Structural Evaluation of Spent Resin Transport Cask by Drop Test

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1. Introduction

The Spent Resin Transport Cask is designed to transport the spent resin, charcoal and other radioactive wastes generated from SRDS (Spent Resin Drying System) at Go-Ri, Young-Gwang and Ul-Jin nuclear power plants. It carries 200 and 320 drums filled with those wastes and the design was proposed considering the handling at SRDS and cargo-working. The radiation level of Spent Resin Transport Cask is 850 Ci which is above the value defined in the IAEA regulation. Thus, the Spent Resin Transport Cask is categorized as a type B package. The design should comply with the following regulations, the conditions of Ministry of Education, Science and Technology notification No 2008-69, IAEA Safety Standard Series No. TS-R-1 and US 10 CFR Part 71. In this study, several free drop tests were performed to evaluate the structural integrity of the proposed cask design under the hypothetical accident condition defined in the regulation.

2. Structural Evaluation by drop test

Fig 1 shows the test model of Spent Resin Transport Cask. A 1/3 scale model was prepared with the same fabrication procedure with that of the full size cask and the test specimen was instrumented with 12 strain gauges and 1 ~ 4 accelerometers on cask body. The cask is hoisted by 9m and released onto the target of which the characteristics are defined in the regulation. The strain and acceleration data are obtained during the impact events using the Labview software from National Instrument (Fig. 2). These data are used to analyze the structural response of the case body at various locations.

Fig. 1. Spent Resin Transport 1/3 scale model

The test consists of 5 free drop tests with different attitudes of the cask and 2 puncture tests: Lid down drop, Bottom down drop, horizontal drop, C.O.G. (Center Of Gravity) drop, Oblique drop, Lid puncture and Side puncture as shown in Fig. 3 and Fig. 4 To check the seal integrity after each drop(s), we measure the leakage between the double O-rings with the gas pressure rise test.

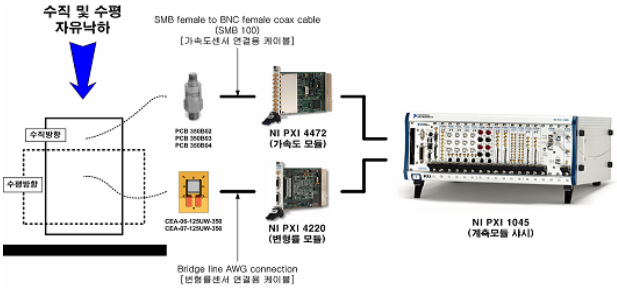

Fig. 2. Data acquisition system

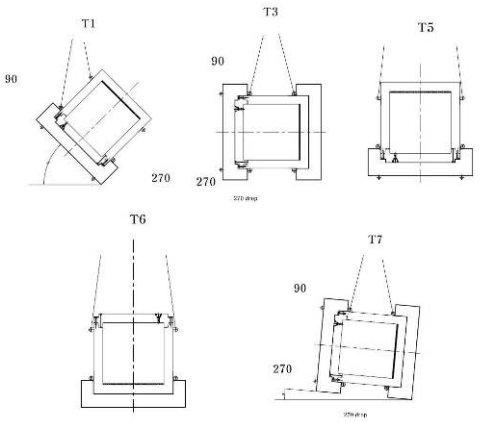

Fig. 3. Position of free drop test

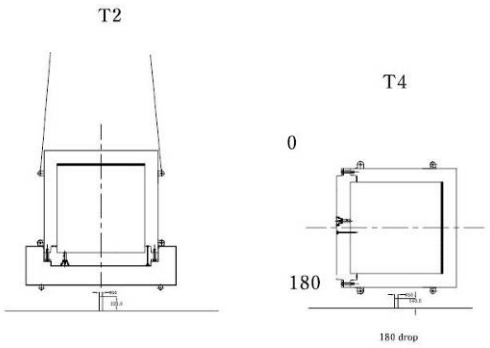

Fig. 4. position of puncture test

Fig. 5 shows the time history of acceleration from No.8 acceleration sensor at C.O.G drop. The maximum acceleration about 820g occurs at 2.162 second. Fig. 6 shows the strain history from No.1 strain sensor. The maximum value is -2.0E-4 at 2.08 second. Fig. 7 shows the deformed shape after C.O.G drop. As can be seen

from the figure, most of the impact energy was absorbed by the impact limiter at the impact point.

