Conceptual Design for HIC Transport Package

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1. Introduction

Korea Hydro & Nuclear Power Co. Ltd.(KHNP) is developing a HIC(High Integrity Container) transport package to transport a high integrity container from the radioactive waste treatment facility of the nuclear power plant to the interim storage building of radioactive waste. The transport package is designed according to the requirements of the Korean and the IAEA transport regulations for Type B package. The transport package provides containment, radiation shielding, structural integrity and passive heat removal for normal transport and hypothetical accident conditions. This paper describes the conceptual design for the HIC transport package.

2. HIC Transport Package

High integrity container transport package is to transport a HIC as shown in Fig. 1 from the radioactive waste treatment facility of nuclear power plant to the interim storage building of radioactive waste in the same nuclear power plant site. The length and diameter of the HIC are 1.3m and 1.2m, respectively. The loaded weight of the HIC is about 2 tons.

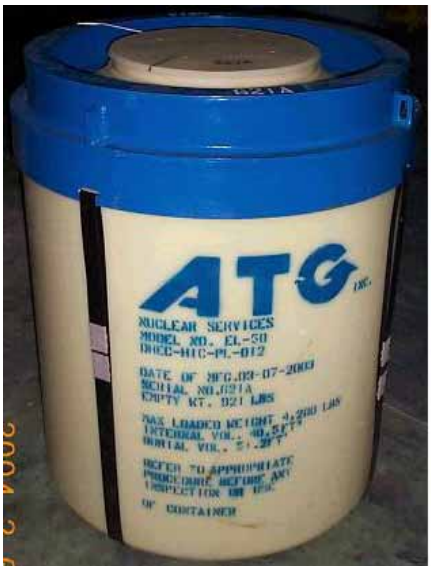


Fig. 1 High integrity container

The transport package as shown in Fig. 2 is designed in accordance with the requirements of the Korea Atomic Energy Act and the IAEA Safety Standards Series No.TS-R-1 for Type B package due to the radioactivity arising from spent resin contained in the high integrity container exceeds the limits of the related regulations. It provides containment, radiation shielding, structural integrity and passive heat removal for normal transport and hypothetical accident conditions in accordance with the related regulations.

A cylindrical transport package which constitutes the containment vessel is closed by the lid, and provides containment boundary for the radioactive material. The containment boundary of the transport package consists of a thick-walled cylindrical body with an integrally-welded bottom and is closed by a lid, which is fastened to the package body by lid bolts and sealed by double O-rings. Main structural material of the package is carbon steel. Impact limiters filled with wood to absorb the impact energy under 9m free drop conditions as a hypothetical accident are attached at the lid side and at the bottom side of the package during transport. The overall package length is about 1.9m and the diameter is about 1.9m. The transport weight is about 17 tons.

During transportation, the transport package is placed in the vertical position on the specially designed trailer and restrained symmetrically by the tie-down members, which is designed in accordance with the related regulations. And, it will be intended to be shipped as exclusive use.

