The ICRP 60 and the Agency's Regulations for the Safe Transport of Radioactive Material

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INTRODUCTION

The International Commission on Radiological Protection (ICRP) has adopted its new *"1990 Recommendations of the International Commission on Radiological Protection"* in November 1990, they were published in 1991 as "ICRP Publication 60." Two main scenarios are considered by the new ICRP's recommendations:

a) Protection in proposed and continuing practices (further subdivided as protection against actual exposures and protection against potential exposures); and

b) Protection by intervention.

Although intervention means any activity in order to decrease the overall exposure, removing existing sources, modifying pathways or reducing the number of exposed individuals, in relation to the transport of radioactive materials, protection by intervention is related mainly to emergency planning, while protection against actual and potential exposures can be considered as the subject of most of the requirements of the *"Regulations for the Safe Transport of Radioactive Material"*, of the International Atomic Energy Agency (IAEA).

Some issues of the ICRP 60

Because of their potential influence on the transport Regulations, the following issues of the new ICRP's recommendations are noted:

(1) In practice, the annual equivalent dose limit for members of the public has been ratified in 1 mSv.

(2) The need to optimize the level of protection as well as the use of source-related dose constraints as a restriction to the procedures for optimization is stressed.

(3) Criteria for protection against potential exposures have been introduced including those related with risk limits and constraints.

(4) Doses resulting from minor mishaps and misjudgements have been included as part of the "normal conditions."

The transport requirements

In order to facilitate the analysis made in this paper, the transport requirements established by the Agency Regulations are considered as a coherent set aimed at protecting the man (and in consequence the environment and property) against actual and potential exposures, namely both in normal and accidental conditions of transports (those requirements aimed at protection by intervention are not considered here).

Examples of requirements aimed at limiting the exposure in normal conditions are: the specification of maximum allowable radiation levels; the limitations of the package accumulation and the values for deriving segregation distances. Examples of requirements aimed at limiting either the probability or magnitude of potential exposures are those limiting the package radioactive contents as a function of their ability to withstand different kinds of tests.

Obviously, the simplification made is ideal because there are requirements which can be considered in both categories and even also as aimed at protecting in case of intervention (e.g. labelling is used for segregating packages from members of the public because of radiation levels, for limiting the accumulation of packages transporting fissile material to prevent a criticality accident and to identify the contents of the package as radioactive for emergency actions after an accident happens).

In addition, it should be noted that a change in a given requirement can have several effects besides the one desired. For instance, a reduction of the activity limits for a Type A package could produce, 'inter alia':

(a) An increase of the number of Type A packages and the frequency of their shipments;

(b) A decrease of the individual dose of members of the public, but not of their collective dose, and could increase either the individual or collective dose of workers as both;

(c) A reduction of the exposures resulting from an accident, but an increase in the expected frequency of accidents owing to larger number of shipments.

NORMAL CONDITIONS OF TRANSPORT

The possible effects of the new ICRP's recommendations on the transport requirements dealing with normal conditions can be evaluated considering separately the effect of the reduction of the annual equivalent dose limits (ADLs) and the case of optimization and dose constraints.

Reduction of the ADLs

The effect of the reduction of ADLs has been analyzed in a previous paper of the authors, *"Changes in the Annual Dose Limits and their Potential Impact on the IAEA Transport Regulations"*, *Biaggio et al. 1989.*

In the above quoted paper it is concluded that if a reduction of the highest dose incurred by workers and members of the public is needed, two possible regulatory solutions seem to be available:

- To eliminate the Category III-Yellow for beta and low energy gamma emmiters, or

- To eliminate the Category III-Yellow for every light package (e.g. less than 20 kg).

This conclusion arose from several assumptions, some of them summarized here for clarification:

(a) Special operational requirements during carriage and in transit storage should be limited to a few simple directives, mainly based on the information displayed on the labels.

(b) As far as possible packages with radioactive materials should be handled, loaded or stored by conventional means.

(c) If the total activity to be transported per year is independent of the transport requirements, any change in the rules for package accumulation or for segregation will increase handling and the frequency of shipments.

(d) If the dose rate is reduced by increasing the packaging shielding, the weight to be handled will increase and can be envisaged in situations where the dose incurred by users will be augmented. In addition, heavier Type A or industrial packages could have a lower ability to withstand accidents.

(e) Most of the dosage incurred by non specialized workers and members of the public come from light packages.

These assumptions seems to be still valid and, therefore, the suggested solutions should be analyized in spite of the fact that in the case of workers their exposure does not appear to be high, except for distribution systems highly concentrated and a similar situation seems to be that of the members of the public, *"Assessment of the Radiological Impact of the Transport of Radioactive Materials", IAEA-TECDOC-398,1986.*

Optimization and dose constraints

In dealing with optimization, it is stressed that the procedure of optimization should be carefully structured, is essentially source-related and will first be applied at a design stage. Therefore, only the level of protection of each specific transport activity can be optimized. The best example is probably the case of specially dedicated transport systems where the whole activity is designed and operated by specialists. Therefore, it seems that at a regulatory level only to require optimization is possible.

It should be also stressed that both normal and accidental conditions of transport should be considered when optimizing because it happens some time that a dose reduction is achieved by increasing the probability of accidents (e.g., when imposing some routing restrictions).

As a conclusion, it appears that present paragraphs 204 and 205 of the Regulations should be expanded, emphasizing the need to optimize from the design stage and to consider the dose incurred by specialized and non-specialized workers and those of members of the public, and requiring to take into account both normal and accidental conditions of transport. The use of suitable dose constraints should be also requested (see below).

