STATUS OF CO-ORDINATED RESEARCH EFFORTS ON TRANSPORT SAFETY REGULATORY ISSUES

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ABSTRACT

The International Atomic Energy Agency (IAEA) encourages research by its Member States and involved international organizations into transport safety regulatory issues which are of particular interest to them. This is typically done through establishing Co-ordinated Research Projects (CRPs) for specific topical areas. The IAEA does not undertake the research itself, it simply acts as a facilitating and co-ordinating body to facilitate communication and decisions between researching parties. CRPs in the transport area are intended primarily to benefit deliberations on regulatory requirements on any need for change to these requirements and on methods for complying with them. This paper provides an update on the following CRPs:

- Accident Severity at Sea During Transport of Radioactive Material (CRP completed)
- Development of Radiological Basis for the Transport Safety Requirements for Low Specific Activity Materials and Surface Contaminated Objects (LSA/SCO) (ongoing CRP)
- Accident Severity During Air Transport of Radioactive Material (ongoing CRP)
- Radiological Aspects of Package and Conveyance Non-Fixed Contamination (CRP initiated)

INTRODUCTION

Issues with the IAEA Transport Regulations which are of particular interest to Member states can be further investigated under an IAEA CRP. The need for a CRP is usually established at a meeting of the Transport Safety Standards Committee (TRANSSC) (previously known as TRANSSAC and prior to that known as SAGSTRAM). TRANSSC is a standing body of senior regulatory officials which provides advice to the IAEA concerning its transport safety programme. A CRP can be initiated when at least five Member States offer to carry out work to address an issue of interest. The IAEA does not carry out the research but it co-ordinates and facilitates the work and provides an opportunity to publish the results. The four CRPs which are discussed in this paper deal with issues which have been of interest during the past decade. The following updates provide, for each of these CRPs, some background on the reasons for establishing the CRP, a listing of the countries and organizations participating in the CRP, an overview of the results to date, a summary of further work and the expected product.

CRP "ACCIDENT SEVERITY AT SEA DURING TRANSPORT OF RADIOACTIVE MATERIAL"

In the 1990s, the maritime transport of radioactive material, in particular the shipments from France to Japan of plutonium, of high level vitrified wastes and of fresh mixed oxide (MOX)fuel, attracted

much publicity. In 1992, a Joint IAEA/IMO/UNEP Working Group on the Safe Carriage of Irradiated Nuclear Fuel and other Radioactive Materials by Sea considered many safety aspects associated with plutonium transports. The Group recommended that the three organizations adopt a draft code of practice for the "Safe Carriage of Irradiated Nuclear Fuel, Plutonium, and High Level Radioactive Wastes on board Ships". The Group further considered a number of issues related to accidents at sea, accident statistics, risk studies and emergency response. The Group concluded that all the information available in this area demonstrated that there were very low levels of radiological risk and environmental consequences from the transport of radioactive material. The Group further recommended that the matter be kept under review by the three organizations involved.

In its ninth meeting held at the Agency in 1993, the Standing Advisory Group on the Safe Transport of Radioactive Material (SAGSTRAM) recommended that a new Co-ordinated Research Project be established to study the fire environment on board ships. This task was meant to tie in with the recommendations of the Joint Working Group to keep matters related to sea transport of radioactive material under review.

The resulting CRP on the severity of accidents in the maritime transport of radioactive material involved participants from France, Germany, Japan, Sweden, United Kingdom and the United States of America. The project, which extended over a period of approximately five years addressed multiple issues including the fire environment aboard ships.

The final outcome of this CRP is IAEA TECDOC-1231 "Severity, Probability and Risk of Accidents during Maritime Transport of Radioactive Material", published in July 2001. The principal technical conclusions of this CRP are:

- Ship collisions depend on ship traffic density and thus on the region of the ocean in which a ship is sailing. Traffic density does not affect the frequency of ship fires. However, the chance of a fire during a voyage increases directly with voyage distance or sailing time.

- Ship collisions and ship fires are infrequent events; most ship collisions and ship fires will not subject a RAM transport package on the ship to any mechanical or thermal loads; the chance that a ship collision or a ship fire will subject a RAM transport package to loads that might fail the package is very small.

- If a ship collision subjects a RAM flask to crush forces, the magnitude of these forces will be less than or at most comparable to the inertial forces experienced by the flask during the regulatory certification impact test.

- Ship collisions are unlikely to damage a RAM flask, because collision forces will be relieved by collapse of ship structures, not flask structures.

