AN OVERVIEW OF THE PACKAGE's TESTING TO SATISFY THE IAEA's REGULATIONS FOR THE SAFE TRANSPORT OF RADIOACTIVE MATERIALS IN ROMANIA

Gheorghe VIERU, Ph. D
Institute for Nuclear Research
0300 Pitesti, P. O. Box 78
ROMANIA

ABSTRACT

After emphasizing the importance of the packaging tests in ensuring that the requisite safety features built into the design of packages comply with the Romanian Nuclear Regulatory Body - National Commission for Nuclear Activities Control (NCNAC) requirements and to IAEA's Regulations [1, 2, 8], the paper presents the type and production testing for type A packages (containers) which have been developed within Institute for Nuclear Research (INR) Pitesti [2]. The paper describes and contain illustrations showing the various tests conducted on the prototype package and how they relate to normal conditions and minor mishaps during transport. Quality assurance and quality controls measures taken in order to meet technical specification provided by the design are also presented and commented. The paper concludes that the justification for containment, based on the use of freight container and the pessimistic assessment of potential inhalation doses to those persons involved with the packaging and transport of radwastes, supports the containers as being suitable for classification as an Industrial Type 3 (IP-3).

INTRODUCTION

The IAEA Regulations for the Safe Transport of Radioactive Material [1, 3, 4, 5] gives specific requirements for packages to qualify as Industrial Packages and laying down detailed requirement which appropriate to the degree of hazard represented by the material taking into account its form and the quantity of it being carried. The objective is to protect persons [3, 5], property and the environment from the effects of radiation during the transport of radioactive material. Safety in the transport of radioactive material is dependent on packaging appropriate for the contents being shipped, rather than operational and/or administrative actions required on the package. It is assumed that a package may be damaged in a severe accident and a proportion of the contents may be released. The required resistance to minor damage is ensured by requiring that the resistance of the package to damage be based on a combination of physical tests which are intended to simulate conditions which could arise in normal transport [1, 6], such as falling from vehicles or being dropped from similar heights, being exposed to rain, being struck by sharp object which may penetrate their surface, or having other cargo stacked on top. Type A packages must be designed to satisfy all of the requirements imposed on an IP-3 package, and also meet additional test requirements if the radioactive content is in liquid or gaseous form. They must also satisfy stringent additional dimensional, ambient environment, internal pressure and containment specifications which are not imposed on industrial packages [4, 6].
The packages (drums) when tested to this requirements, should prevent:

- loss of dispersal of the radioactive contents, and
- loss of shielding integrity which result in more than a 20 % increase in radiation level at any external surface of the package

They also should be designed so that any additional shielding which is provided shall be capable of withstanding the static and dynamic stresses resulting from normal handling and routine conditions of transport and of preventing a loss of shielding which would result in more than a 20% increase in the radiation level at any external surface of the package [4, 5]. The criteria for successful testing of some packages - IP3- has used the phrase "*would prevent loss or dispersal*". The maximum allowable leakage rate for normal transport of Industrial and Type A packages has never been defined quantitatively in the Regulations but has been specified in a practical sense. The wastes to be packaged are generated [2] by INR TRIGA research reactor, post-irradiation laboratory and radiochemistry activities; these may be metallic pieces, protection equipment, used ion exchanger from TRIGA, organic liquid radioactive wastes and used filters, etc. The paper presents a review of the qualification tests performed for the type A packages used for storage and ransport of radioactive materials known either low specific activity (LSA), in Romania.

TEST FACILITIES

All qualifications (type) tests for type A waste packages were carried out internally by the Reliability and Testing Laboratory of the Institute for Nuclear Research Pitesti [2], where all the facilities for testing and quality control have been developed. The developed tested facilities support design, evaluation and certification of RAM and hazemat transport packages. INR Pitesti is the unique manufacturer for radwaste packages (type A and B, in the future). Romanian test capabilities are used to perform and simulate the required qualification tests as well as for type A and B packages, in the nearest future. Impact testing (free drop testing) of packages up to 1,000 Kg are performed using a 20 t crane and special additional tools (welding cutter or other release mechanical methods). The short flee flight assure a convenient orientation of the package at impact. The instrumentation chain contains sensible ancillary electronic instruments (scopes, multimeters, power supply) and proper dedicated transducers which covers all the necessary data acquisition tools during package testing. Data collected are analyzed via high speed computers and the result are displayed or printed. The experience on testing is proved during RAM transportation to the disposal site. All tests were monitored and recorded.

QUALIFICATIONS (TYPE) TESTS OF PACKAGES USED FOR STORAGE AND TRANSPORT OF LOW LEVEL ACTIVITY RADIOACTIVE WASTES

The qualification tests for radioactive waste packages, have been performed in accordance with Technical Specifications (TS) covered by Romanian Standards [8] and to comply to the IAEA's Regulations for Safe Transportation [1, 4, 6].

