The IAEA Regulations for the Safe Transport of Radioactive Material: New Strategies for the Future

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INTRODUCTION

The International Atomic Energy Agency's *Regulations for the Safe Transport of Radioactive Material* (IAEA, Safety Series No. 6, 1990) recently celebrated their 30th anniversary. They continue to serve as the regulatory basis for both international and domestic transport in most of the IAEA's Member States. In the 30 years of their existence 5 comprehensive revisions were published to keep the *Regulations* abreast of major scientific and/or technological developments. Comprehensive revision has evolved into a formal process involving a 10-year cycle, the current one culminating in a new edition in 1996.

Traditionally the *Regulations* are designed to ensure protection from the effects of the ionizing radiation emitted by the radioactive contents of a package during transport. The underlying philosophy is that reliance is placed principally on the design of the package itself, a philosophy also adhered to in the transport of other dangerous goods. Further, the consignor as the person or the organization having specific knowledge of the materials being offered for transport should as far as possible be responsible for ensuring that regulatory requirements are met. Also consistent with the transport of other dangerous goods is the principle of multi-modality, which aims at the suitability of packages for moving materials by all modes of transport in a safe, practical, cost-effective and expedient way.

IAEA PROGRAMME

The activities of the IAEA concerning the safe transport of radioactive material can be distinguished in three main areas:

1. *The maintenance of the Regulations*, which includes the development, the review and the updating of Safety Series No. 6 and its supporting documents;
2. *The implementation of the Regulations*, which includes assistance to Member States and co-operation with other international organizations in the proper implementation of the Regulations; and
3. *The establishment of Co-ordinated Research Programmes* which support both the maintenance of the Regulations and their implementation.

The structure of the IAEA's programme is presented in Figure 1.

THE CONTINUOUS REVIEW AND REVISION PROCESS

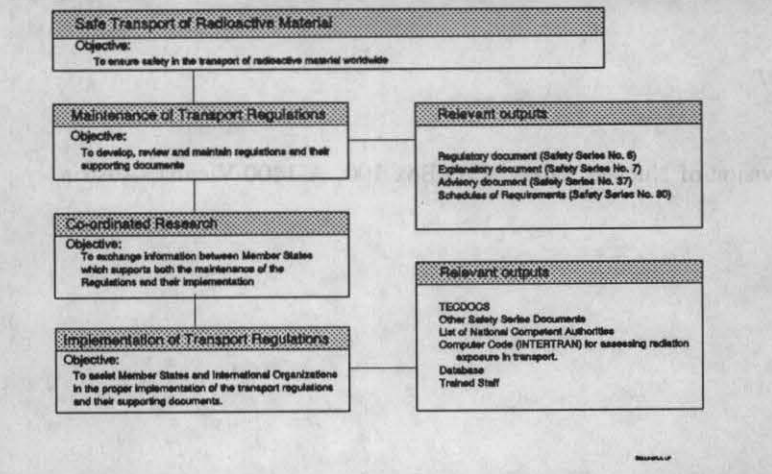

Figure 1. Programme structure and outputs for the programme on the Safe Transport of Radioactive Material

It was recognized already at an early stage that amendments to the *Regulations* should be reflected on a timely basis, in order to allow Member States and other international organizations enough time within which to consult their interested parties for the effects of those changes. Later, the Standing Advisory Group on the Safe Transport of Radioactive Material (SAGSTRAM), the main advisory group on the subject matter to the Director General of the IAEA, recommended further streamlining of regulatory revisions. The result was the establishment of a formal process to ensure continuity and consistency in the identification, processing and discussion of proposals for regulatory amendment. An extensive description of the Continuous Review and Revision Process was presented at the PATRAM '89 Symposium in Washington DC. Although there is no need now to deal with it in much detail it would be helpful to briefly recall its structure. The IAEA's rules for change in the *Regulations* distinguish between the following classes of amendments:

1. *Minor changes*
2. *Changes of detail, and*
3. *Major changes.*

SAGSTRAM recommended a 10-year revision cycle for the *Regulations* consisting of two main phases: an initial phase involving review of the latest edition, followed by a revision phase leading up to the next comprehensively revised edition. In the first phase, review panels would convene in the second and fourth years, each meeting resulting in a formal supplement to the latest edition of the *Regulations*. Those two review panels are expected to process most of the proposed minor changes and changes of detail. In the second phase, revision panels convened in the sixth, eighth and tenth years would consider mainly the proposals which would result in major changes to the *Regulations*. Most of those proposals are prepared by Consultants Services, Technical Committee or Advisory Group meetings, depending on the impact of the change. The Continuous Review and Revision process in shown schematically in Figures 2 and 3.