- Ship fires are not likely to start in the RAM hold. If a fire starts elsewhere on the ship, its spread to the RAM hold is not likely. Even if a fire spreads to the RAM hold, the lack of fuel or air will usually prevent the fire from burning hot enough and long enough in the RAM hold to cause the

release of radioactive material from a RAM flask or, given flask failure due to a preceding collision, to significantly increase the release of radioactivity from the failed flask.

- Heat fluxes from small creeping fires which do not engulf the RAM hold are unlikely to exceed the heat fluxes developed by the regulatory test fire for flask certification.

- Most radioactive material released to the interior of a RAM flask as a result of an accident will deposit on interior flask surfaces; therefore, flask retention fractions are large and flask-to-environment release fractions are small.

- Should a ship collision or fire lead to the sinking of a RAM transport ship and thus loss of a RAM flask into the ocean, recovery of the flask is likely if loss occurs on the continental shelf. If this flask is not recovered, the rate of release of radioactive material from the flask into ocean waters will be so slow that the radiation doses received by people who consume marine foods contaminated as a result of the accident will be negligible compared to background doses.

- If a RAM transport ship, while in port or sailing in coastal waters, is involved in a severe collision that initiates a severe fire, the largest amounts of radioactive material that might be released to the atmosphere as a result of the accident would cause individual radiation exposures well below background.

Consequently, since the probabilities of severe ship collisions and severe ship fires are small and since the individual radiation doses that might result in the event of such collisions or fires are smaller than normal background doses, the risks posed by maritime transport of highly radioactive material such as irradiated nuclear fuel, vitrified high level waste and mixed oxide fuel in Type B packages are very small.

CRP "DEVELOPMENT OF RADIOLOGICAL BASIS FOR THE TRANSPORT SAFETY REQUIREMENTS FOR LOW SPECIFIC ACTIVITY MATERIALS AND SURFACE CONTAMINATED OBJECTS (LSA/SCO)"

During the development of the 1996 edition of the IAEA Transport Regulations a number of issues were raised concerning the packaging and transport of low specific activity material and surface contaminated objects (LSA/SCO). In 1995 SAGSTRAM concluded that there was insufficient basis for making major changes to the requirements for LSA/SCO and recommended that a sound radiation protection basis was needed to support any major changes to the LSA/SCO transport requirements. SAGSTRAM further recommended that a CRP be initiated to provide this basis. The IAEA requested proposals for research agreements under the CRP titled "Development of a Radiological Basis for the Transport Safety Requirements for Low Specific Activity Materials and Surface Contaminated Objects (LSA/SCO)". Initially there were five proposals from Brazil, France, Germany, the United Kingdom and the United States of America. The first Research Co-ordination Meeting (RCM) was held in Oak Ridge, TN, USA, 1-5 December 1997. Canada participated as an observer and followed up with a proposal which was accepted under the CRP. The second RCM was held in Rio de Janeiro, Brazil, 15 -19 March 1999. South Africa participated as an observer and followed up with a proposal which was also accepted under the CRP.

Following the second RCM it was apparent that a new system, called the G-system, to provide a radiological basis for what is currently LSA/SCO would still require significant developments which needed to be supported with additional funding which was not available at that time. Independent of the work on the G-system a better radiological basis was being developed in particular in the area of LSA ores. Also, guidelines for using the existing LSA/SCO classification had been developed by one of the participating Member States and appeared to be effective in providing guidance for the classification of LSA/SCO materials. Although the results at the time of the second RCM indicated that valuable additional information and understanding regarding LSA/SCO materials and shipments would be produced by this CRP, it had also become clear that the CRP would not meet the original objective of providing a comprehensive radiological basis for LSA/SCO requirements.
A Consultant Services Meeting (CSM) was held at the IAEA offices in Vienna, 13-17 December 1999 to develop recommendations for further work under this CRP. The CSM explored several options, including extending the CRP, holding additional CSMs or starting a new CRP.

An ad-hoc RCM was held in Ottawa, Canada, 11-14 April 2000, providing an update on the CRP work on ores including an outline of the ore-related work that South Africa expected to undertake under the current CRP. The ad-hoc meeting concluded that a good radiological basis could be developed for several LSA limits. The ad-hoc meeting recommended that the applicability of the Q-system (which provides a radiological basis for limits for Type A packages) should be further investigated with regard the LSA classification of ores. It was recognized that even the work related to ores could not be completed within the time frame of the usual three RCMs and it was recommended that the CRP be extended either with a fourth RCM or an additional CSM.

