TRANSPORT OF RADIOACTIVE MATERIALS AS PART OF THE TRANSPORT OF DANGEROUS GOODS

B. SCHULZ-FORBERG, H.W. HÜBNER
Federal Institute for Materials Testing,
Berlin (West)

Abstract

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The transport of radioactive materials (RAM) can be seen as being a part of the transport of dangerous goods. The United Nations has provided recommendations for the classes of dangerous goods 1 to 6 and 8 to 9, while class 7 requirements have been developed by the IAEA. Both UN and IAEA rules cover all modes of transport, and their work is being followed by other transport-mode related bodies. In all classes of dangerous goods, except class 7, the safe containment of substances under normal transport conditions is required. Some safety margins are provided, for example by safety factors in relation to working loads and specific material requirements. Class 7, however, defines an accident-safe packaging, the so-called Type B(U) package, that is designed, tested and approved at a much higher level of safety than other types of packagings, which, in any case, are only for small quantities of RAM and which in this respect are comparable to the UN packagings mentioned above. The marking of the packagings with the UN symbol and with the Type B(U) plate should guarantee unhindered shipment. In general, the UN and IAEA bases are accepted all over the world.

1. INTRODUCTION

The transport of radioactive materials (RAM) can be considered to be a part of the transport of dangerous goods. In general, the United Nations Recommendations for the Transport of Dangerous Goods [1] present the internationally accepted level of safety. Since the same set of requirements are used all over the world, these recommendations are an important component of the worldwide safety system.

The United Nations provides recommendations for all classes of dangerous goods, except for class 7 radioactive materials. While the UN Recommendations are valid for all transport modes for classes 1 (explosives), 2 (gases), 3 (flammable liquids), 4 (flammable solids), 5 (oxidizing substances), 6 (poisonous substances), 8 (corrosives) and 9 (miscellaneous dangerous goods), class 7 requirements have been developed by the IAEA on behalf of the UN and cover UN and all other modes of transport. It is expected that the IAEA will continue to follow general UN guidelines in order that its regulations fit into the whole system of rules [2].

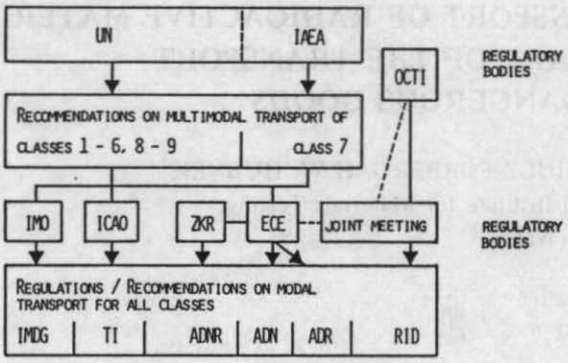

FIG. 1. Class 7 transport regulations in the framework of dangerous goods transport legislation.

United Nations and IAEA work is followed by the 'mode-related' bodies (Fig. 1). The International Civil Aviation Organization (ICAO) has derived a set of regulations, based on UN and IAEA work, using a set of rules for air transport entitled ICAO Technical Instructions [3]. The International Maritime Organization (IMO) has done the same for the sea mode with its International Maritime Dangerous Goods (IMDG) Code [4], which governs the transport of dangerous goods on the sea. There are no worldwide accepted regulations for road and rail, but there are rules for Europe. The UN Economic Commission for Europe (ECE) has been the leading organization in the preparation of the Accord européen relatif au transport international des marchandises dangereuses par route (ADR) [5]. Closely linked with the UN through the 'Joint Meeting' is the Office central des transports internationaux par chemins de fer (OCTI), which prepared the Règlement international concernant le transport des marchandises dangereuses par chemin de fer (RID) [6]. Both ADR and RID are conventions valid in their member states.

2. UN AND IAEA ACTIVITIES

The goals of the UN and the IAEA are to ensure the safety of people, property and the environment. United Nations Recommendations give both the principles of classification of the substances to be transported and the definition of the classes. The main areas are:

- Listing of dangerous goods by UN number
- General packaging requirements
- Testing procedures
- Marking
- Labelling and placarding
- Shipping documents.

All of these items are necessary to eliminate risk during transport, or to reduce it to a generally acceptable minimum. Uniformity at the world level for all modes of transport is a key safety element.

Dangerous goods are listed in three groups, the so-called packaging groups I, II and III. Substances in packaging group II are dangerous, group III contains substances less dangerous than normal (group II) and substances in group I are more dangerous than normal. The overall principle is to keep the substances contained during normal shipping conditions. For example, packaging group II requires a drop height of 1.2 m, packagings of group III are dropped from 0.8 m and packagings for group I substances are tested by a free drop from 1.8 m. Additionally, the principle is not that the tests should represent real shipping conditions or real incident conditions, but should instead provide the same degree of deformation and damage that would be caused by incident conditions.

