Current Status of Korean Multi-modal Transportation Test(MMTT)

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1. Introduction

The U.S. and other countries are paying keen attention to the issue of transport safety of spent nuclear fuel, which has degraded since long-term storage. Korea has been preparing for the test under Korea's normal transport conditions since 2017 when it participated in an international joint study with the United States and Spain to conduct a DOE's multi-modal transportation test(MMTT).

10 CFR71 and 72 require integrity and retrievability of spent nuclear fuel to be maintained during normal operation, and in recent years, it has also emerged as a very important issue in terms of the acceptance of residents. Transport safety shall be ensured under normal transport conditions to ensure retrievability of spent fuel, and it is essential to obtain the load data applied to the transport system and spent fuel under normal transport conditions. In the United States, testing and interpretation of transport safety assessment under normal transport conditions are carried out jointly by various national laboratories, but no relevant research has been conducted in Korea. Therefore, it is urgent to carry out transport tests on road and sea transport routes based on the domestic transport scenario, to obtain load data, to develop an analytical model for integrity assessment and to establish a methodology for evaluation.

With the aim of developing a system for evaluating the integrity of spent nuclear fuel under normal transport conditions on road and sea, the KAERI, KEPCO NF, KORAD, and ACT are participating in the project. One of the important part of the task is road and sea transport tests conducted by the KAERI using actual transport cask and simulated fuel assemblies, which will be carried out between 2020 and 2021.

2. Preparing for the Korean MMTT (Multi-modal Transportation Test)

2.1 Test model

The KORAD-21 transport cask being manufactured to carry out road and sea transport tests have made some design changes to use a test model suitable for the purpose of testing. The main dimensions of transport package such as canisters and casks have not been changed, but air intakes, exhausts and related parts have been removed from the test model because they are not important components for road and sea transport testing. The material of the cask was changed from the ASME standard materials to the equivalent ASTM and JS standard materials, and the ASME standard products such as bolts were used without change.

The production of the canister, basket and cradle, the internal structure of KORAD-21 transport cask, will be completed by December 2019, with the cask body, shock absorber and lifting device to be built by June 2020. Test model is being fabricated by Doosan industry and the fabrication progress of the major components are shown in Fig. 1.

Fig. 1. Test model fabrication (a) canister (b) internal structure (c) installation of disks into canister (d) cask (e) cradle.

A trailer with 10-axis will be used for the road test in Fig. 2. The axle spacing is 1.5 m and the permissible load per axle is approximately 30 tonnes. There is a hydraulic cylinder inside the trailer that can compensate for a height difference of 30 cm to maintain the level of the trailer.

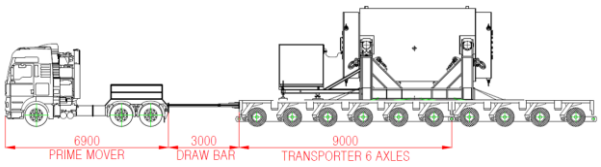

Fig. 2. Schematic drawing of trailer to be used in road test

2.2 Data Acquisition System

Data must be measured stably during road and sea transport tests. The test environment of this test is required to introduce a data measurement system with shock resistance and waterproof and dustproof grade in extreme environments (dust, salt water, vibration and impact load). Also, since sensors must be attached to all

of load transfer paths, data measurement systems must provide multiple channels (64 channels of acceleration, 32 channels of strain). We chose HBM's SomatXR shown in Fig. 3 as a data acquisition system to meet these specifications.

The types of accelerometers to be used in the transport test are divided into two types: IEPE type accelerometers and Piezo-resistive accelerometers. The IEPE type accelerometers are installed on platforms, cradle, casks, canisters, baskets, and fuel nozzles, while the piezo-resistive accelerometers are installed on fuel rods. It consists of 16 IEPE type three-axis accelerometers(48 channels) and 16 Piezo-resistive type accelerometers(16 channels). The installation location of IEPE type accelerometers are shown in Fig. 4.

Battery-based measurements should be made for smooth data measurements in coastal and maritime transport environments where power is not supplied for an extended period of time. A large capacity battery should be installed.

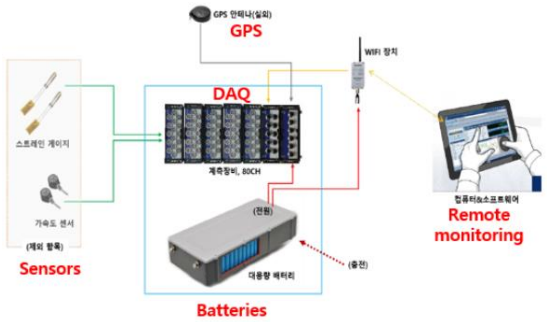

Fig. 3. Data acquisition system diagram.

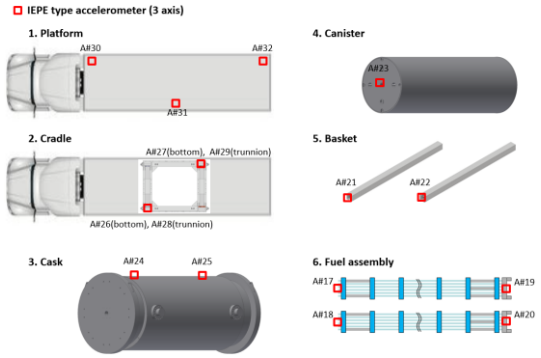

Fig. 4. Data acquisition system diagram.

2.3 Types and schedules of road transport tests

The road transport tests shall be carried out as follows. As mentioned in the previous section, they consist of a pretest of trailer without cask for identifying the dynamic characteristics of trailer, a cask handling test and an actual test with trailer and loaded cask together. The cask handling test consists of a transport test that moves the position of an upright transport cask using a crane and a test of settling the transport cask on the cradle. The pretest will be carried out first and it will take some time between the pretest and the actual test. The handling test will be carried out during that time. The handling test for transport containers may be carried out immediately before the actual test.

2.4 Test route

Every country is interested in safe storage and transportation of spent nuclear fuel from nuclear power plants. However, the transportation route of spent fuel is different depending on the situation in each country. The US carries spent nuclear fuels mainly by rail. Spain uses heavy haul trucks to transport them to the roads. Korea expects that maritime transportation using ships will become a major mode. Since there is a possibility that road transport happens within the power plant site or within the spent fuel management facilities, Korean MMTT will be conducted on road transport condition. The road transport test will be conducted tests first in the yard of Doosan industry. The test route is shown in Fig. 5.

Fig. 5. Route of road transportation test in Korea.

3. Summary

KAERI is preparing to conduct multi-modal transport tests to assess the integrity of spent nuclear fuel under normal transport conditions. Two surrogate fuel assemblies will be loaded in a full-scale cask. A road transport test will be performed in 2020 and a marine test in 2021.

ACKNOWLEDGMENTS

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