The gas pressure rise test (Fig. 8) was performed with the following sequences. Firstly, the air pressure between the double O-rings are made almost to zero using the vacuum pump. Secondly, after 15 min, the pressure rises in the space between the double O-rings are measured and the leak rate is calculated. The allowable leak rate is given in the IAEA regulation for the type B packages. Table I shows the result of leak-rate after every free drop and puncture test. The measured leak-rates do not exceed the allowable leak-rate. Thus we concluded that the Spent Resin Transport Cask maintain Structural safety under Hypothetical Accident Conditions.

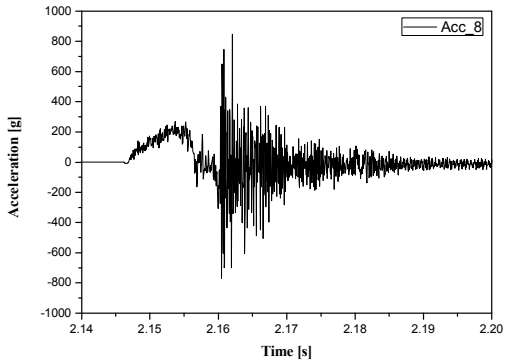

Fig. 5. value of gravity acceleration

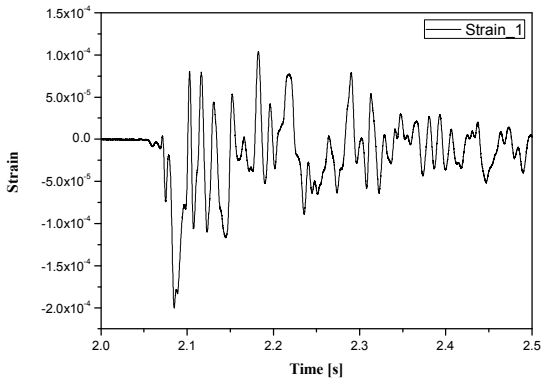

Fig. 6. value of strain

Fig. 7. Deformed shape after C.O.G drop

Fig. 8 reduce pressure system

table I: Result of reduce pressure test

Accident Conditions	leak-rate (std·cm^3/s)		structural safety
	allowance	measure	
initial condition	4.33E-2	9.55E-3	safety
C.O.G, Lid Punc.	4.33E-2	8.57E-6	safety
Horizontal, Side Punc.	4.33E-2	1.62E-5	safety
Lid Down	4.33E-2	9.56E-4	safety
Bottom Down	4.33E-2	7.74E-6	safety
Oblique	4.33E-2	2.99E-3	safety

3. Conclusions

We conducted 5 free drop and 2 puncture tests with Spent Resin Transport Cask. The result of reduce pressure test shows that maximum leak-rate is 9.55E-3 std·cm^3/s, and minimum leak-rate is 7.74E-6 std·cm^3/s which is much smaller than the allowable leak-rate or 4.33E-2 std·cm^3/s. As a result, we confirm that Spent Resin Transport Cask maintain Structural safety under Hypothetical Accident Conditions.

REFERENCES

[1] Korea MEST Act.2008-69, Regulations for Packaging and Transport of Radioactive Material, 2008.
[2] IAEA Safety Standards Series No.TS-R-1, "Regulation for the safe transport of radioactive", 2005.
[3] US NRC Code of Federal Regulations, Title 10, Part 71, "Packaging and Transportation of Radioactive Material", 2004.