Romanian authorities, within INR Pitesti, developed 4 types of type A packages to be used for storage, transport and disposal of LLW [2]. These are:

- ABBD-1 is a type A package used for final storage (30 years) of low level activity wastes up to 6.07GBq (0.164Ci)/drum. The drum is manufactured from 1mm thick mild steel

and has the following dimensions**: height:** 915 ± 10mm, **diameter:** 600 ± 5mm, **volume:** 220liters, **total content weigh**t: 300÷600 Kg, (1994);

- Type II package used for temporary storage of solid low level activity wastes at CANDU NPP Cernavoda is manufactured from 1.5mm stainless steel, with a removable lid and a sealed tool; dimensions: **inner diameter**: 570mm, **max. diameter**: 600mm, **height**: 905mm, **weight** (empty): 35 Kg; volume: 220 liters; (1995);

- BON-1 220 liters type A packages, intended to be used for temporary storage of low and medium level of radioactive compacted solid radwaste; dimensions: **inner diameter** 570 ÷1mm, **max. diameter**: 600 mm, **height**: 905 ÷0.7 mm, **volum**e: 220 liters; **weight** (including content): 440Kg; (1997);

- CDF -1 420 liters type A package, intended to be used for final storage of low level radioactivity liquid radwastes; is made from 1.5 mm stainless steel and has the following dimensions: **inner diameter**: 720÷7mm, outer **diameter**: max. 750 mm; **height:** 1065 ÷ 3mm; volume: max. 420 liters, (1998).

For carrying out the qualification tests for radioactive waste packages, in accordance with Technical Specifications (INR Standard 130/1990) [2], and meeting the IAEA Regulations concerning the number of specimens subjected to the tests (taking into consideration the usage, availability of packaging and cost of an individual package, the materials and methods of construction and the actual test results, together with the low use factor) only one package (drum) was tested for every kind of radioactive waste [2, 8]. It should be noted that the content of the specimen for testing is real radioactive waste intended to be transported and stored [2].

Test Requirements for Type A Packages

Before certification the package was subjected to production tests and qualified for durability to comply with standard requirements for mechanical properties, leaktightness, resistance to corrosion, loading and drop tests. The drum was visually examined and no faults or damages or defects were detected during specific manufacturing controls, such as: welding control, visual inspection, sealing test, etc. With reference to the type A package radioactive waste contents, a selection has been made with respect to the predominance of the activity and to the representatives of the practices and exposures. More than 10 radionuclides with different activities were identified, such as Co-60, Co-58, Cs-137, MN-54, Sb-124, U-238, Nb-95, Cs-134**,** etc., with the following distribution: *Co-60*: 80%; *Co-58:* 18%; *Cs-137*: 0.5%; *Mn-54*: 0.5%. The knowledge of isotopes and their distribution is useful for the assessment of the expected radiological consequences and accident risks. Type A packages must be able to retain their contents or without allowing more than a specified increase in external surface radiation level and shielding integrity if subjected to: *free drop test, compression and penetration test.* [1, 2, 8]. These tests requirements constitute the compulsory minimum specifications for the manufacturer [9] and were performed by the Reliability and Testing Laboratory of SCN Pitesti in accordance with the Romanian and IAEA's Regulations, such as:

The free drop test: the test was performed for 2 hours **after** the end of the water spray test and the drum was thus dropped so as to suffer maximum damage; the drop height was *1.2 m.* ***Test pass criteria:*** no rupture of the outer shield, no release the sealing lid and the limits of the release

fraction of the package contents, if any, to be within the range of *0.1%* to *1 %*. ***Results:*** after the test the container was subjected to visual inspection and no damage or defects were observed;

Fig. 1 The free drop test for ABBD-1 package

The compression test: the test is intended to ensure that effectiveness of containment, shielding and any spacers are maintained while package is stacked in such a way normally likely to occur during loading, unloading, transport and intermediate storage. Before testing, the drum was subjected to 1 hour water spray test. After two hours the compression test was performed. ***Test pass criteria****:* package to withstand for a period of 24 h at 5 times its weight. ***Results:*** no damage were observed at the end of the test.

Fig. 2 The stacking test for type II package

The penetration test: the test is intended to demonstrate the capability of the package to withstand the kind of puncture damage which may arise in routine transport, such as: *sharp objects falling on the package, damage from loading hooks, and the like.* ***Test pass criteria:*** no rupture of the outer shield, and the limits of the release fraction of the package contents, if any, to be within the range of 0.1% to 1%**.** ***Results:*** the drum shield was indented about 0.1 mm and the sealing lid was not affected. No release fraction of the content and no other damages were observed.

Fig. 3 The penetration test for type II package

The water spray test have been performed in accordance with the Regulations for the Safe Transport of Radioactive Material (1996 Edition, Requirements - ST-1), para. 721, so the specimen have been subjected to "*a water spray test that simulates exposure to rainfall of approximately 5 cm per hour for at least one hour*".

