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## **NFT's Approach to Preservation and Improvement of Technical Skills for Cask Maintenance: Education and Training Program for Cask Maintenance Using the NFT Cask Mock-up**

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### **Abstract**

Nuclear Fuel Transport Co. (NFT) owns about 60 casks for transport of spent fuel from nuclear power plants to the reprocessing plant as part of Japan's nuclear fuel cycle, and periodically inspects and maintains these casks to preserve their performance. However, recently, transport of spent fuel in Japan has decreased significantly and most casks have not been used for several years. Currently, unused casks are exempted for the most part from maintenance requirements prescribed in the Safety Analysis Report (SAR) as well as the NFT cask periodic maintenance procedures.

So, due to the great decrease in the number of personnel gaining experience in cask maintenance and repair work, the cask maintenance education and training program using the NFT cask mock-up was developed in order to sustain and improve cask maintenance technical skills. NFT started this program at the beginning of FY2019.

### **1. Introduction**

NFT is the only company in Japan that transports nuclear materials such as spent fuel and LLW, and it plays an important role in most backend transport in Japan, as shown in Figure 1(a). One of NFT's jobs is to maintain and repair about 60 casks, which NFT owns, for transporting spent fuel from nuclear power plants to the reprocessing plant, as shown in Figure 1(b). Maintenance and repair work of NFT cask requires specialized knowledge and technical skills. However, because of the severe circumstances in Japan's nuclear industry and the difficulty that the reprocessing plant has in receiving spent fuel, recently the number of such transports has decreased significantly in Japan. As a result, most NFT casks have been not used regularly and exempted from the maintenance requirements prescribed in the Safety Analysis Report (SAR) as well as the NFT cask periodic maintenance procedures for several years, and no casks will have been used as of the end of FY2019.

In such a situation, NFT has faced a difficult challenge in that the retirement of highly-skilled workers has led to a loss of technical tradition and the decrease in opportunities to engage in cask maintenance has resulted in differences in the level of technical skills that individuals possess. If these challenges

are not addressed, there is great apprehension about a sharp decrease in the number of people who are capable of maintaining and repairing NFT casks in the near future.

So, in order to preserve cask maintenance technical skills at the current and raise these to a higher level, we constructed the NFT cask mock-up for the first time, which is the dedicated apparatus for maintenance and repair training. Furthermore, NFT initiated the cask maintenance education and training program using the NFT cask mock-up at the beginning of FY2019.