The recommendations from the December 1999 CSM and the April 2000 ad-hoc RCM were presented at the 15-19 May 2000 meeting of the IAEA Transport Safety Standards Advisory Committee (TRANSSAC), (formerly SAGSTRAM). TRANSSAC agreed that the CRP should be extended for the ore-related work. The IAEA decided that the extension should be through an additional CSM for the ore-related work only.

The decisions concerning the extension of the CRP were presented at the third RCM which was held near Cape Town, South Africa, 19-23 February 2001. Japan participated as an observer at this meeting. The progress reported at that meeting included:

- A potential further development of the Q-system involving the determination of A_1 and A_2 limits where currently “unlimited” is specified in the regulations. This development could result in a radiological basis for upper and lower limits for the LSA-I category materials.
- Refinement of theoretical models for the determination of specific activities and dose rates of uranium ores as a function of the uranium content. The theoretical models for determination of specific activity show a good correlation with experimental data for ore grades ranging from 0.1 % to 10 % uranium.
- Further development of a computer programme to estimate dose rates as a function of the distance from consignments of different shapes and sizes.

- Development of transport scenarios based on actual ore transport operations complete with dose rate measurements. This work could lead to applying the Q-system approach (considering the various pathways) to transport scenarios for LSA material. One interesting observation is the possibility that, in case of long transport times, normal transport conditions for very low activity materials could result in higher doses than accident conditions.

The work on the G-system was finalized in this CRP with a review of potential areas for future development. The work on guidelines for the existing LSA/SCO requirements had been completed by the previous RCM. It was agreed that the ore related work would be pursued. This work includes completion of the theoretical models and more measurements to validate the models. It was also agreed to develop a common approach to presenting the results. It is intended to complete this work in time for a CSM in March 2002. Completing the work by that time would facilitate the possible use of the results in the next revision cycle of the IAEA Transport Regulations which begins in January 2002. The preparations for publishing a TECDOC with the results of this CRP will commence following the March 2002 CSM.

CRP "ACCIDENT SEVERITY DURING AIR TRANSPORT OF RADIOACTIVE MATERIAL"

The 1996 edition of the IAEA Transport Regulations introduced limits on the activity of radioactive material to be transported by air in Type B packages. Type B packages are used for the transport of high activity radioactive material. Type B packages are designed to provide protection from the radioactive contents even in the event of serious transport accidents. The world wide experience with the transport of radioactive material has been excellent. There has been no fatality or serious injury resulting from the radioactive nature of material being transported. This safety record includes experience for all modes of transport and it includes experience with Type B packages in normal transport and in transport accidents. In response to concerns from Member States the 1996 IAEA Transport Regulations introduced specific limits on the activity of radioactive material which could be transported by air in Type B packages and also introduced Type C packages for air transport of radioactive material with higher levels of activity than specified for air transport of Type B packages. Type C packages are even stronger than Type B packages. Type C packages must be designed to survive serious air transport accidents.

Accident experience was used in developing the design requirements for Type C packages. However, during the development of these requirements it was recognized that additional data collection and accident analysis could be helpful in the continued development and/or justification of the regulations. TRANSSAC, at its 26 February- 1 March 1996 meeting, recommended the establishment of a CRP dealing with issues arising from the air mode. The IAEA initiated the CRP entitled "Accident Severity During Air Transport of Radioactive Material" with a letter (5 August 1997) to interested Member States and International Organizations, requesting proposals for research agreements with the overall objective to further study the issues related to accident forces.

The Member States and International Organizations participating in this CRP are Canada, France, Germany, Sweden, United Kingdom, United States of America, the International Civil Aviation Organization (ICAO) and the International Federation of Air Line Pilots' Associations (IFALPA).

The programme has involved regular RCMs as well as several ad-hoc meetings. The first RCM was held in, Ottawa, Canada, 28 September - 2 October 1998, the first ad-hoc meeting was held in San Francisco, USA, 14-17 September 1999. The second RCM was held in London, UK, 13 -17 November 2000 and a second ad-hoc meeting was held in Montreal, Canada, 3-5 April 2001.

The progress to date includes the following:

Agreement was reached concerning the accidents to be considered, the data required for analysis, the method to obtain data not available from the accident reports and the methodology to analyze the data.