The 9 m free drop test: the 9m free drop test was performed for packages used for transport and storage of liquids radwaste [2, 8]. The yielding of the shells resulted in a 1.2% increase in the diameter of the test specimen at this location (this increase was also indicated by permanent strain measured by strain gauges). Post test helium leak testing indicated that the specimen on both ends remaining leak tight. The comparison of predictions and test measurements showed that the test matched the actual deformations very well. No other severe damages were observed. The simulated contents was water.

Fig. 4 The 9m free drop test for CDF-1 package designated to liquid wastes (before and after)

It is assumed that type A packages may be damaged in a severe accident and that a fraction of their contents may be released [2, 9]. The regulations therefore prescribe limits on the maximum

amounts of radionuclides that can be transported in such packages. These limits ensure that in the event of a release the risks from external radiation or contamination are low. The qualification program are conclusive enough to qualify the container as a reliable one, suitable for conditioning, temporary or final storage of LLW wastes.

QUALITY ASSURANCE (QA) AND QUALITY CONTROL (QC) ORGANIZATION AND RESPONSIBILITY

QA and QC were carried out by the manufacturing staff themselves. In this was the responsibility for high quality products always rests with the manufacturer, and the consciousness of, and desire for, quality in each worker involved will be stimulated. Delegation of a quality or compliance assurance function to a separate or independent organization will have a negative effect on the motivation of the manufacturing staff, and responsibility will be felt to have been shifted to the assurance personnel. QC was reduced to certain special criteria which indeed will be fulfilled, but the quality of the complete product itself will have first priority. It was also incorrect to postulate possible treatment worker or shipping error and as a result of this to define additional requirements.

Before testing the specimen (drum) was inspected and examined [2] and no faults were found or recorded, nor any damage due to defects during construction or preparations for testing (according to the treatment technology); no corrosion, accidental deterioration or other distortions of features or divergences from specifications or drawings were found. Conformity with the specifications was checked on receipt for supplied materials and intermediate products. Protection against corrosion (paint, oil films, etc.) was checked. Additionally, before the qualifications tests were begun, the specimen was checked for non-fixed radioactive contamination on its external surface, using the wipe method by swabbing with alcohol. The measured activity was less than 1 Bq (allowed limit: less than 185 Bq) [2].

CONCLUSIONS

The experience with testing has shown that the existing package is adequate to withstand the required tests for qualification: it is strong and resistant to a drop. The bottom of the package has a minimal economic impact on the overall package cost and helps to maximize the use of an existing package design. It is considered that these results, with respect to the qualifications tests carried out, are satisfactory, and meet Romanian [8] and the IAEA's Regulations for the Safe Transport of Radioactive Materials (RAM) [1]. Nevertheless this testing experience will be improved, in the future. Our conclusion is that these type A packages (for solid and liquid radwastes) will survive most potential road and rail accidents intact but will fail to forces grater than those specified in the IAEA's Regulations [9].

ACKNOWLEDGEMENT

The author would like to acknowledge the able assistance of the International Atomic Energy Agency (IAEA) Vienna, both for technical and financial assistance (under contract). Also, I would like to thank the Sandia National Laboratory (SNL), Albuquerque, US. In addition, he would like to thank to Dr. Richard R. Rawl (IAEA), Dr. Chris Olsen (SNL), Dr. Richard

Yoshimura (SNL), for their valuable advice and constructive criticism. Any deficiences in this paper are the sole responsibility of the author.

REFERENCES

1. International Atomic Energy Agency, Regulations for the Safe Transport of Radioactive Material, 1996 Edition, REQUIREMENTS, No. ST-1 (1990).
2. Institute for Nuclear Research, The Treatment Technology for Radioactive Waste, INR Pitesti (Internal Document), (1990)
3. International Atomic Energy Agency, Basic Safety Standards for Radiation Protection - 1982 Edition, Safety Series No.9, Vienna, IAEA (1982).
4. International Atomic Energy Agency, Explanatory Material for the IAEA Regulations for the Safe Transport of Radioactive Material - 1985 Edition (as Amended 1990), Safety Series No.7 Vienna, IAEA (1990).
5. International Atomic Energy Agency, Radiation Protection Procedures - 1973 Edition, Safety Series No.38, Vienna, IAEA (1973).
6. International Atomic Energy Agency, Developments in the Transport of Radioactive Waste, Proceedings of a Seminar held in Vienna, 21-25 February 1994, IAEA-TECDOC-802, June 1995, Vienna, IAEA (1995).
7. M. ONCESCU, "Radioprotection Handbook", Institute of Atomic Physics, Bucharest, Magurele (1981).
8. State Committee for Nuclear Energy, National Regulations for Safe Transport of Radioactive Materials, Bucharest (1975).
9. G. VIERU, "Risk and safety Evaluation in Radioactive Waste Transport in Romania", RAMTRANS, Vol. 10, No. 2, pp. 105 - 112, Nuclear Technology Publishing, London (1999).