Year 0	Major revision and publication of new editions of Safety Series No.s 6, 7, 37 and 80
Year 2	Publication of Supplements
Year 3	Publication of further Supplements
Years 5-6	Reprints of Safety Series No.s 6, 7, 37 and 80 including all changes
Year 10	Major revision and publication of new editions of Safety Series No.s 6, 7, 37 and 80

Figure 2. Cycle of the Continuous Review/Revision Process

STATUS OF CURRENT REVIEW/REVISION CYCLE

In the current review/-revision cycle the first experience with the Continuous Review and Revision Process has been obtained. On the one hand, the efficiency of the process was demonstrated to the effect that some major problems could be identified in a timely fashion. On the other, the process highlighted the increasing complexity of the transport regulations, provoked by the need to be responsive to new developments with respect to both the materials being shipped and the modes of transport used.

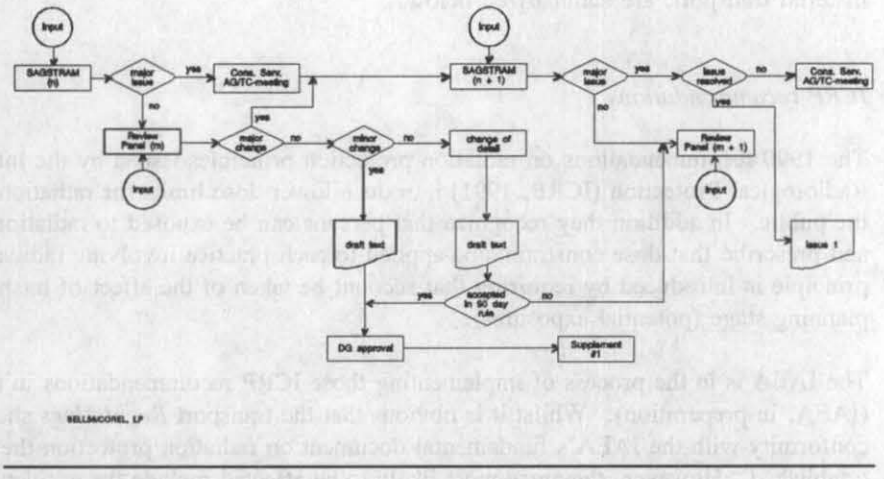

Figure 3. Simplified flow chart for the Review/Revision process

The first phase of the review/revision cycle was completed, and the first step of the second phase has been made. The transition between the two phases is marked by the publication of As Amended versions of the 1985 Edition of the *Regulations* and its supporting documents (IAEA, Safety Series Nos. 7, 37 and 80, 1990).

Up till now three review and one revision panel meetings were held. Altogether more than 300 proposals for change were submitted and most of them have been processed. It is assumed that most of the imperfections or impractical provisions in the Regulations have been taken care of. However, the IAEA will solicit Member States for additional input for small amendments before the next Revision Panel meeting in 1993. This will allow accommodation of practical experience with the 1985 Regulations, which were only fully implemented through modal regulations in 1991. Table 1 summarizes the results of the various Review and Revision Panel meetings, broken down according to the aforementioned classification.

Classification of proposals	Review Panel 1 Supplement 1986	Review Panel 2 Supplemement 1988	Review Panel 3 As Amended 1990	Revision Panel 1
Minor change	22	9	28	-
Change of detail	3	22	8	-
Major change	14	7	37	42
Rejected or remanded for further consideration	-	44	64	21
Total	39	82	137	63

Table 1. Summary of processed proposals for change to the transport Regulations

THE NEW TRENDS

Several major issues that emerged from the deliberations during the review/revision process will determine the structure and the appearance of the 1996 edition of the *Regulations*. The main trends which were identified as having a substantial influence on the *Regulations*, and consequently on the practice of radioactive material transport, are summarized below.

ICRP recommendations

The 1990 recommendations on radiation protection principles issued by the International Commission on Radiological Protection (ICRP, 1991) introduce lower dose limits for radiation workers and for members of the public. In addition they recognize that persons can be exposed to radiation from more than one source and prescribe that dose constraints be applied to each practice involving radioactive material. A new principle is introduced by requiring that account be taken of the effect of mishaps and accidents in the planning stage (potential exposures).

The IAEA is in the process of implementing those ICRP recommendations in its Basic Safety Standards (IAEA, in preparation). Whilst it is obvious that the transport *Regulations* should continue to be in conformity with the IAEA's fundamental document on radiation protection the precise impact still needs to be established. However, the areas most likely to be affected include the accident design basis (Q-system, A_1 and A_2 values), package radiation levels, and the definition of the term "radiation worker".

Transport of large volumes of radioactive material

There may be an increasing need to transport new types of materials or materials occurring in heretofore unequalled volumes and quantities. As many nuclear power stations and research reactors approach the end of their economic life, wastes from decommissioning or decontamination of nuclear facilities could become available in massive amounts, depending on national waste management policies. The current concept of transporting radioactive material, *i.e.* in a packaged form, and consequently with a minimum of operational controls might prove to be inadequate.

