

The Radiation Protection Programme in Transport of Radioactive Material: Some Aspects of Its Implementation

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INTRODUCTION

The basic concern of the safe transport of radioactive material is the protection of persons against ionizing radiation. Radioactive material is the only class of dangerous goods, that gives rise to interaction with the environment during regular transportation without occurrence of any incident.

Since the first appearance of the recommendations for the safe transport of radioactive material in 1961, the underlying principle was to exclude high exposures by limiting the dose rate levels at packages and conveyances. These corresponded to the 'permissible doses' of ICRP at that time. The ALARA (As Low as Reasonably Achievable) or optimization principle was not required in the way it is postulated in present regulations.

RADIATION EXPOSURES

Originally the 'permissible dose' for occupational exposure was 1 mSv per day. In the meantime these values were reduced several times with the last step in ICRP 60 (ICRP 1990) where the occupational exposure is limited to an effective dose of 20 mSv per year averaged over 5 years. The exposure for members of the public is reduced to 1 mSv per year, with the introduction of source-related constraints well below 1 mSv per year. Therefore if an individual is exposed to several independent sources he will not receive more than 1 mSv/y. During the last 30 years the principles of optimization and ALARA were developed. This calls for consideration of exposures to workers and the public even in situations below the limiting values.

The limiting radiation dose levels for packages and vehicles have not been changed in Safety Series No. 6 since the beginning. Examples are (IAEA 1990):

- Maximum dose equivalent at the surface of a package: 2 mSv/h
(Shipment under exclusive use: 10 mSv/h)
- Maximum dose equivalent at the surface of a conveyance: 2 mSv/h
- Maximum dose equivalent at a distance of 2 m from the external surface of a conveyance: 0.1 mSv/h

With the new recommendations of ICRP 60, the exposures taking place by transportation of radioactive material had to be reviewed. A simple reduction of the limiting dose rates would have resulted in commercial consequences and had to be justified by unacceptable exposures of individuals occurring in transports.

An extensive survey of practices in transportation, involving different modes of transport, revealed that current practice did not give reason for a change of the limits. The original model for defining the dose rate limits obviously had been robust and conservative enough to satisfy even the new ICRP recommendations considering also the significant increase of shipments.

RADIATION PROTECTION PROGRAMME

In keeping the dose rate limits in the transport regulations unchanged, more attention must be given to measures to control exposures to workers and the public. The requirement of optimization has to be considered as a main objective of radiation protection. This leads to the necessity to establish Radiation Protection Programmes (RPPs). The need was clearly recognized in the discussion on the impact of ICRP 60 on the recommendations of the safe transport of radioactive material. A Consultant Service Meeting (CSM 1993) was convened to give advice and elaborate the principles of Radiation Protection Programmes (RPP). The following is the essence of the findings of this consultant meeting.

It must be stressed from the beginning that requiring a RPP depends to a high degree on the activity of the material and the relevant dose rates during normal transport and incident or accident situations. In addition the workloads for the companies and administrations have to be considered carefully in regard to getting a justifiable cost-benefit effect. It should also be recognized that many companies may already have established a RPP.

The scope of a RPP for transport should mainly focus on the carriage and storage in transit with the associated activities. First steps of emergency measures have to be considered. Generally transportation takes place between fixed installations with well-established RPPs.

A RPP has the following main purposes:

- It should give consideration of radiation protection measures to transport.
- It should give practical advice for an adequate application of radiation protection.
- It should ensure that the objectives of radiation protection are met.
- It should enhance the safety culture.

The aim of RPPs is to cover radiation protection for incident- and accident-free transport and give advice for first actions in cases of accidents.

A graded approach in requiring RPPs should be taken according to following distinction:

- a. Excepted packages have a minor radiation level and a small quantity of radioactive material. RPPs would not be required.
- b. Category I-white packages have a small radiation level. The content can be a quantity of up to A_1/A_2 . RPPs should consider measures to initiate emergency response.
- c. In all other cases an exposure-related approach for establishing RPPs has to be considered. Some graded requirements are given in the new draft of Safety Series No. 6 according to the expectation of levels of effective doses that may be received. Information from different sources support the assumption that in transport the effective dose received by a worker is usually not more than $3 \mu\text{Sv}$ per transport index (TI) handled (CSM 1993).

Further estimates of actual effective doses received or probabilities of exposures including accidents need consideration.

The list of elements of RPPs to be applied to transport should include:

- roles and responsibilities
- dose limits and constraints
- optimization
- occupational exposure
- dose assessment
- segregation distances
- emergency response
- training.

If the TI values and the amount of radioactive material being handled per year are small, simple RPPs may be adequate. A Competent Authority Approval may not be needed, but relevant documentation should be available on request.

Major operations need elaborate RPPs. The Competent Authority should have the responsibility for verifying the adequacy of RPPs.

TRANSPORTATION DOSE ASSESSMENT BY USING INTERTRAN-2

The INTERTRAN-2 package is a computer code system for the assessment of radiological consequences and risks for the transport of radioactive material. It was developed within the Coordinated Research Programme of the International Atomic Energy Agency on probabilistic safety assessment techniques related to the safe transport of radioactive materials, and allows users to study normal conditions of transport and accident conditions separately. It is applicable to all modes of transport, in particular also to multimodal shipments, and can deal with nuclear material and industrial material as well as radiopharmaceuticals.

The INTERTRAN-2 code allows the user to analyze, compare, improve or optimize specific transportation problems and options from the viewpoint of resulting doses to different groups of persons. But the resolution of such analyses may be limited by the quality of available data.

Such an analysis provides useful information for the establishment of an appropriate Radiation Protection Programme. Based on TI values of packages involved in a specific transport situation, e.g., the resulting doses to different groups of persons like radiation workers, handlers, drivers, or members of the public under normal conditions of transport can be studied, taking into account such parameters as:

- number of packages
- characteristic package dimensions
- number of shipments
- velocity of shipments
- average exposure distances to different groups of persons involved
- stop time, handling time, storage time
- number of handlings
- shipment routes, etc.

as appropriate for the case to be analyzed.

Depending on the results, the nature and extent of the measures to be employed in a Radiation Protection Programme can be derived.

The INTERTRAN-2 Code can also be applied to study specific accident situations. Such investigations are useful to derive appropriate emergency response action, which should also be considered within a Radiation Protection Programme.

CONCLUSION

Considering the new recommendations of ICRP 60, the application of Radiation Protection Programmes to the transport of radioactive material must be required. A graded approach has to be taken according to the probability of exposures and the doses received. There are situations where no RPPs are needed. In cases of major operations elaborate RPPs should be introduced, which would require Competent Authority approval. Actual exposure situations can be calculated by using INTERTRAN-2

REFERENCES

- IAEA 90, Regulations for the Safe Transport of Radioactive Material 1985 (As Amended 1990), Safety Series No. 6, IAEA 1990.
- ICRP 90, 1990 Recommendations of the International Commission on Radiological Protection, Annals of ICRP, Vol 21, No. 1 - 3, 1991.
- CSM 93 Private Communication IAEA, Consultant Service Meeting on Radiation Protection Programmes 1993.