The Status of Cask Manufacturing Technology and Performance Test in Korea

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1. Introduction

After the announcement of the results about the public deliberation committee on Shin Kori 5&6 project in October 2017, the government's policy has been directed toward reducing nuclear power plants and urgently required plan to deal with spent nuclear fuel.

In accordance with the policy of reducing nuclear power plants, we will be facing on the closing of Kori 2, 3&4 and Hanbit 1&2 plants within the next 10 year and the wet storage of spent nuclear fuel in the plant are expected to reach saturation by 2024.

According to this reality, it is necessary to secure the design and manufacturing technology for the spent nuclear fuel. Doosan heavy industries & construction contracted a technology agreement with NAC (U.S) and recently acquired the design technology of transport & storage cask.

Since there are no companies that have both cask design and manufacturing technologies in Korea except for Doosan, we review the current status and experience about Doosan's cask design, fabrication and performance test and would like to establish the basis and standard for securing domestic design and manufacturing technology.

2. Dry Storage Cask Technology

2.1 Applicable Standard

The cask system differs from the applicable codes & standards according to the detailed components, but basically, the quality assurance system shall be established, and the design, material procurement, fabrication, inspection and testing process shall be performed according to the applicable code of each components.

Transport Cask : ASME Sec.III Div.3 WB (KEPIC MNT)
Canister – ASME Sec.III Div.1 NB (KEPIC MNB)
Basket – ASME Sec.III Div.1 NG (KEPIC MNG)
MSO – ASME Sec.III Div.1 NF (KEPIC MNF)
Transfer Cask – ASME Sec.III Div.1 NF (KEPIC MNF)

2.2 Design & Fabrication

In order to design and manufacture the cask, ASME Sec.III Div.3 WA, WB and WC (KEPIC MNT, MNS) code requirements as well as ASME Sec.III Div.1 (KEPIC MN) applied to the existing nuclear steam supply system shall be applied throughout the design and fabrication of Cask.

2.2.1 Quality Assurance Requirements

In addition to nuclear quality assurance requirements, ASME NQA-1 (KEPIC QAP), the general requirements of ASME Sec.III Div.3 WA (KEPIC MNA) shall be applied.

a. Certification to supply the component & parts
   The supplier who want to manufacture the components & part of cask shall acquire the certification of code that require to the equipment (1N, CS, SC, TC) & parts (1NP, CSP, SCP, TCP).

b. Establishing a quality assurance system
   The supplier who want to manufacture the components & part of cask shall establish the quality assurance system about all process of design, material procurement, fabrication, inspection and testing.

2.2.2 Design

a. The applied code difference as each components
   According to the applicable codes for each components, the design requirements (NX-3000) of each code shall be applied.
   The basket is designed with NG(MNG)-3000, canister with NB(MNB)-3000, transport cask with WB(MNT)-3000 and storage cask with NF(MNF)-3000.

b. Regulatory requirements
   Prior to code requirement, the design method required by the regulatory guides and requirements for each components shall be applied. NUREG-1617 shall be applied to transport cask and NUREG-1536 to storage cask.

2.2.3 Material

The components that shall be designed and fabricated according to code requirements shall be basically apply the material approved by code like ASME Sec.II (KEPIC MD).

a. The classification of components and parts
   According to NUREG/CR-6407, the major components of cask are classified as the safety

functions and their relevance. Recently, from Shin-Kori 5&6 unit construction project the detail quality grade of components and parts have been classified and managed. Also, the components and parts of cask shall be classified and procured as the each quality grade.

b. The acceptable code material, parts and CGID

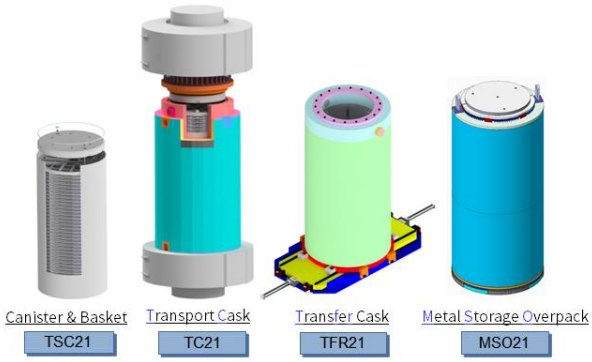
For category A grade item that code requirements shall be applied, the material and parts shall be procured from code certification holder that design and fabricate as code requirements.

If it is difficult to procure the material and parts from code certificate holder because the material and parts is commercial item, the supplier of cask procure the commercial items and then shall perform the dedication(CGID) procedure to prove the items that is no problem for the satisfaction of code requirements and performance of safety function.

c. The prevention of counterfeit/fraudulent, suspect item

Because of the case that counterfeit the certificate of material and parts supplied to nuclear power plant, the confirmation procedure to the purchase documents about the certificate of material and parts will be reinforced.

