Multi-Modality Concept for Radioactive Material Transport: Reality or Fiction

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INTRODUCTION

The transport of dangerous goods in general and radioactive material in particular is an activity often undertaken by organizations operating in international networks. By the very nature of the materials, safety during transport benefits from an internationally agreed set of standards. In recognition of these facts the Economic and Social Council of the United Nations in 1959 charged the International Atomic Energy Agency with the task of establishing recommendations relating to the safe transport of radioactive material. The first edition of the IAEA's Regulations for the Safe Transport of Radioactive Material (IAEA, 1961-1990), hereafter called the *Regulations*, was published in 1961 and many comprehensively revised editions and amended versions have followed since. The publication of the next edition of the *Regulations* is scheduled for 1996. A full summary of the publication scheme of the IAEA *Regulations* and their supporting documents is presented in Table 1.

Table 1. Year of publication of the IAEA Regulations and their supporting documents

Safety Series No. 6 Revised Edition	Safety Series No. 6 Supplement	Safety Series No. 6 (As Amended)	Safety Series No. 7 Explanatory	Safety Series No. 37 Advisory	Safety Series No. 80 Schedules
1961			1961		
1964					
1967					
1973				1973	[1])
"		1979		1982	[1])
1985					
"	1986				
"			1987	1987	1986
"	1988		1988[2])	1988[2])	1988[2])
"		1990	1990	1990	1990

[1]) Schedules are included in Safety Series No. 6
[2]) Supplements

The IAEA *Regulations* serve as the regulatory basis for all international mode-specific transport agreements as outlined in Table 2. Either through those modal agreements or by direct incorporation or referencing, it is ensured that the IAEA *Regulations* are implemented worldwide in essentially the same way. The initial concept of the IAEA *Regulations* envisaged that they would not only be applied uniformly throughout the world but also that they would be multi-modal, i.e., that they would be basically independent of the mode of transport or the particular conveyance carrying the radioactive material. In general, the IAEA has maintained the multi-modal nature of its *Regulations*. However, the *Regulations* themselves (in paragraph 109) make an allowance for slight national variations solely for domestic purposes and thus recognize the need to take account of the specific circumstances prevailing in a particular mode of transport by including some mode-specific provisions.

Table 2. Mode-specific international transport organizations

Mode of Transport	International Organization	Name of Regulations	Scope
Air	ICAO	Technical Instructions for the Safe Transport of Dangerous Goods by Air	Worldwide
Air	IATA	Dangerous Goods Regulations	Worldwide
Sea	IMO	International Maritime Dangerous Goods Code	Worldwide
Road	ADR/ECE	European Agreement concerning the International Carriage of Dangerous Goods by Road	Regional
Rail	OCTI/RID	International Regulations concerning the Carriage of Dangerous Goods by Rail	Regional
Inland Waterway	ADN/ECE	European Agreement for the International Carriage of Dangerous Goods by Inland Waterways	Regional
Post	UPU	Acts of the Universal Postal Union	Worldwide

The rationale behind the mode-independent nature of the *Regulations* is the *"safety by design"* principle, which assumes that packages meeting an appropriate design can be carried by any mode of transport, since the test requirements are thought to be representative of a whole series of accident situations and scenarios. The benefits accruing from this principle include economy- as well as safety-related elements. The use of one package design for all modes of transport reduces cost by minimising delays when changing transport modes, which frequently occurs in the international movement of radioactive material. Simultaneously, shorter transport duration involving less handling operations to the package would certainly improve safety of the shipment.

On the other hand, mode-dependent regulations would by definition be tailored to the specific requirements and conditions of each mode. This would conform with the *Regulations'* hazard-graded approach for package design that requires light packages for material posing low or moderate risk and more robust packages for materials posing a greater potential hazard.

The excellent safety record of radioactive material transport has so far precluded a fundamental discussion on the need for a reassessment of the concept of multi-modality.

