP is intended to define and document a systematic and structured framework of controls to be applied by a transport organization with the primary aim to optimize protection and safety in transport of radioactive material. This is also consistent with RS-G-1.1 which states that: "*implementation of the optimization principle should be the principal driving force behind the establishment and implementation of RPPs*".

The draft document indicates that it is generally recognized that optimization of protection and safety of workers and the public is most effectively addressed at the early stage of transport related activities such as the design, manufacture, scheduling and preparation of the radioactive material packaging. It then discusses the complexity of transport operations and notes that even if radiation protection and safety have been optimized at the pre-operational stage of a radioactive material shipment and priority is given to controlling exposure to radiation in the package design and associated technical measures, there is generally still a need for optimization of radiation protection arrangements at the various stages of transport operations.

An RPP should cover all aspects of transport and associated conditions of transport including normal and routine conditions and transport incidents and accidents (potential exposure). There are, however, some practical and regulatory aspects requiring consideration that may significantly constrain the scope and extent of the regulatory requirement of the establishment of an RPP for transport in practice. For example, the draft guidance document notes that the Transport Regulations do not apply to "*radioactive material movements within an establishment which is subject to appropriate safety regulations in force in the establishment and where the movement does not involve public roads and railways*". This situation is often found in association with transport performed within a nuclear power plant, isotope production facility, hospital nuclear medicine department etc., where staff members of the plant or facility may be involved in transport-related operations such as the packing, loading, preparation, consigning or receipt of a radioactive material shipment. These organizations, however, generally operate under a technical and organizational radiation protection framework similar to or governed by the standards of safety embodied in the Transport Regulations. In the event that a dedicated carrier or shipper organization is contracted solely for the transport operations of a specific consignor or consignee, the consignor/consignee will usually have a properly developed RPP in place and this needs to cover the contracted carrier or shipper operations. In such circumstances the competent authority may not require the carrier or shipper to have a separate radiation protection programme solely for transport if all relevant radiation protection obligations are accounted for by the relevant consignor or consignee organization's RPP.

Both the draft transport RPP guidance document and RS-G-1.1 discuss the need to use prior radiological evaluations of the situation as the first step in the development of an RPP. Specifically, the draft document states that the first step in developing an RPP is to define its field of application

by way of a prior radiological evaluation of the situation which should confirm the adequacy of the RPP. In contrast, RS-G-1.1, regarding the prior radiological evaluation, notes that:

- the purpose is "*to describe, as precisely as necessary, the situation involving occupational exposures",*
- the level of effort is linked to the "*magnitude of the routine and potential exposures and the probabilities of these potential exposures*", and
- the prior evaluation can define what can be achieved during design, and what considerations should be pursued to "*minimize the need for relying on administrative controls*".

It is noteworthy the latter principal is basic in the Transport Regulations, that emphasis on safety is first placed in the packaging and only then on operational controls.

In addition, the draft guidance document notes that a description of the type, nature and volume of radioactive materials being shipped, the magnitude and likelihood of radiation exposures arising from these transport operations, the number of workers potentially involved, the duration of the operations involved and the distance to the radioactive material, are all elements essential to the programme documentation and to defining the scope of the RPP.

The transport programme description provides an indication of the protection measures needed to meet the radiation protection principles of the Regulations, and the elements for classification of the workers, the radiation protection arrangements and monitoring requirements.

BASIC ELEMENTS OF AN RPP FROM THE DRAFT DOCUMENT

The draft document describes and elaborates on some of the basic elements of an RPP defined as a function of the occupational dose category. In preparing an RPP, it must be noted that low occupational dose or occasional transport does not mean an RPP is not required. Indeed, para 301 of the Transport Regulations states that "*A Radiation Protection Programme shall be established for the transport of radioactive material*". Thus, an RPP will – according to the provisions of the 1996 edition of the Regulations – always be required. However, the magnitude of the programme will depend upon radiological risk posed.

The principal radiation protection considerations listed in the draft document that need to be accounted for in an RPP for transport include the following basic elements:

- scope of the RPP
- roles and responsibilities for the implementation of the programme
- dose assessment and optimization
- surface contamination assessment
- segregation and other protective measure
- emergency response arrangements
- training and information
- quality assurance (QA)

It is recommended that each of these elements should be documented with an appropriate level of detail.

The draft document also provides a table illustrating a possible approach to determine the extent of the different elements of the Radiation Protection Programme. This possible approach is shown here as Table 1.

TABLE 1. RPP REQUIREMENTS BY OCCUPATIONAL DOSE CATEGORY

RPP Element	**Occupational dose category***		
	≤1 mSv/y.	**>1, ≤6 mSv/y.**	**>6 mSv/y.**
a) Scope	Yes	Yes	Yes
b) Roles/Responsibilities	Yes	Yes	Yes
c) Dose Assessment	No monitoring required	Workplace or individual dose monitoring	Individual dose monitoring mandatory
d) Dose Limits/Constraints/ Optimization	Yes, but basic	Yes	Yes
e) Surface Contamination	Normally only applies to consignors		
f) Segregation** and other protective measures	Only applicable to II-YELLOW, III-YELLOW, III-YELLOW under exclusive use, and fissile material packages		
g) Emergency Response **	Required, but not dose category dependent		
h) Training **	Yes	Yes	Yes
i) Quality Assurance **	As required		

* Note: A graded approach should be used as appropriate for each RPP element.
** Not only an RPP element, broader considerations may be involved. An RPP can, however, refer to elements existing elsewhere.