The supplier of cask shall assure and grantee that the certificate of material and parts is same and not counterfeit with the original certificate and shall ensure the official traceability of certificate documents as the general procurement requirement of domestic nuclear power plant.



[Figure 1.] Doosan-DSS21(Dry Storage System 21)

2.2.4 Fabrication

According to the applicable code for each component, the fabrication requirements (NX-4000) shall be complied.

a. The establishing of fabrication specification and procedure

The cask designer shall prepare the fabrication specification and provide it to the manufacturer. The manufacturer shall prepare the fabrication procedure complying to the requirements of specification according to the quality assurance system.

b. The manufacturing & supply experience of main components for NSSS

Doosan heavy industries & construction which has supplied the main components to existing nuclear power plants, has established a quality assurance system for the fabrication of main components (reactor vessel and steam generator) and the fabrication procedure that is satisfied with code requirements.

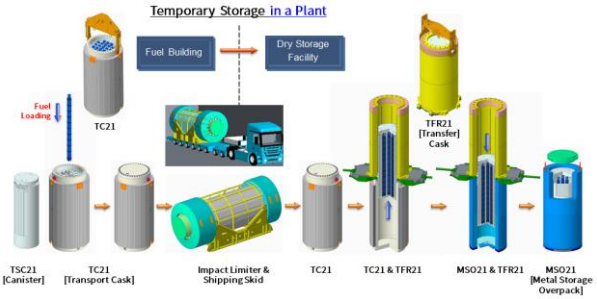
In addition, Doosan heavy industries & construction has established a fabrication procedure that is satisfied with ASME Sec.III Div.1 NB, NF, NG & Div.3 WB and WC (KEPIC MNA, MNB, MNF, MNG, MNT and MNS) code and acquired the certification of code for the manufacturing and supply of cask components and parts already.

c. The manufacturing experience of domestic & Japanese cask

Doosan heavy industries & construction has been fabricated the domestic casks since 1989, and is the only domestic company that can perform the design and fabrication of cask and has the experience of delivery to domestic and foreign customer.

2.2.5 Inspection

According to the applicable code for each component, the Inspection requirements (NX-5000) shall be complied.



[Figure 2.] Temporary Storage in a Plant

2.3 Performance Test of Cask

Before the spent nuclear fuel is stored in dry storage cask, the performance test shall be conducted and

verified to ensure that the storage cask are properly constructed according to regulatory and code requirements.

2.3.1 The regulation requirements

NUREG-1536 requires the dry storage cask to be tested to ensure to perform the intended the safety function during the storage period.

Structural / Pressure Test
Leak Tests
Visual and Nondestructive Examination Inspection
Shielding Tests
Neutron Absorber Tests
Thermal Tests
Cask Identification

Acceptance Test		Canister	Basket	Metal Storage Overpack
Visual & NDE		V	V	V
Structural & Pressure		V	-	V
Leak		V	-	
Shielding Performance	Gamma	V	-	V
	Neutron	-	-	V
Criticality		-	V	-
Thermal		V	V	V

[Table 1.] The Kind of Acceptance Test

2.3.2 The experience of performance tests

Since 1989, Doosan heavy industries & construction has been in the process of manufacturing and supplying the domestic and overseas cask and has established the performance test procedure based on the experience of continuously performing the cask performance test required in the regulatory requirements.

3. Conclusions

3.1 The Wet Storage Status of Domestic Spent Nuclear Fuel and the Required Schedule for Dry Storage Cask

As of 2018, it is estimated that every year at least 30 sets of cask will be required from Kori to Hanbit nuclear power plant to 2024 when we look at the current status of spent nuclear fuel domestic wet storage.

3.2 Doosan's Cask Manufacturing Capacity

Doosan heavy industries & construction can continuously manufacture more than 30 sets of cask per year while maintaining stable quality by utilizing the existing fabrication facilities for the major components of nuclear power plant.

[Figure 3.] Doosan's Shop Interior View

3.3 The Efficiency and Automation of Fabrication Process

In addition to utilizing existing facilities, Doosan heavy industries & construction are promoting automation and efficiency through large-scale facility investment for the major fabrication process (machining, bending, welding, inspection).

3.4 The expectation to revitalize local economy through utilization of domestic supply chain

Doosan heavy industries & construction are making efforts to foster the domestic cask industry and revitalize the local economy by establishing the supply chains together with the local companies about the raw materials, parts, machining, cutting and subcontracting process, except for the entire assembly process.

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