MODAL REQUIREMENTS IN SAFETY SERIES NO 6

The current IAEA *Regulations* have already included some provisions associated with specific modes of transport. A survey of those provisions and their main features is presented in Table 3, which shows that most of the mode-specific requirements apply to air transport. This takes due account of the fact that the radioactive cargo aboard an aircraft is confined to a relatively small space and may be subjected to strong

variations in temperature and pressure. However, all these provisions respect the generic multi-modal approach of the *Regulations* and merely offer a refinement of detail for particular situations.

Table 3. Mode-specific provisions in current *Regulations*

Transport Mode	Paragraph nos. involved	Description of contents
Air	113	Exemption from requirement for multilateral approval by country overflown by aircraft carrying radioactive material
Air	473-475	Restrictions for Type B(M) packages and for packages with radiation levels > 2 mSv/h
Air	515	Limitation of surface temperature of package
Air	516	Containment integrity at ambient temperatures
Air	517	Containment integrity at reduced pressure
Sea	471	Restrictions for packages with radiation levels > 2 mSv/h
Sea	472	Requirements for special use vessels
Rail/Road	467 and 468	Labelling and placarding requirements
Rail/Road	469	Limitation of radiation levels outside the vehicle
Road	470	Limitation of radiation level in driver cabin
Post	476 and 477	Setting allowable limits and procedures for shipment by post

IMPLEMENTATION, THE PRACTICE

Air transport

In 1975 the US Congress passed Public Law 94-79 which imposed a prohibition on the air transport of plutonium until the United States Nuclear Regulatory Commission (USNRC) could develop and test a package that "would not rupture under crash and blast testing equivalent to the crash and explosion of a high-flying aircraft". In 1978 the USNRC published its report "*Qualification Criteria to Certify a Package for the Air Transport of Plutonium, NUREG 0360*" (USNRC, 1978). Without entering into details of that report it can be stated that the test criteria are much more stringent than those for Type B packages as specified in the IAEA *Regulations*. Two packages meeting the very stringent criteria of NUREG 0360 have actually been developed and licensed: PAT-1 (Plutonium Air Transportable package) and PAT-2. Both packages, however, have a relatively limited capacity which prevents them from being used in support of commercial reprocessing programmes.

In 1987 the Murkowski amendment to NUREG 0360 required that the packages designed for the transport of plutonium would be able to withstand the worst case accident, i.e., the drop of a package from an aircraft flying at the maximum altitude and cruising speed.

The reasons for the aforementioned legislation on transport of plutonium and the test requirements as contained in NUREG 0360 have a political rather than a technical background. At the time serious concerns were raised that an aircraft carrying the perceived exceptionally hazardous plutonium would crash in a metropolitan area releasing a large amount of radioactive material and causing prolonged contamination of the environment.

The unilateral adoption of more stringent regulations based not on rational considerations but on the perception of extreme risks associated with one specific material caused considerable concern at the IAEA and several other of its Member States.

On a pertinent recommendation by the Standing Advisory Group on the Safe Transport of Radioactive Material (SAGSTRAM) at its sixth meeting in 1987 the IAEA decided to address the matter as a high priority issue within the framework of the Continuous Review and Revision Process. Broad consensus has since been achieved on most of the fundamental issues related to air transport. The result is a draft text containing regulatory provisions for radioactive material being transported in large quantities or having high activity. For the shipment of those materials a new package type, Type C, with more stringent performance criteria than the Type B package is envisaged to ensure that for all modes of transport a comparable package failure rate in accidents is achieved. This provides the technical rationale for the introduction of a more robust package for air transport. Further communications on this development comprising more detail will be presented later on during this symposium.

It was agreed at the eighth meeting of SAGSTRAM in 1990 that the draft text will be published as a technical document (IAEA-TECDOC) in late 1992 or early 1993 with the objective of incorporating the provisions in the 1996 Edition of the *Regulations*.

It should be borne in mind, however, that the introduction of a package type specifically designed for air transport and the development of regulatory requirements associated with this new package type is the first real example of a fundamental departure from the principle of multi-modality.