Dose constraints are source-related values of individual doses used to limit the range of options considered in the procedure of optimization. With a few exceptions, the possibility of including figures of dose constraints in the Regulations seems to be quite difficult if possible. For instance, for package design, to assess with reasonable accuracy the individual doses knowing the dose rate close around the package is in general impracticable exception made for a specific transport activity.

However, at present the Regulations include some figures of individual dose which could be considered as dose constraints. Paragraph 205 specifies values of individual dose which should be used for deriving segregation distances. The figures (5 mSv for transport workers and 1 mSv for members of the public), should be reduced at the light of the ADLs recommended by the ICRP. Particularly, if it is considered that the value of dose constraints should be selected taking into account, among other factors, that the individual can also be exposed to other radiation sources (at present the draft of *"Basic Safety Standards", IAEA 1991*, indicates a range of 0.1 mSv to 0.5 mSv for members of the public and 20 mSv for workers as dose constraints).

In addition to the case of segregation, the dose rate limits for normally occupied position in road vehicles can be considered as derived from the dose constraints. The current dose rate limit at any normally occupied position in road vehicles is 0.02 mSv and only the driver and assistants are permitted in vehicles carrying packages bearing categories II-Yellow and III-Yellow labels. Members of the public are permitted only in vehicles carrying packages bearing category I-White.

In practice, annual dose limits for workers (20 mSv) may be used as dose constraints to evaluate the annual exposure periods implied by the noted prescribed dose rate limit for normally occupied position (1000 hours per year). Such exposure time could be defended in light of the average exposure periods in normal transport activities. But, it should be clearly stated in the regulatory documents that this maximum dose rate is not automatically acceptable, in other words, the level of protection should be optimized.

ACCIDENT CONDITIONS OF TRANSPORT

The ICRP 60 clearly stated that in dealing with protection against potential exposures neither the ADLs nor the concept of dose constraints do apply. Probabilities and consequences of potential accidents should be evaluated using risk limits and constraints as boundary conditions.

ADLs in Accidents?

In the paper *"Changes in the Annual Dose Limits and Their Potential Impact on the IAEA Transport Regulations", Biaggio et al.1989*, it was indicated that the Q System, described in *"Explanatory Material for the IAEA Regulations for the Safe Transport of Radioactive Material, IAEA 1990*, use the ratio between the individual doses expected in hypothetical accidents and the applicable ADLs for limiting the probability of occurrence of significant exposures in potential accidents, by requesting the use of a given type of package in function of its radioactive contents. In addition, it was noted that to take the ADLs for workers as reference values was somewhat arbitrary and that any dose quite below the threshold for non-stochastic effects could be used with the same objective. Finally, the mentioned paper recommended not to change the present activity limits for packages only on the basis of a change in the ADLs but to review the Q System to assure that reference doses and intakes are quite below the thresholds for non-stochastic effects.

This recommendation seems to be still fully valid in the light of ICRP 60. Moreover, the ICRP stresses that ADLs are neither applicable to protection against potential exposures nor to protect by intervention. In order to avoid future confusions the authors also recommend now not to use in the Q System figures similar to the ADLs as Annual Limits of Intake (ALI).

Risk limits and risk constraints

By the inclusion of new concepts and refinements of the old ones the ICRP has defined a framework which cover, at least conceptually, all radiation protection aspects in transport.

Although this quite significant development will be of great utility, the possibility of using risk limits and risk constraints when dealing with protection against potential exposures arising from eventual transport accidents involving radioactive materials, it seems to be at present highly limited as practically impossible because of, 'inter alia', the following reasons:

(a) Quantitative risk limits are not recommended yet,

(b) Transport is an special activity in which it is difficult to identify critical groups and even more difficult to establish quantified risk limits.

Further more will be needed in the area of risk limits, and at present it seems to be reasonable, neither to change present requirements on limiting radioactive contents nor to modify requirements related with test severities or after test acceptability criteria on the basis of risk limits or risk constraints.

MINOR MISHAPS AND MISJUDGEMENTS

Although this subject should be included under the title "Normal Conditions of Transport" accordingly with the new ICRP recommendations, the authors have preferred to deal with it separately because it seems that this question should deserve special attention during the next revision of the Agency's Transport Regulations.

In fact, it appears that no effort has been made in the part to try to quantify the doses incurred by a person if a minor mishaps happens (more probably, this was not documented). In addition, there is some lack of historical information both in dose incurred and on the more common cases of mishaps or misjudgements when transporting radioactive materials.

Based only on the author's experience, the usual mishaps seems to be wrong address of the consignee, packages temporarily missed, labelling mistakes and, in a quite few cases, the shipment as empty of a packaging actually carrying a decayed sealed source. Although, it cannot be anticipated the occurrence of large doses, it seems quite probable to exceed the 1 mSv annual equivalent dose limit for members of the public if small packages, which can reach up to 2 mSv/h on the surface, can be involved in a minor mishap and remain close to a member of the public during some hours.

CONCLUSIONS

The on-going revision of the IAEA Safety Series No. 9, which is aimed at putting this publication in line with the new ICRP recommendations will, for the first time, provide a convalidated radiological framework for the 1996 revision of the Agency Transport Regulations.

However, to adapt to the transport area the radiological principles and criteria will require a significant effort and a carefully evaluation of the overall impact of each change proposed.

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