It is of paramount importance that the new Regulations do not inhibit the movement of those materials but remain flexible enough to accommodate unconventional cargo.

Uranium hexafluoride

SAGSTRAM has recommended that provisions for the transport of uranium hexafluoride be developed by the IAEA and that those provisions be subsumed in the next comprehensive revision of the *Regulations*. As a first stage in that development process the IAEA published a technical document (IAEA, 1991) that represents the consensus among international experts concerning the main issues.

Outstanding problems, which include the need to achieve an international agreement on the heat transfer models required to demonstrate compliance with the newly introduced temperature test for UF_6 packages, as well as the determination of safe and practical exemption levels from the specific provisions for UF_6, will be addressed and hopefully resolved between now and 1996.

In departing from a policy adhered to so far in the *Regulations*, the inclusion of specific provisions for the transport of UF_6 is remarkable on two counts:

i. It is the first time in history that specific provisions for a single chemical compound are being developed, while throughout the Regulations a generic approach is followed;

ii. Because at low enrichments it is a compound with relatively low radiological hazards but substantial corrosive properties, it is necessary that the provisions for UF_6 transport also cover the non-radiological hazards.

Air transport of large quantities of radioactive material

In the *Regulations* much emphasis is placed on package design for overall safety. Tests have been developed to demonstrate the ability of packages to survive accidents. Those tests do not aim to simulate specific accidents or accident scenarios, but rather to produce the same kind and amount of damage that would result from real accidents. The *Regulations* are basically mode-independent, a philosophy adopted to facilitate the smooth transfer of packages between modes. This approach implicitly assumed that the level of safety is essentially comparable for all modes of transport. The excellent safety record of radioactive material transport hardly justified the need to introduce radical changes in the *Regulations*. However, a technical evaluation of accident severity and accident scenarios particularly for air transport of radioactive material demonstrated a justifiable reason for a reappraisal of those concepts. A bottom line assumption in the multimodal approach of the *Regulations* is the equality of failure rates of packages for all modes of transport. New information on accident statistics for aircraft has, however, demonstrated that the accident environment for the air transport mode is more severe than for any of the surface modes.

Probabilistic safety assessment techniques

The *Regulations* are traditionally deterministic in their approach: it is assumed that packages designed to withstand accidents will not fail under all foreseeable situations. The probability of occurrence of such situations has not played an important role in the development of the *Regulations*. This has in general led to designs of packages which by far exceed the applicable performance requirements. However, the rigorous adherence to deterministic criteria such as equal failure rates for packages for all modes of transport would, as exemplified under the previous point, lead to the necessity of developing increasingly robust packages. The application of probabilistic safety assessment techniques which have developed into maturity for the assessment of the safety performance of nuclear power stations might need to be considered in connection with the transport *Regulations*.

THE RESPONSE OF THE IAEA

The aforementioned main issues determine for a large part the IAEA's programme of work with regard to radioactive material transport and constitute the areas to which most of the available resources will be directed until the publication of the 1996 Edition of the *Regulations*. The schedule of actions being undertaken by the IAEA to bring the issues to a solution within the medium-term future is summarized in Figure 4.

ICRP recommendations

In June 1992 a Technical Committee meeting was convened in Vienna to provide guidance on the implementation of the ICRP recommendations and the IAEA's Basic Safety Standards and to assign responsibilities for further work. Another Technical Committee meeting is scheduled for early 1993 to monitor progress.

Some of the recommendations that emerged from the 1992 meeting are:

- the reference dose level of 50 mSv as the basis for the calculation of A_1 and A_2 values should be retained;
- unless pertinent exposure data related to transport of radioactive material would indicate otherwise, no need exists to reduce package radiation levels;
- the Q-system should be updated and extended to incorporate LSA and SCO material; and
- a nuclide-specific approach to determine surface contamination limits is not recommended for practical reasons.

Transport of large volumes of radioactive material

A Technical Committee meeting dedicated to issues relating to LSA and SCO type material is scheduled for the last quarter of 1993. One of the aims of that meeting is to assess the adequacy of current definitions, bearing in mind that most of the LSA and SCO type of material originates from the radioactive waste area, and that these materials might become available in unprecedented amounts and dimensions from decommissioning of nuclear power stations.

