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Structural and Shielding Safety of a Transport Package for Radioisotope Sealed Source Assembly

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1. Introduction

As some kinds of radioisotope (RI) sealed source are produced by HANARO research reactor, a demand of RI transport package is increasing gradually. Foreign countries, which produce the various RIs, have the intrinsic model of the RI transport package. It is necessary to develop a RI and its transport package simultaneously.

It is difficult to design a shielding part for this transport package because the passage for this source assembly should be provided from the center of shielding part to the outside of the package. In order to endure the accident conditions such as a 9 m drop and puncture[1,2], this transport package consists of the guide tubes, a gamma shield and a shock absorber. This paper describe that a shielding and structural safety of RI sealed source transport package are evaluated under the accident conditions.

2. Design and Safety Evaluation of Transport Package

In this section a safety evaluation of transport package are described. And this transport package consists of the guide tube, gamma shield and shock absorber.

2.1 Design Concept

This package is capable of transporting four ^{192}Ir sealed source assemblies. This sealed source assembly has a source capsule, a flexible cable or spring and a connector and its length is about 190 mm. The transport package could be divided to two containers as shown in Fig. 1. ; one is a shock absorbing container and the other is a shielding container. The shock absorbing container has Polyurethane foam surrounded by a carbon steel case. The shielding container includes tungsten, lead, curved guide tubes and stainless steel case.

A general transport package has a containment boundary, which prevents a radioactive material from a leakage. It is necessary for performing a stress analysis of the containment boundary to confirm whether it continue an elastic range or not.[3] The sealed source transport package has not the containment boundary. It is important to sustain the relative location from the shielding part to an end plug. A surface radiation level of the transport package will be changed because a shielding thickness is also changed according to the location of the sealed source

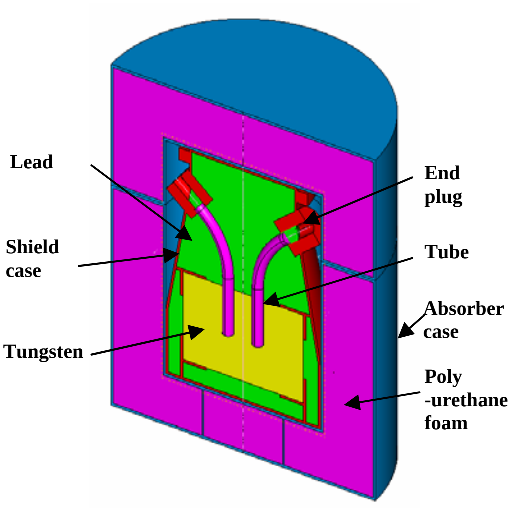

Figure 1. Overview of transport package for RI sealed source assembly.[4]

2.2 Shielding Safety

The design capacity of package is 4 sets of Ir-192 150 mCi sealed source assemblies so package can contain 600 mCi totally. For the conservative aspects, dose rate for transport package is based on the surface of shielding container not absorbing container. MCNP is used for dose rate calculation and shielding container consists of mostly tungsten with lead. Axial sectional view of container model is shown in figure 2. Dose rates for 8 points on surface are calculated and the results are shown in table 1. All results are under dose rate limit of 200 mrem/h on the surface of container and maximum dose rate on the surface is 154 mrem/h in case 4 consisting of 54.4 mm tungsten and 22.6 mm lead. On the basis of results, transport package for RI can satisfy regulation limits for transport package.

Table 1. The dose rate results of transport package.

NO.	Tungsten(mm)	Lead(mm)	Air(mm)	Results (mrem/h)
1	50	21	0	92.6
2	74.5	25.6	0	1.56
3	53	22	0	104
4	54.4	22.6	0	154
5	58.5	24.3	0	104
6	72.7	21	0	2.88
7	0	99.6	94.5	8.25
8	0	78.4	118.4	54

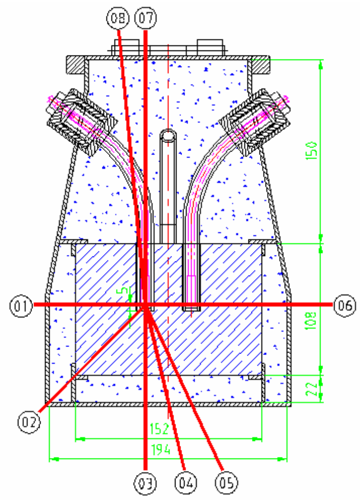

Figure 2. Axial MCNP model for RI sealed source assembly

2.3 Structural Safety

In view of the structural safety, the deformation of shock absorber is calculated by using ABAQUS/ Explicit code. Fig. 3 shows the deformation of the analysis models for 9 m oblique drop and 1 m puncture drop. As maximum deformation is within 2 mm, The relative displacements between the center of the shielding part loaded the sealed source and the end plug are also evaluated. In an impact moment, this relative displacement is changed as shown in Fig. 4.

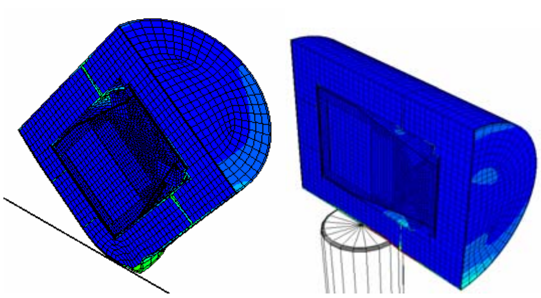

Figure 3. Analysis model during 9 m oblique drop and 1 m puncture.

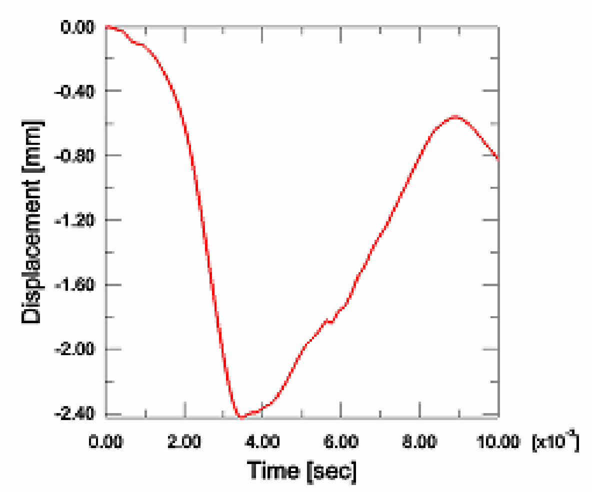

Figure 4. Relative displacement of 9 m top vertical drop between the center of tungsten and the plug of sealed source assembly.

3. Conclusion

In the case of RI sealed source transport package, the structural and shielding safety would depend on a continuation of the initial shielding thickness. It is important how much a location of the sealed source is varied. And by predicting this variation of shielding thickness the shielding integrity could be evaluated.

REFERENCES

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[2] IAEA Safety Standard Series No. TS-R-1, "Regulations for Packaging and Transportation of Radioactive Material,” 2000 Ed.

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[4] K.S. Seo, J.C. Lee, K.S. Bang, D.H. Kim, J.H. Lee and J.B. Kim, “Structural, Thermal Analyses for Transport Package of Radioactive Waste,”, KAERI/CR-207/2005, 2006.