Sea transport

Also in the area of sea transport of radioactive material developments are taking place which could in principle disrupt the multi-modal concept of the *Regulations*.

Concerns in some Member Governments of the International Maritime Organization (IMO) about the risks of transporting irradiated nuclear fuel (INF) by sea prompted the IMO's Sub-Committee on the Carriage of Dangerous Goods (CDG) at its 42nd meeting in 1992 to adopt a proposal to release a specific code that will impose restrictions on INF transport aboard non-purpose built vessels. The requirements embodied in this proposal are outlined in Table 4.

Table 4. Requirements for ships carrying INF in flasks

Ship's class	Aggregate radioactivity in INF carried on board a ship	Structural and other safety related requirements to the ship
INF-1	< 4000 TBq	To the satisfaction of the Administration
INF-2	> 4000 TBq but < 2 x 10^6 TBq	Damage stability, fire protection and temperature control
INF-3	> 2 x 10^6 TBq	Purpose built ship

The rather unexpected wide support for this proposal from IMO Member Governments, which are broadly the same countries as the IAEA Member States, can partly be attributed to the publication of a report contracted by Greenpeace (Large, 1990). The main thrust of that report is the allegation that the risks connected with the transport of INF and radioactive waste have always been underestimated and that particularly the accident environment at sea would exceed the IAEA package performance standards should the radioactive material become involved in a fire. This statement was substantiated by examples of ship fires having a much longer duration and higher temperatures than those taken into account in the IAEA *Regulations*' thermal test.

Among the experts on radioactive material transport the view prevails that the authors of the Greenpeace report may be exaggerating their case by:

- including statistics on fires involving ships that carry fossil fuels in bulk (*e.g.*, oil tanker fires);
- not appreciating the difference between peak temperatures and average flame temperatures;
- quoting overall fire durations rather than considering the length of time that a package may be engulfed by the fire; and
- not addressing the probability of such casualties occurring.

SAGSTRAM in its eighth meeting noted this development with great concern and supported the view that neither such dramatic changes in ship design for the larger quantities of INF, nor the fire protection measures for the ship's class INF-2 were justified and recommended that the IAEA voice its Member States' concerns in a letter to IMO. That letter was dispatched on 6 May 1991. In order to underscore the importance that the IAEA assigns to the preservation of the multi-modal concept, the letter bore the signature of the Director General of the IAEA and was addressed to his counterpart at the IMO. It offered to assess the risks of sea transport of such material in close co-operation with IMO and to make any necessary modifications to the *Regulations* should it be found that accident conditions on board ships were indeed more severe than that for the land mode, thus rendering inadequate the current Regulatory tests.

An IAEA Advisory Group that convened in Vienna in December 1991 charged the IAEA Secretariat with the task of providing the IMO with more background information on the IAEA viewpoint. A second letter from the IAEA Director General was sent to IMO on 21 January 1992. It was preceded by a background paper submitted to the 43rd meeting of IMO's Sub-Committee on the Carriage of Dangerous Goods. The letter proposed to establish a joint IAEA/IMO Co-ordinating Group whose aim would be to discuss contentious issues and to initiate a decision making process which can benefit from the availability of sound technical and statistical information. At its 60th meeting in April 1992 IMO's Maritime Safety Committee (MSC) agreed to establish a Joint IAEA/IMO Working Group which should start its activities concurrently with the 61st meeting scheduled for December 1992.

The representative of Greenpeace, which recently acquired observer status at IMO bodies, strongly objected at the MSC meeting against further discussion and pleaded for adoption of the original IMO proposal. Greenpeace also demanded that the IAEA conduct new tests on INF flasks to demonstrate ability to withstand the effects of worst-case maritime accidents. Greenpeace further urged IMO to ask its Member Governments to suspend the sea transport of INF, plutonium or high level nuclear waste since the current standards were inadequate.

A comparison of the diverging views between IAEA, IMO and Greenpeace in relation to INF transport by sea is compiled in Table 5.