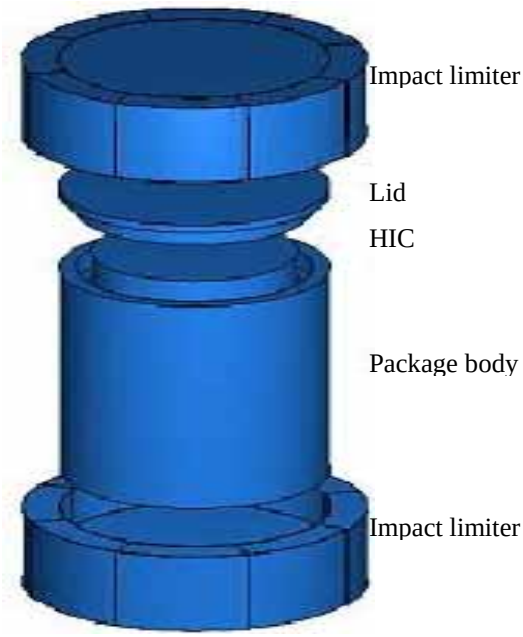


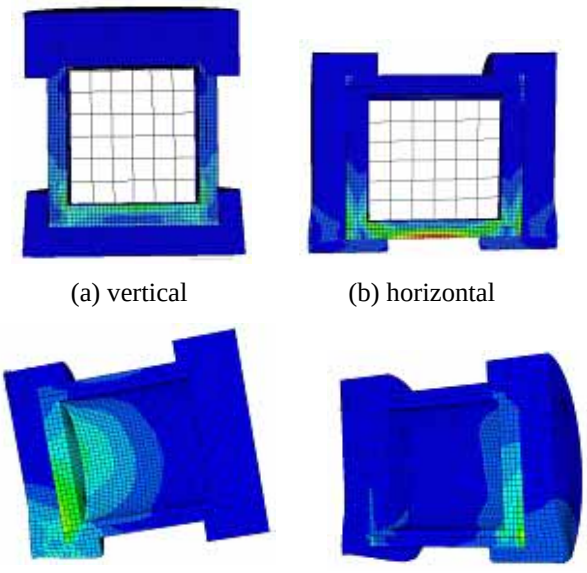
Fig. 2 Configuration of HIC transport package

3. Conceptual Design

The transport package is so designed that under normal transport conditions the radiation level does not

exceed 2mSv/h at any point on, and 0.1mSv at 2m from, the external surface of the package. It is so designed that, if it were subjected to hypothetical accident conditions, it would retain sufficient shielding to ensure that the radiation level at 1m from the surface of the package would not exceed 10mSv/h with the maximum radioactive contents. Shielding for the HIC transport package from radiation is provided by the thick-walled package body and the lid made of carbon steel. The shielding analysis was carried out and the source terms were calculated using the computer code. The thickness of the package body wall and of the lid meets the dose rate limits of the related regulations.

The transport package is to maintain the structural integrity not to release radioactive material under normal transport and hypothetical accident conditions. It should withstand a 9m free drop impact onto an unyielding flat surface in a position causing maximum damage and a 1m drop impact onto a mild steel round bar in an orientation causing maximum damage. The structural analysis to ensure that the integrity of the transport package is maintained under all credible loads for 9m free drop and 1m puncture conditions was performed using the FEM code. The impact analysis for the 9m free drop as shown in Fig. 3 was carried out for the vertical, horizontal and oblique drop, respectively, as it is difficult to define the impact direction.



(a) vertical (b) horizontal

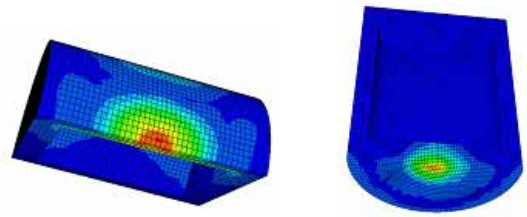
(c) oblique

Fig. 3 Stress contours for 9m free drop conditions

The maximum damage will result from impact where the puncture bar is directly located below the center of gravity so as to maximize the package rotating off the bar due to the presence of moment arm between the bar and the center of gravity. The combination of drop orientation and bar location as shown in Fig. 4 is the side drop onto the bar with the bar vertically below the center of gravity and the lid down drop onto the bar with the bar co-linear with the package axis.

Stresses arose in the components of the package due to various loads that originate under each condition. Stresses were compared to respective allowable values. The integrity of the transport package has been found to be preserved for 9m free drop and 1m puncture conditions.

Hereafter the thermal analysis under fire accident condition will be carried out by imposing 800^{o}C fire temperature for 30 minutes followed by a post-fire equilibrium which is followed for 4 hours.



(a) side-on (b) side-on

Fig. 4 Stress contours for 1m puncture conditions

4. Conclusions

The development of a HIC transport package to transport safely a high integrity container containing dry spent resin is ongoing by the KHNP. The transport package is in compliance with the requirements of the Korean and the IAEA transport regulations for Type B package. Hereafter more detailed analyses and design for the package will be performed and the safety tests using a prototype test model will be carried out. The package will be licensed in accordance with the Korea Atomic Energy Act and fabricated in accordance with the requirements of the ASME B&PV Code Section III.

REFERENCES

[1] International Atomic Energy Agency, Regulation for the Safe Transport of Radioactive Material, IAEA Safety Standard Series No.TS-R-1

[2] Korea Ministry of Science and Technology, Korea Atomic Energy Act

[3] American Society of Mechanical Engineers, Rules for Construction of Nuclear Power Plant Components, Boiler and Pressure Vessel Code, Section III

[4] U.S Code of Federal Regulations, Packaging and Transportation of Radioactive Material, Part 71, Title 10, Energy

[5] U.S Nuclear Regulatory Commission, Design Criteria for the Structural Analysis of Shipping Cask Containment Vessels, Regulatory Guide 7.6