While the capacity for packages ranges up to 400 kg (450 L), that of the intermediate bulk container (IBC) has gone up, to 3000 L. Both packagings and IBCs will bear UN markings, guaranteeing safe containment. Prior to the application of the UN markings, tests and approvals by the competent authorities are performed.

In addition to packagings and IBCs, the list of UN-approved forms of containment is completed by tank containers (TCs). These start from 450 L and reach a level of about 30 000 L. Normally the tanks are fitted with an ISO specification framework of approximately 6 m (20 ft) size. Unfortunately, the UN TC is not in service. While the mode-related bodies (ICAO, IMO, ECE, OCTI) have taken over the responsibility for packagings and IBCs, their specifications deviate for TCs, even in the design requirements. Thus, the TC accepted worldwide is an IMO portable tank.

Since the IAEA has ruled that all radioactive substances are RAM (even those which have a secondary risk higher than the radioactive one), every radioactive substance is subject to its regulations. The RAM can be shipped in strong industrial packagings, or in Type A and Type B packagings. Their basis is the so-called A_1/A_2 figure, with A_1 and A_2 coming from the maximum permissible intake (MPI). As a guideline, 10^3 MPI can be shipped in a normal packaging, and 10^6 MPI in a Type A packaging. Both types of packagings have to withstand tests which would cause damage such as that which would occur under normal shipping or incident conditions. In this respect, the relationship to the UN system of regulations is clear. Furthermore, they do not need official approval, except if the contents are fissile. Thus, in this case, a registration procedure is lacking.

When shipping more than 10^6 A_1/A_2, a Type B packaging is required. This is an accident-safe packaging. The same principles cover this procedure, but at a much higher level of safety. Here, the intention is not to simulate accidents or to reproduce in a synthesis the outcome of risk studies, but to provide, by using higher levels of specifications, the same degree of damage as would be caused under accident conditions. The result is to be seen in the so-called Type B(U) packaging, the U standing for unilateral. Here again we find a similarity to UN markings for packagings of all

classes other than class 7. Type B(U) guarantees unhindered international shipment, with testing and approval by a competent authority as the necessary precaution.

3. IAEA PACKAGINGS

3.1. General remarks

The packagings described by the IAEA do not at present fit into the UN system. There is no limited range of weight or volume comparable to the limits of 400 kg or 450 L, no comparable testing and approval procedure for industrial and Type A packagings. The very complex behaviour of RAM may be one reason for this deviation, though a second reason is to be found in the working procedures of the UN and IAEA, which are characterized by a lack of information exchange. It would be a great advantage if the IAEA and the UN were to work together more closely to improve this communications flow.

In any future review process between the UN and IAEA, it should be stated that industrial and Type A packagings, as well as UF_6 cylinders, should be treated by both in a co-ordinated manner, especially UF_6. It would be helpful if the UN were to produce detailed requirements for the transport of pressure vessels in general to complete the system for packagings. On that basis, the IAEA could work out the special provisions for UF_6 cylinders even when the radioactive risk is lower than the chemical one.

3.2. Type B(U) packagings

What are the reasons for the unhindered international transport of large quantities of RAM in Type B(U) packagings? The very high level of design requirements that have lead to an accident-safe cask and the detailed work of experts at the IAEA once a first impetus is given. Problems and special tasks are handled by consultants and different technical committees to cover areas in the necessary depth. While a Co-ordinated Research Programme is usually initiated and continued, it is the panels that have really developed the internationally accepted Safety Series Nos 6 and 37 [2, 7]. The work is focused by the scientific secretariat of the IAEA, which provides both administrative and scientific guidance.

Though every Member State is assured that the results of IAEA efforts are a very high level system of regulation, the IAEA is anxious to hold to these levels. Thus if it were found that the 9 m drop test did not represent a heavy mechanical load for lightweight packagings the crush test could be introduced into the new regulations [2, 8].

Another advantage of a system of higher levels of safety is that these levels are so conservative as to allow different engineering approaches not requiring only one prescribed procedure. Therefore the regulations do not contain specific material

