



The Design, Construction and Testing of Packaging

Essentially uniform regulations, based on the IAEA Regulations for the Safe Transport of Radioactive Materials, have been adopted on a world-wide basis with the aim of ensuring safety in the transport of radioactive and fissile substances by road, rail, sea and air.

The application of these regulations over a period of almost 20 years has resulted in practically complete safety in the sense that there has been no evidence of death or injury that could be attributed to the special properties of the material even when consignments were involved in serious accidents. In the regulations, reliance is placed, to the greatest extent possible, on the packaging to provide adequate shielding and containment of the contents under both normal transport and accident conditions.

The Agency organized an international seminar in 1971 to consider the performance tests that have to be applied to packaging to demonstrate compliance with the regulatory requirements. The general conclusion was that the testing programme specified in the regulations was adequate for the near future, but that further consideration should be given to assessing the risks presented by the increasing volume of transport.

The second international seminar, which is the subject of this report, dealt with all aspects of the design, construction and testing of packaging for the transport both of relatively small quantities of radioactive substances, which are being used to an ever increasing extent for medical and research purposes, and of the much larger quantities arising in various stages of the nuclear fuel cycle.

The programme covered the general requirements for packaging; risk assessment for the transport of various radioactive and fissile substances, including plutonium; specific features of the design and construction of packaging; quality assurance; damage simulation tests, including calculational methods and scale-model testing; tests for the retention of shielding and containment after damage; and the experience that has accumulated in applying the regulations to national and international transport.

In the opening paper, Brobst (USA) referred to the justified pride in the safety record over the past 20 years, to the economic and technically sound packaging designs that have been developed and to the excellent co-operation between national and international bodies in smoothing out administrative difficulties in international transport.

He suggested that the points now requiring most attention are: the reassurance of the public that transport is as safe as it should be, the re-examination of the performance tests in the light of experience in transport by all modes, a review of the prescribed limits on radiation levels around packages, the development of quality assurance and compliance programmes, and recommendations on transport controls such as escorts, dedicated vehicles and speed limits.

A general review of packaging requirements by Sousselier and Cohendy (France) noted that the regulatory requirements have been prepared in advance of the actual needs and that experience is showing that they serve their purpose very well. Nevertheless, there is no room for complacency and some topics, for example transport by sea and the transport of plutonium by air, call for continuing study.

Several papers on risk assessment suggested that the greatest risk component, which is still very small, is attributable to the collective dose delivered to the population during routine transport. Another component which merits attention is the dose to workers handling the packages. A practical application of the assessment techniques revealed little difference between the risks involved in transporting either plutonium dioxide or liquid plutonium nitrate by rail or by road.

The transport of limited quantities of radiopharmaceuticals and similar products in Type A packages, amounting at present to more than one million consignments per year throughout the world, was reviewed. The situation is in general satisfactory, but the rapid growth in the traffic will call for continuing attention, including the application of cost-benefit analyses. The difficulty of introducing any change within a short time in the vast number of packages in use was emphasized.

Sedov (USSR) described work on the development of a unified range of multi-compartment barrel-type containers for transporting sealed gamma-ray sources, which meet the requirements of the USSR transport regulations and the 1973 Revised Edition of the IAEA regulations.

The development of tests for assessing leakage from packages was the subject of papers from Canada, Federal Republic of Germany, Sweden, United Kingdom, and the Commission of European Communities. The aim of these studies was to derive practical tests for demonstrating compliance with the requirements set forth in the IAEA regulations.

Special problems associated with the transport of spent fuel and plutonium by sea were dealt with in two papers from USA and Japan. In the first of these, the consequences of rupture of the package and dispersal of the contents were evaluated, and it was concluded that only on the most pessimistic assumptions would the dose to individual members of the public from a single consignment be as high as the dose from average background radiation. In the second paper, tests were described which showed the effects of water pressure on a spent fuel cask at a pressure of up to 500 kg/cm².

A large part of the programme was devoted to tests intended to reproduce the type of damage to packaging that might be caused in the most severe accidents in different modes of transport. Several of the papers were concerned with tests that would give assurance that packages of plutonium would not rupture under crash and blast-testing equivalent to the crash and explosion of high-flying aircraft. Other dealt with the survival of packaging when subjected to high-speed impacts against rigid targets. Some of these tests employed full size prototypes of the packaging; other were applied to scale models. Analytical and empirical techniques were also described which could predict the resulting degree of container damage as a function of container design, impact speed, impact attitude and hardness of the target.

Barker (USA) discussed the application of quality assurance to transport packaging. A quality assurance programme includes qualification testing to demonstrate that the

packaging design meets the requirements, inspections to avoid human error in assembling packages, checks of radiation and contamination levels, verification tests on randomly distributed individual packagings, and full-scale tests in staged accidents.

Thermal tests which simulate the damage caused by severe fires were dealt with specifically in papers from the Federal Republic of Germany, Japan and the United Kingdom.

A group of papers described actual experience over a period of years in the transport of radioactive materials, including spent fuel. Grella (USA) reviewed the period 1971–1975. Of 32 000 reported incidents involving hazardous materials, only 144 have involved radioactive materials. In only 36 cases was there any release of contents or radiation levels above prescribed limits. Most of these releases were from LSA or Type A packages. Two incidents involving release or excessive radiation levels from Type B packages were attributable to human failure in following the packaging requirements. In two severe road accidents no release occurred from Type B packages. At present about 2 1/2 million packages of radioactive materials are transported annually in the USA.

Musialowicz (Poland) reported that in the period 1971–1975 eighteen transport incidents involving radioactive materials occurred in Poland; none of these has had any consequences from a radiological safety point of view. In this same period, measured doses to transport workers have not exceeded three-tenths of the maximum permissible dose for occupationally exposed persons.

Experience over one-and-a-half years in the use of the Nuclear Assurance Corporation second-generation casks for the transport of spent fuel assemblies was provided by Rollins (USA). More than 300,000 cask-miles of travel by road have been recorded and the casks have been handled at 10 different nuclear facilities.

Two panel meetings were organized to discuss questions related to the assessment and approval of package design, and the future development of environmental tests for packaging. In both discussions some prominence was given to the necessity to reassure the public that the present regulatory requirements provide an acceptable level of safety. More might also be done to bring home to the public the benefits that have been obtained as a result of the world-wide transport of radioactive materials in comparison with the small risk of damage in transport. Suggestions were made that the IAEA should issue explanatory documents, in addition to the present advisory material, which would outline the intentions of the regulations and show clearly the comparative levels of safety that they provide.



REPORT ON AN INTERNATIONAL SEMINAR, OSLO, 24–27 MAY 1976

The seminar was attended by 137 participants from 25 countries and 2 international organizations.

Nuclear Fuel Quality Assurance

The objectives of the seminar were to provide educational lectures on the basic concept of quality assurance and quality control as applied to nuclear fuels and to review current applications.