Safety Tests of a Type A Transport Package for Radioactive Waste

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1. Introduction

A type A transport package for radioactive waste from the radioactive waste treatment facility to the interim storage building of radioactive waste of a nuclear power plant has been developed. If a type A transport package were subjected a free drop test, a stacking test and a penetration test under the normal conditions of a transport, it would prevent (a) loss or dispersal of the radioactive contents and (b) a more than 20 % increase in the maximum radiation level at any external surface of the package.[1~3] For a stacking test, the type A transport packages are verified by the finite element analysis.[4] In this paper a free drop test and a penetration test under the normal conditions of a transport of the type A transport packages with a bolted lid were performed. After conducting the drop tests, the torque to unfasten the bolts and the gap between the body and the lid are measured so that a loss or dispersal of the radioactive contents is evaluated. To examine an increase in the maximum radiation level, the thickness of the shielding material using the ultrasonic thickness gauge are measured.

2. The Type A Transport Package

The type A transport package is for a transport of four radioactive waste drums whose radiation activities are smaller than A1 and which are not classified as a low specific activity material and a surface contaminated object. The weight of a waste drum is 400 kg. Carbon steel was employed as a main structural material of the transport packages. For a shielding material, carbon steel with a 50 mm thickness which plays a role as a structure material is used. A capacity of the packaging is 1.6 ton and the total weight is 6.96 ton. The inner support is used to maintain a clearance between the drums which is 100mm. The internal dimensions are 1,540 mm(L) x 910 mm(H) x 1,540 mm(W) and the external dimensions of the package are 1,899 mm(L) x 1,239 mm (H) x 1,900 mm(W). A corner fitting whose size and configuration are specified in ISO 1161[5] and fork-lift pockets whose dimensions are provided in ISO 1496-1[6] are used as a lifting device.

To avoid a streaming radiation in the shielding path and to reinforce the structure integrity for the side drop test, a 10 mm step between the bottom and the flange on the lid is made. A rubber gasket is used at the flange and twenty-four bolts are used to contain the lid.

3. A Drop Test

For the type A transport packages a bottom-vertical drop test and a top-oblique drop test are executed in sequence. For a top-oblique drop test the model of the type A transport package is inclined with 20°. The bolts are fastened with 200 N·m in the order as shown in Figure 1. The drop height is 0.9 m which is regulated in the regulations for the weight of the transport package which is from 5,000 kg to 10,000 kg.

The top-oblique drop of the type A transport package is performed as shown in Figure 2. The square pipes and the corner fitting near the impacted point mainly are deformed.

Table 1 shows the torques to unfasten the bolt, the changes of the gap between the body and the lid and the decreases in the shielding thickness for the bottom-vertical and top-oblique drop tests for the type A transport package. The bolts are not failed and unfastened. The maximum and average torques to unfasten a bolt are 390 and 290.3 N·m and 452.4 and 326.4 N·m for a bottom-vertical drop test and a top-oblique drop test, respectively. The torque to unfasten a bolt for a bottom-vertical drop test is smaller than that for a top-oblique drop test.

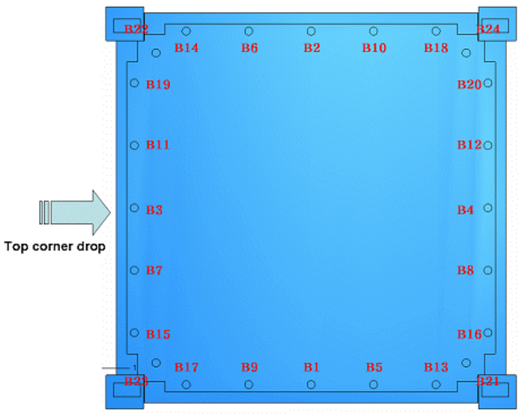

Figure 1. The order of the fastening bolts for top-oblique drop of the type A transport package.

The changes of the gap between the body and the lid are 0.07 mm and 2.14 mm, respectively. The gap between the body and the lid is not the gap between the flange of the body and the lid. There is a rubber gasket with a 3 mm thickness between the flange of the body and the lid. The changes of the gap between the body and the lid for a horizontal drop test, 2.14 mm showed the effects of a deformation of the square pipe. The height of a step, 10 mm is higher than the change of the gap, the bolts are not failed and the rubber gasket is working so that there is no loss or dispersal of the radioactive contents.

When compared with the thickness of the wall, 50 mm, the decreases of the thickness of the shielding material measured for the free drop tests of the type A transport package by using a ultrasonic thickness gauge are insignificant(0.01~0.02 mm) so that a loss of the shielding integrity is negligible in terms of the overall shielding integrity.

The type A transport package maintained the structural integrity for a free drop test under normal conditions of a transport.

Figure 2. The top-oblique drop test of the type A transport package.

Table 1. The torque to unfasten the bolts, the change of the gap between the body and the lid and the decrease in the shielding thickness for a free drop test for the IP-2-b transport package.

		A horizontal drop	A side-oblique drop
The change of the gap (mm)		0.07	2.14
A torque to unfasten a bolt (N·m)	Max.	390	452.4
	Ave.	293.9	326.4
The failure of the bolts		No	No
A decrease in the shielding thickness (mm)		0.01	0.02

4. A Penetration Test

A bar of 3.2 cm in diameter with a hemispherical end and a mass of 6 kg are dropped onto the lid of the packaging with a 1 m height. A groove which has an 8.79 mm diameter and a 0.97 mm depth appeared at the impact point as shown in Figure 3.

The torque to unfasten the bolt and the gap between the body and the lid is insignificant so there is no loss or dispersal of the radioactive contents. The depth of the groove means a decrease in the shielding material by neglecting the deformation at the other side of the lid. The depth of the groove, 0.97 mm is almost 2% of the thickness of the wall so that a loss of the shielding integrity is negligible in terms of the overall shielding integrity.

Figure 3. Deformation at the impact area for a penetration test of the type A transport package.

5. Conclusion

The free drop tests and a penetration test of the type A transport package are executed under the normal conditions of a transport. The torques to unfasten the bolts and the gap between the body and the lid are measured so that a loss or dispersal of the radioactive contents is evaluated. To examine an increase in the maximum radiation level, the measured decreases in the thickness of the shielding material are insignificant so that a loss of the shielding integrity is negligible in terms of the overall shielding integrity.

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