The upcoming transport of plutonium from France to Japan is another example of a shipment that is producing a high tide of publicity. The movement by sea of this undoubtedly hazardous radioactive material causes considerable concern to the countries along the shipping route. Some have already announced restrictions on the passage of the shipment along their coasts. This is all the more surprising since the ship that will carry the plutonium is purpose-built, in IMO terminology, and thus fully meets the INF-1 requirements specified in the draft INF Code, which embody the highest survival capability.

Table 5. A comparison of views on transport of irradiated nuclear fuel (INF)

Subject	IAEA	IMO	Greenpeace
Material to be considered	All radioactive material	INF	Material related to the nuclear fuel cycle
Need for change	Change must be justified		All transport by sea should be stopped
Adequacy of Regulations	Adequate		Inadequate
Where to apply changes (if necessary)	Package requirements in Regulations	Additional conveyance requirements (INF-Code)	INF-Code and IAEA Regulations
Accident statistics	To be assessed	To be assessed	Accidents postulated to cause damage in excess of IAEA tests

EVALUATION AND CONCLUSIONS

The two examples just discussed demonstrate that the principle of multi-modality that has been a cornerstone of the IAEA *Regulations* for more than 30 years has come under severe attack. The 1996 Revised Edition of the *Regulations* will undoubtedly accommodate more mode-specific provisions than any other Edition published heretofore.

This criticism should not be taken as a plea for conservation of the structure and basic principles underlying the *Regulations* merely because they have served well in the past. It was recognized from the beginning that regulations are dynamic and should be adjusted to the needs of the users, thereby benefitting from new safety concepts and scientific and technological developments. All Revised Editions of the *Regulations* have thus far included changes agreed upon among experts and that were considered to be instrumental in improving the safety of radioactive material transport.

The Continuous Review and Revision Process was established to structure the submission and processing of all proposals for change to the *Regulations*. The experts from many Member States concurred in their view that departures from the multi-modality principle should be kept to a minimum. The plans of the IAEA to develop regulations requiring more robust packages for air transport of large quantities of radioactive material could be construed as the start of a modal cascade. This regulatory initiative, though, is justified by the fact that it is limited in scope to an area already covered in other modes, where the air mode is distinctly different.

Yet the alarming observation can now be made that deviations from the multi-modality principle have been introduced not by experts but by politicians reacting to public concerns on transport risks. Although political realities cannot be disregarded, the structure and contents of the transport *Regulations* should continue to be based on sound technical judgement and determined by international agreement among experts.

Up till now, the strength of the *Regulations* lies in their coherence and simple application to all modes of transport. This asset is worth preserving.

The establishment of fully mode-specific transport regulations, a development that is not completely imaginary, will certainly take account of all intricacies and special conditions relevant to each mode, but will not facilitate the smooth movement of packages requiring multi-modal shipment. A further digression towards strictly national regulations or regulations based on bilateral agreements becomes conceivable. That

would have a deleterious effect on the international movement of radioactive material or at least impose so many administrative constraints that shipment of this material would be rendered virtually impossible!

Increasing divergence of the regulations for the various modes of transport or for specific environmental or demographic conditions will compound the relatively simple but effective approach that currently prevails. It seems illogical that the imminent fundamental changes to the structure of the *Regulations* should occur at a time when the validity of the concepts that they embody can be derived from the absence of any significant release of radioactive material from packages involved in accidents during a period spanning more than 30 years.

A development that is likely to disrupt a successful formula will eventually not be in the benefit of safety and should therefore not be encouraged by the transport community. I hope that PATRAM'92 marks the start of a growing awareness that the attention of environmental groups is increasingly focussed on the international transport of radioactive material especially in relation to the nuclear fuel cycle. It has therefore become more than ever necessary to maintain international consensus on the basic concepts. The existence of too many modal variations would make radioactive material transport more and more vulnerable to criticism from anti-nuclear and environmental groups and, more importantly, bring it to a complete halt.

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ACKNOWLEDGEMENT

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