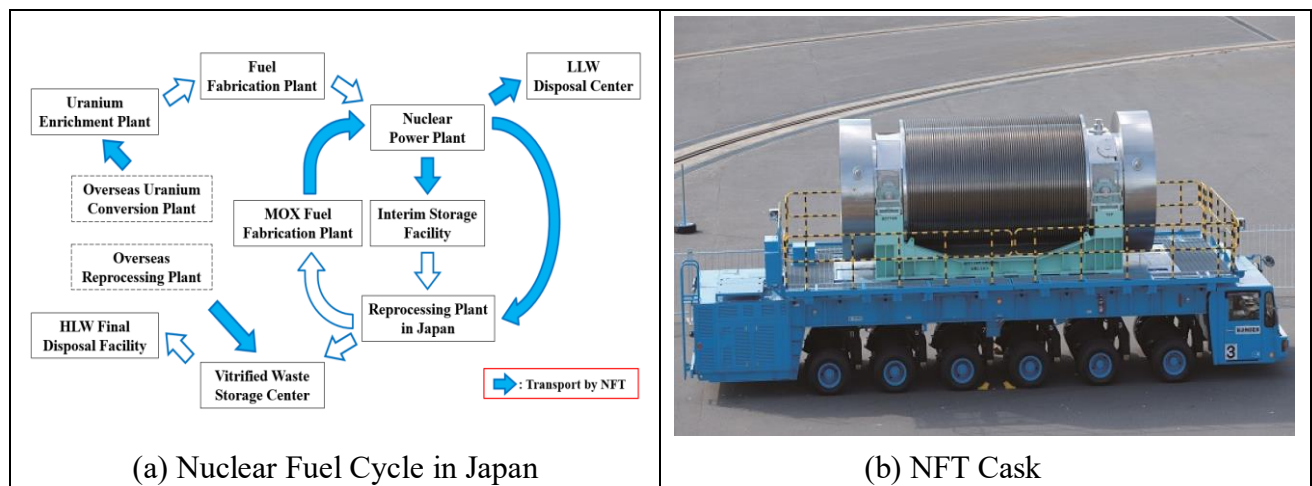


Figure 1. Nuclear Fuel Cycle in Japan and NFT Cask

## 2. NFT Cask Mock-up Specifications

The NFT cask mock-up constructed for practical training in NFT cask maintenance is not as long as an actual NFT cask, but its structure is basically the same as shown in Figures 2 and 3(a). Moreover, worksite around the cask mock-up, for example scaffolding plates, resembles an actual work site (see Figure 3(b)). Therefore, practical training using the cask mock-up enables trainees to acquire good knowledge and technical skills at a level commensurate with work on an actual NFT cask.

Key characteristics of the apparatus structure are:

- Dimensions: 2,500 mm high and 2,500 mm wide with a weight of 1,500 kg
- Mixed design of two NFT casks often used in actual transport, 38B type and 14P type
- Critical cask functional components, such as seal boundaries, are full-size
- Component materials and strength of cask mock-up are slightly different from an actual NFT cask
- It is more difficult to fit a trunnion on main body of cask mock-up than on an actual cask due to the more severe dimensional tolerance between a trunnion and main body
- Lid flange can be replaced so that repair training on seal boundary may be repeatedly conducted
- Most parts can be repeatedly used in disassembling and reassembling the cask mock-up

In addition, there is no need for radiation exposure controls because the cask mock-up is set up outside a radiation-controlled area. Therefore, we may conduct the practical training without the restriction of

working hours as in actual cask maintenance.

Also, specific conditions posing problems may be intentionally created, such as gas leaking from seal boundaries or significant damage exceeding the acceptance criterion. This is one of the most valuable characteristics of the cask mock-up. In fact, such problems rarely occur at an actual cask maintenance site, therefore there is some possibilities of performing repairs at site that even skilled workers have not experienced. One such case involves gas leaking from a damaged flange on the part attached to the lid. As a matter of practice, it may take a long time to figure out how to repair and actually repair the damage at an actual site. However, as mentioned above, because the flange attached to the lid of the cask mock-up may be replaced, we can have personnel verify how to repair, which would be impossible to conduct at an actual site. In this respect, use of the cask mock-up definitely contributes to improving the feasibility and efficiency of difficult repair work.