Accidents considered for analysis are the accidents since 1990 with the heavier aircraft (greater than 27000 kg maximum certified take off weight) involving destruction of the aircraft. About 350 such accidents are reported in the ICAO Accident/Incident Data Reporting (ADREP) system. About 208 of these accidents involve either high impact velocity or low impact velocity with significant fire or water immersion. These 208 accidents were reported by 72 ICAO Member States.

An accident questionnaire was developed for obtaining data concerning the following:

- accident identification
- aircraft impact parameters (velocities, impact angles)
- impact location parameters (surface types and orientation)
- in-flight and surface fire parameters (durations, sizes, combustible material)

Many of the data required in this CRP with regard to accident severity are not available from the ADREP database because the accident reports in the ADREP system are prepared to determine the cause of the accident rather than the severity. Accident investigators may have additional information, not contained in the ADREP database, but relevant for the CRP. Accident questionnaires, completed with as much information as possible from data contained in ICAO's ADREP database, were therefore sent to the Accident Investigation Units of the 72 ICAO Member States which reported the selected 208 accidents, with a request to further complete the questionnaires to the extent possible so that an analysis of the data can be carried out.

Based on the response from 24 Member States and further investigations carried out by CRP members more detailed information is now available for 64 accidents. Some initial evaluation of these data will be carried out with regard to the following:

- impact velocities (compared with the regulatory requirement of a 90 degree impact on unyielding surface)
- fire conditions (compared with the regulatory requirement of a 60 minute engulfing fire of 800 ^{0}C)
- immersion
- sequencing of accident environments

An evaluation of accident frequencies will be based on worldwide air claims data and depending on the information available the accident frequencies may be generated for various flight phases.

Statistical data evaluations will be conducted to gain insight on data variability and statistical validity.

An ad-hoc meeting is scheduled for February 2002 to review the initial experience with analysis of the available data. The third and final RCM is tentatively scheduled for June 2002. Preparations for publishing a TECDOC will follow the final RCM. It is expected that this CRP will contribute significantly to a better understanding of the accident environment which may be experienced in air transport of packages containing radioactive material.

CRP "RADIOLOGICAL ASPECTS OF PACKAGE AND CONVEYANCE NON-FIXED CONTAMINATION"

During the year 1998, non conformance issues to the current system of the IAEA transport regulations on surface contamination were identified by several competent authorities during transport of irradiated nuclear fuels. These events resulted in suspensions in shipments of radioactive materials in some countries especially shipments of irradiated nuclear fuel and high-level wastes. At the February 2001 meeting of the Transport Safety Standards Committee (TRANSSC) (formerly TRANSSAC), it was recommended that a new CRP be expeditiously undertaken to address the radiological aspects of package and conveyance non-fixed contamination.

Six countries, France, Germany, Japan, Sweden, UK, USA and one organisation, World Nuclear Transport Institute (WNTI) signed research agreements for participating at this CRP.

A preliminary meeting was hosted by Transnucléaire of France. It was convened in Paris, France 2-4 May 2001. During this meeting:

1. a background of the contamination issue was briefly developed,
2. each participating country communicated on how they dealt with the matter,
3. each participating country made presentations on what they were going to work in the framework of the CRP,
4. the problems to be addressed were agreed,
5. the terms of reference for the CRP were established,
6. the tasks to be undertaken by each participant were defined, and
7. a schedule for the future actions was fixed.

The conclusions of this meeting are the following:

- The current contamination limits in the Transport regulations are based on a model developed decades ago. That model focuses on small packages such as those used to ship radiopharmaceuticals. It was agreed that there is a high-priority need to look at and agree on a revised contamination model as the first step in the CRP, and to develop an enhanced contamination model for all types of packages/conveyances. The review should be undertaken quickly. A contamination model co-ordination group will establish a schedule for completion of

this effort and then undertake the work. This will identify weaknesses and strengths, areas that need improvement, and areas and parameters that need to be added. Model development should go forward, beginning as soon as possible, with frequent contacts being made between key identified contacts in each country/organisation working on model development.

- The overall CRP will focus on assessing, validating and enhancing models; collecting data where available to assist in validating the model; performing studies to assist in assessing optimisation of and limitations of doses in operations, and considering preventative methods to enhance understanding of contamination mechanisms and to assist operators in applying contamination requirements.

- The contamination model co-ordination group will begin work as soon as possible. The co-ordination of this work will be undertaken using the Internet as much as possible.

- The first RCM will be held 7-9 November 2001 in London. Later RCM's will be scheduled as the CRP effort proceeds.