A Fundamental Study on the Regulation for Safety/Security Standards for Performance Test of Spent Nuclear Fuel Transportation Package

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1. Introduction

The public debate on spent nuclear fuel in Korea began in October 2013, and in June 2015, a "Recommendation on the Management of Spent Nuclear Fuel" was submitted to the Ministry of Trade, Industry and Energy. Based on the results of the public debate, the Korean government confirmed a basic plan for high-level waste management. Ever since then, the government has been pursuing spent nuclear fuel management project. Accordingly, research and business plans in various fields have been proceeded, and research on transport packages and storage systems for spent nuclear fuel became one of the key related topics.

In the United States, the DOE manages a database of information related to spent nuclear fuel, and its reliability is assured as state-level. However, in Korea, KHNP manages the database of spent nuclear fuel. It is necessary to establish a regulatory position to assure the reliability of key safety information for transport, storage, and disposal of spent nuclear fuel because there is no agreement and verification on essential information and management requirements related to spent nuclear fuel in Korea yet [1]. Likewise, establishing a regulatory position or a legal basis for the evaluation of protection performance in terms of physical protection that KINAC intends to pursue in the future would be similar in the same context above.

In this paper, the domestic and foreign regulatory framework for spent nuclear fuel transport package will be examined, and what additional supplements might be needed for the regulatory requirements when a sabotage and security conditions is added will be discussed.

2. Domestic and Foreign Regulatory Frame (design standard/transport)

2.1 U.S.NRC 10CFR71 Packaging and Transportation of Radioactive Material (2012)

NRC Regulations Title 10, code of federal regulations deals with the requirements binding on all persons and organization who receive a license from NRC to use nuclear materials or operate nuclear facilities. Especially, part 71 of CFR is about Packaging and Transportation of Radioactive Material. This part establishes requirements for packaging, preparation for shipment, and transportation of licensed material and procedures and standards for NRC approval of packaging and shipping procedures for fissile material [2]. As of now, it should be considered that the standards and tests for transport packages for spent nuclear fuel covered in 10 CFR 71 are not tests that assume an accident related to sabotage of theft with malicious intention, but rather a standard for minimizing the radioactive effects resulting from possible accidents during its transportation.

2.2 IAEA Specific Safety Requirements No.SSR-6(Rev.1): Regulations for the Safe Transport of Radioactive Material [3]

IAEA SSR-6 (Rev.1) deals with the classification, requirements and controls for transport from general provisions for radioactive materials and packages. In particular, Section VI (Requirements for Radioactive Material and for Packagings and Packages) describes in detail the general requirements for nuclear material transport containers as well as the requirements for each container type. In the section VII, demonstration of compliance with the performance standards required in Section VI shall be accomplished by variety of methods such as impact, percussion, bending, heat, free drop, penetration test, etc.

Packages for radioactive material related contents are specifically mentioned in the safety standards, but not from the perspective of security standards. It is briefly stated in the IAEA NSS No.14 (Nuclear Security Recommendations on Radioactive Material and Associated Facilities), but this is still recommendation, not requirements.

2.3 Nuclear Safety and Security Commission Public Notice No. 2014-50 (Rules on the Packaging and Transportation of Radioactive Materials, etc.) [4]

The notice stipulates essential items for the packaging and transportation of radioactive materials among the rules such as the enforcement decree, enforcement rule of the Nuclear Safety Act, and technical standards for radiation safety management. It describes the arrangement of packages in normal conditions and transport accident conditions,

verification of technical compliance, verification tests, and overall design approval requirements.

The contents related to the physical protection of nuclear materials and nuclear facilities follow the Act on Physical Protection and Radiological Emergency, and the contents related to the performance test of transport packages are not mentioned in it.

3. Transportation Package Performance Test

The overall performance tests of transport packages were for assuring radiation safety from various transport accident conditions during transport. Considering the physical characteristics -heavy weight, solidity, durability, etc.- of the transport package, it is expected that it will be difficult to inflict significant damage through malicious actions of individuals or simple theft. Also, the protective performance for the package at the level of incidents such as large-scale impacts or excessive thermal conditions might be guaranteed from the performance test for safety standards for the design of packages.

3.1 NUREG-2125(Spent Fuel Transportation Risk Assessment) [5]

The U.S.NRC establishes a regulatory framework for the packaging of spent nuclear fuel in accordance with U.S. Federal Law 10 CFR part 71, “Packaging and Transportation of Radioactive Waste” (2004) In September 1977, NRC presented NUREG-0170, “Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes”, and assessed the adequacy of those regulations to provide safety assurance. This report presents the results of a fourth investigation into the safety of SNF transportation. In this report, studies on transportation risk, accident data, scenarios for transporting spent nuclear fuel, regulations on transporting radioactive materials, selection of transport packages, and cask responses according to various accidents are described. In addition, technical elements related to the design evaluation of casks and details of the accident analysis evaluation are covered in detail in NUREG-1536, “Standard Review Plan for Spent Fuel Dry Storage Systems at a General License Facility.”

3.2 Performance Test Requirements for Package Types

The domestic Nuclear Safety Act prescribes the requirements to ensure the safety of radioactive material transport, and classifies the package type into the following six types on the premise that the safety level of the package corresponds to the potential danger of the radioactive content. The performance tests required for the six different types of package are shown in the table below [6].

	Free Drop test	Stacking Test	Water Spray Test	Penetration Test
Type L				
IP-1				
IP-2	●	●		
IP-3	●	●	●	●
Type A	●	●	●	●
Type B	●	●	●	●
Type C	●	●	●	●

Table 1 Test Requirements for Transportation Package under Normal Operating Conditions

4. Conclusion

Regulatory standards related to the safety of transport of spent nuclear fuel are mandated by the IAEA and the U.S.NRC. However, security-related elements are recommended, not mandatory, which seems to be because the physical characteristics of the spent fuel transport packages are designed to a level to offset possible threats in case of general theft and accidents. Therefore, the performance tests of spent nuclear fuel packages to ensure safety are carried out under various influences and conditions might be utilized in the aspect of physical protection and security regulations in response to the security accidents. However, it is necessary to analyze how far the maximum impact that can be exerted in the event of sabotage or unpredictable accidents will differ from the current performance test regulatory standards. In a future study, cases of performance tests under various conditions will be collected to see if the performance test for safety can be linked to protection performance tests.

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