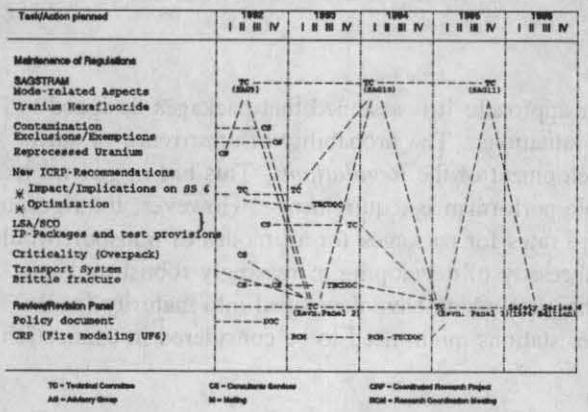

Figure 4. Timeline summary of activities

Further, a seminar on the transport of radioactive waste is projected for 1994. It will provide the forum for information exchange between experts on transport of radioactive material and those on waste management, who represent the supply side for this material.

The objective of both activities is to identify issues of common interest to both subject areas and to eliminate in a timely way any problems that could arise from differing approaches or policies. The arrangements for both activities and the selection of participants will be undertaken in close co-operation with the Waste Management Section of the IAEA.

If indeed large volume streams of radioactive waste are foreseen the transport of those materials from the production site to temporary storage facilities or waste repositories in a controlled but unpackaged form should be considered. In relation to this the Transport Systems approach, on which a communication was presented recently (Pettersson, 1991) could be evaluated for its safety merits and further pursued if found to meet the criteria.

Uranium hexafluoride

The main problem associated with the new requirements for the transport of UF_6 are related to heat transfer modeling for the envisaged temperature test for UF_6 cylinders. In several countries research on this subject is in progress or is considered to be undertaken. In order to facilitate international co-operation and agreement on methodology the IAEA has initiated a Co-ordinated Research Programme (CRP), which was approved under the 1993/94 programme and budget. At least 6 Member States have indicated their interest in the subject by submitting research proposals. It is expected that the outstanding problems can be resolved before publication of the 1996 Edition of the *Regulations*.

Air transport of large quantities of radioactive material

The fact that containment of the radioactive contents could not be warranted under all foreseeable conditions should existing designs of Type B packages become involved in an aircraft crash prompted the US government to put a ban on the shipment of plutonium by air. The USNRC subsequently developed technical criteria for air qualified packages for transport of plutonium (USNRC, 1978). Although two packages which meet those criteria have been developed, the package designs were never used in practice because of their limited capacity. The unilateral adoption of a more stringent regulatory regime by the US for air transport of plutonium was a matter of concern both to the IAEA and to some of its other Member States. SAGSTRAM recommended that the issue should be studied further in order to ensure a consistent safety level throughout the Regulations.

After two Technical Committee meetings, one Advisory Group meeting and three Consultants Service meetings a broad consensus was reached on criteria for air transport of radioactive material in large amounts or with high activity. The result is a draft text containing regulatory provisions for a new type of package, Type C, envisaged to meet more stringent performance criteria than the Type B package. The material will be published by the end of 1992 or early in 1993 as an IAEA technical document. It is the intention that the provisions be developed further with a view to incorporate them in the 1996 Edition of the Regulations. Detailed information on this issue is contained in another paper being presented at the current symposium.

Probabilistic safety assessment techniques

As mentioned earlier, the *Regulations* are basically deterministic in nature, and the validity of this approach is justified by the excellent safety record that radioactive material transport enjoys, a conclusion supported by SAGSTRAM.

SAGSTRAM also considered, however, that the potential benefits of the application of probabilistic safety assessment (PSA) techniques be fully explored. SAGSTRAM particularly encouraged Member States to participate in PSA evaluations and exchange information on the results. Thus, a Co-ordinated Research Programme on the application of PSA techniques is currently in progress. The product of this CRP, which is scheduled for completion by the end of 1993, is an international computer code for the assessment of risks for various exposure pathways during transport, and as such the successor of the INTERTRAN code.

SAGSTRAM further recommended the collection of factual data related to transport of radioactive material (on accidents, shipments and exposures), which can be used as input or as reference material for the computer code, which is thought to be specifically useful for comparative risk assessments. The benefit of comparative risk assessments lies in the ability to demonstrate consistency with other aspects of the nuclear fuel cycle or with transport of other hazardous materials, or with other modes of transport.

CONCLUSIONS

The IAEA is currently deeply involved in the Continuous Review and Revision process in preparation for the new Edition of the *Regulations* whose publication is due in 1996.

While recognizing the risk of prejudging the situation, the experience obtained so far indicates that the structured setup of the Review/Revision process has functioned according to expectations: proposals for change have been submitted at regular intervals and major issues have been identified in a timely fashion.

While the traditional concepts of multi-modality and transport in a packaged form will continue to prevail in the new Regulations and the deterministic approach will be retained, certain developments seem to cause some perturbations.

To be able to respond to the increasingly demanding political requirements to demonstrate the adequacy of the safety (or risk) level, a pooling of factual information is necessary.

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ACKNOWLEDGEMENT

The authors would like to acknowledge the assistance of Ms. L. Pek, IAEA Division of Nuclear Safety, in the preparation of visual aids.