As an input to the table, a preliminary categorization of the personnel exposure can be made by using existing dose data. Alternatively, the draft document suggests that a comparison of the dose to transport index (TI) ratio can be used, and provides additional guidance in that area as an annex. However, it is further noted that the dose to TI ratio must be used with caution. Its application in defining personnel exposure is dependent on the operations associated with the packages, for example manual or remote handling. Assignment to dose category 1 (occupational dose <1mSv/y, column 2 of Table 1) can only be accepted if the result of the preliminary dose evaluation indicates that the doses are most likely to be below 1 mSv/year.

The draft document notes that in applying Table 1 and using a TI to dose ratio approach, it must be recognized that, although existing package designs may result in TIs well in excess of 10, such high external dose rates do not necessarily result in high exposures. Operational procedures and other protective measures including segregation are important in such circumstances. The competent authority may approve special arrangements in particular circumstances.

The TI to dose ratio table in the annex to the draft document is shown in Table 2.

Table 2. Examples of Collective Dose per Transport Index

Type of Transport		No. of Workers	Total TI Handled	Total Dose Received (mSv)	Collective dose (μSv/TI)	Ref.
UK transport	(Road)	12	70000	122	1.7	4
	(Road)	71	15000	36	2.4	
	(Road)	5	36000	30	0.8	
	(Road)	6	15000	30	2.0	
	(Road)	4	6000	20	3.3	
USA transport of Radiopharmaceuticals						5
	(Road)	6	11750	3.0	1.1	
	(Road)	6	12430	18.2	1.5	
	(Road)	6	12766	19.8	1.5	
	(Road)	6	12621	19.3	1.5	
	(Road)	6	12418	22.5	1.8	
	(Road)	6	15049	20.4	1.4	
	(Air)	371	49174	115	2.3	
	(Road)	134	80000	149	1.9	
	(Road)	133	80000	158	2.0	
	(Road)	128	80000	145	1.8	
	(Road)	120	80000	145	1.8	
	(Road)	9	2612	1.65	0.6	
	(Road)	10	2696	1.95	0.7	
	(Road)	16	3453	6.95	2.0	

OUTSTANDING MAJOR ISSUES REQUIRING RESOLUTION PRIOR TO PUBLICATION

During the review of the draft document, a number of issues were identified by reviewers that still require resolution prior to publication. These include:

1. Table 1 shown above, which is key to the basic elements section appears to indicate that the only basic difference in RPP requirements is in the dose assessment, and that these requirements are nothing more than a replication of the requirements in para 305 of TS-R-1[2]. Thus, the utility and/or adequacy of the table and associated discussion has been questioned (part of the problem concerns the location of the table and its associated discussion in the text; suggestions have been made to reverse the order of Sections 3 and 4 for clarity).
2. The Safety Guide RS-G-1.1 should be referenced as appropriate throughout the transport RPP guidance document and the concepts therein should be used where possible to strengthen the document.
3. More emphasis needs to be placed on prior radiological evaluation, and this needs to be coupled to RS-G-1.1.
4. In Section 5 of the draft document, it is indicated that management is responsible for ensuring exposures are limited. Responsibilities of workers are not mentioned. These responsibilities need to be added to the transport RPP guidance document so it is consistent with RS-G-1.1.
5. RS-G-1.1 indicates that "*management should consider classifying working areas*" and then elaborates on requirements for controlled areas and supervised areas. This issue needs to be addressed in the guidance document indicating how controlled areas do or do not apply to transport.

6. The draft document was developed with the intent that it would be published as an IAEA technical document (TECDOC). Current guidelines preclude it being published in this manner since it has been written in the form of guidance containing prescriptive '*shall*' and '*should*' statements. Having been drafted in this form, IAEA publication guidelines preclude it being published either as a TECDOC of as a Safety Report. However, it can be published as a Provisional Safety Guide, which is essentially in the format of a TECDOC, but indicates it is intended to eventually be published in the Safety Standards Series, and that the document "*is in a preliminary form on which comments are requested before the manuscript is submitted for consideration as a Safety Standards Series publication*". Thus, consultation with the IAEA's Transport Safety Standards Committee (TRANSSC) on the form of this document will be sought.

CONCLUSION

This paper has provided an indication of the extent to which the guidance document for an RPP for transport has progressed, and the problems that must be resolved before it can be published. Work will be undertaken to redraft the text and circulate to the contributors to the draft and to consult with TRANSSC members on the form the publication should take with a view to having the document ready for publication by the end of 2001.

CONTRIBUTORS TO THE DRAFT GUIDANCE DOCUMENT

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REFERENCES

[1] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, 1985 Edition (as amended 1990), Safety Series No. 6, IAEA Vienna, (1990).

[2] INTERNATIONAL ATOMIC ENERGY AGENCY, Regulations for the Safe Transport of Radioactive Material, Safety Standards Series No. TS-R-1 (ST-1, Revised), IAEA Vienna, (2000).

[3] INTERNATIONAL ATOMIC ENERGY AGENCY, *Occupational Radiation Protection*, Safety Standards Series No. RS-G-1.1, International Atomic Energy Agency, Vienna, Austria (1999).

[4] Wilson C., et al. *Towards the Implementation of ALARA for Transport*, Proceedings of the 10th International Symposium on the Packaging and Transportation of Radioactive Material (PATRAM '92), Science and Technology Agency, Ministry of Transport, Tokyo, Japan (1992).

[5] Brown R. personal communication concerning experience of the US radiopharmaceutical industry with radiation exposure to transport workers, Mallinckrodt Inc., St. Louis, USA. (2000).