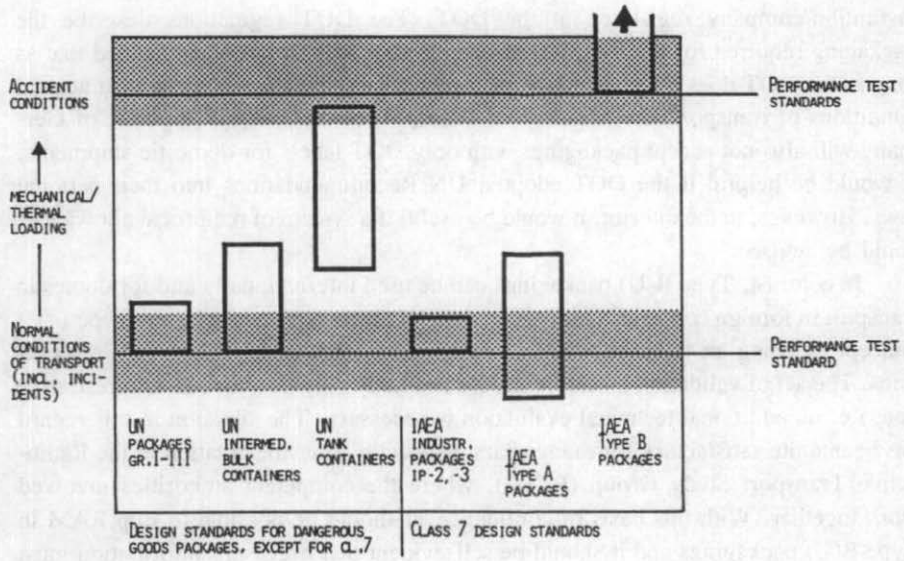

FIG. 2. Correlation of UN and IAEA design standards relative to normal transport and to accident conditions.

requirements or one specified procedure. Equivalent evaluations will always achieve the safety goal in a tolerable range (Fig. 2).

Thus, IAEA safety philosophy allows for the use of the approval procedure, the use of analogy, calculations, model testing and prototype testing to meet the requirements. For instance, brittle fracture as a material datum only has to be taken into consideration, but no special verification procedure is required.

The criteria for an approved packaging are given by the limitation of the surface dose rate, the leaktightness and the subcriticality of fissile material, i.e. primary conditions for meeting the requirements. The IAEA has renounced so-called secondary conditions derived from primary ones.

4. EXPERIENCE WITH UN/IAEA REGULATIONS

Packagings for dangerous goods having UN markings should in theory be transported unhindered between all Member States, since it has been internationally understood that these markings would guarantee adherence to UN standards. The intention here was to allow the free flow of packagings, not only for transit shipments but also for domestic transport of packagings coming from abroad.

Up until now no rejections have been observed except by the United States of America, where UN marked packagings can arrive at a port or airport, but then need additional US Department of Transport (DOT) approval, generally issued by an

institution/company registered at the DOT. The DOT regulations describe the packaging required for the transport of dangerous goods. It has been decided that as long as the DOT does not accept UN markings as guaranteeing safety against normal conditions of transport, the Ministry of Transport of the Federal Republic of Germany will also not accept packagings with only DOT labels for domestic shipments. It would be helpful if the DOT adopted UN Recommendations into their national laws. However, in the interim, it would be useful if a system of reciprocal allowances could be devised.

In contrast, Type B(U) packagings can be used internationally and for domestic transport in foreign countries. All IAEA Member States have accepted the Type B(U) concept as being an internationally accepted safety standard, without any reservations. The act of validation therefore should normally only be a formal administrative one, i.e. no additional technical evaluation is necessary. The situation in this regard has been quite satisfactory for many years, especially after the creation of the Radioactive Transport Study Group (RTSG), where the competent authorities involved work together. With this basis of confidence, it should be possible to ship RAM in Type B(U) packagings and it should be self-evident that necessary information must be given on a voluntary basis. Many Type B(U) packagings are designed only for domestic transport, while others are used internationally and are revalidated by the countries concerned. All of this information is continuously registered at the IAEA (where a list of current certificates is in preparation Ref. [9]). All validations of this list have been issued without additional technical evaluations.

However, this process is far from being self-evident. The following is given as an example of the problem. For the shipment of spent fuel elements, a new generation of casks has been designed using, for the first time, modular cast iron as cask material. The use of this material is in line with IAEA Regulations, which do not prescribe certain types of material. Nevertheless, extended testings and evaluations have been carried out, including full-scale drop tests at –40°C. These have been performed for the first time for casks having a total mass of up to 100 t [10]. The approval procedure has successfully been completed and has led to the issue of Type B(U) certificates of approval, validated in the meantime by the competent authorities by normal administrative procedures.

Some difficulties arose, however, during the validation process for domestic transport purposes in France and for shipments to and in the USA. Both countries insisted on new evaluation procedures of their own. While France accepted ADR/RID shipments and only required specific investigations concerning domestic use, the US DOT did not (and continues not to) allow shipment to the USA.

France, which originally would have chosen another engineering approach for its approval procedure, has finally accepted that the original approach is only one of the possible satisfactory evaluations as determined by the IAEA, since it takes into account detailed information presented by the country of origin. The USA, however, does not appear to accept the philosophy of different, but equivalent, engineering approaches, insisting instead on its own evaluation system even for incoming shipments.

Thus, it would be better, in the first instance, to start from a general basis of confidence between well-known competent authorities to allow shipments based on IAEA guidelines. If there are any concerns left that the IAEA Regulations do not cover, it would be better to submit these problems to the IAEA itself for consideration within the normal revision process.

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