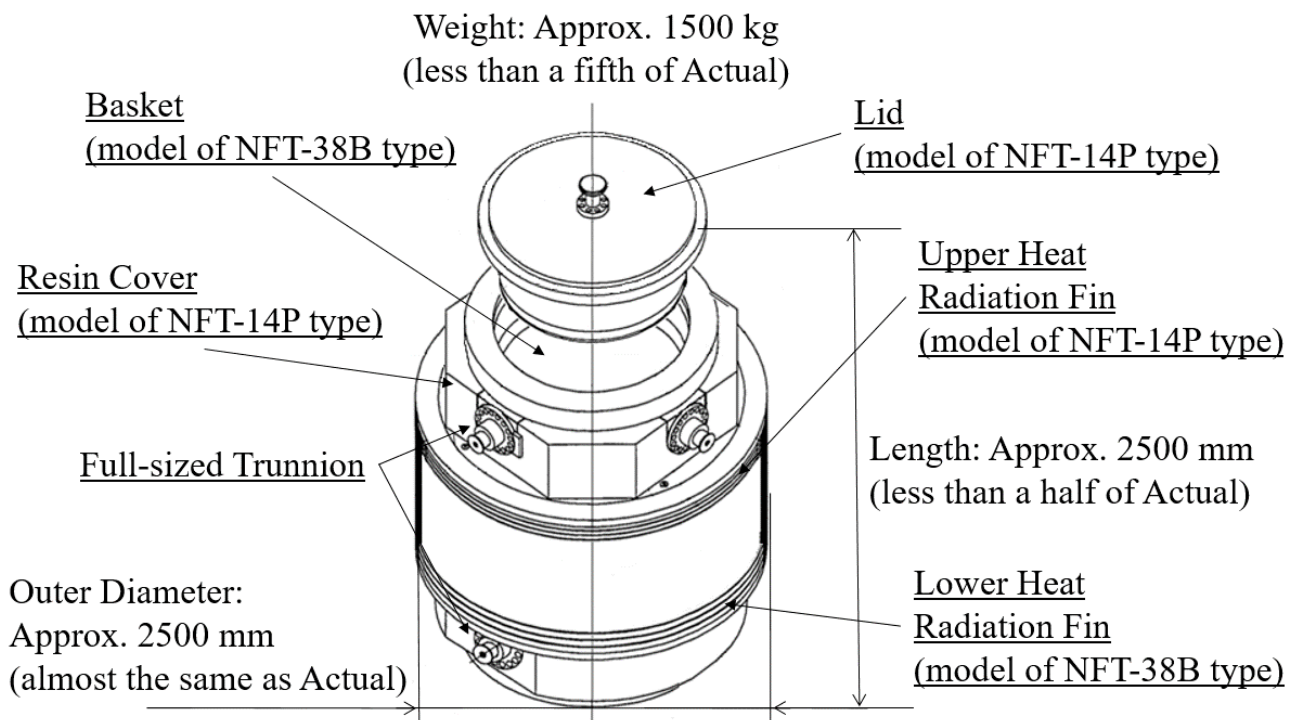


Figure 2. NFT Cask Mock-up Specifications



Figure 3. NFT Cask Mock-up and Worksite

### 3. Education and Training Program for Cask Maintenance Using the Cask Mock-up

#### 3.1. Program Purpose and Courses

Having taken into consideration the considerable decrease in cask maintenance opportunities, we structured this education and training program, which uses the cask mock-up, so that the principal aim is to compensate for the loss in opportunities to perform cask maintenance as well as to preserve and improve technical skills needed for cask maintenance. It is expected that utilization of this program will enable newly assigned personnel to cask maintenance to acquire a good knowledge of how to maintain and repair NFT casks and, furthermore, allow all personnel engaged in cask maintenance to enhance their technical skills, which also raises the quality of performance inspections and work management.

In this program, several education and training courses are offered to the participants:

- Course 1 (for newly assigned personnel): Basic lecture about NFT casks and study tour are offered twice a year
- Course 2 (for all personnel engaged in cask maintenance): Practical training, together with classroom education as necessary, is offered twice a year
- Course 3 (for others personnel not engaged in cask maintenance): Study tours are offered as needed

As shown in Table 1, the participants in Course 2 are enabled to operate and perform most of maintenance requirements prescribed in the NFT cask periodic maintenance procedures. Section 3.2.2 provides a detailed description of the Course 2 training.

Table 1. NFT Cask Periodic Maintenance Procedures and Operation

Section	Work No.	Content	Operation
Testing and Confirmation	NMT-1	Visual Inspection	Yes
	NMT-2	Operation Confirmation for Valves	Yes
	NMT-3	Leak Tightness Inspection	Yes
	NMT-4	Seal Performance Confirmation of Parts filled with Silicon Sealant	Yes
	NMT-5	Seal Performance Confirmation of Quick Coupling and Closing Plug	No
	NMT-6	Surface Contamination Inspection	Yes
	NMT-7	Seal Performance Confirmation of Trunnion and Fusible Plug	Yes
	NMT-8	Confirmation of Cask Internal Cavity	Yes
	NMT-9	Non-Destructive Test (NDT)	Yes
	NMT-10	Seal Performance Confirmation of Lid Expansion Chamber	Yes
	NMT-11	Confirmation of Lifting Performance of Trunnion	Yes
	NMT-12	Pressure Testing	No
	NMT-13	Confirmation of Water Level Adjustment Function	No
	NMT-14	Seal Performance Confirmation of Shock Absorber Cover Plates	No
	NMT-15	Seal Performance Confirmation of Welded Part on Resin Cover	Yes
	NMT-16	Confirmation of Neutron Absorbing Performance	No
	NMT-17	Confirmation of Radiation-Shielding Ability	Yes
	NMT-18	Confirmation of Heat Transfer Performance	Yes
NMT-21	Seal Performance Confirmation of Welded Bush of Fusible Plug on Partition Plate	Yes	
Maintenance	NMM-1	Cask Component Replacement	Yes
	NMM-2	Torque Fastening	Yes
	NMM-3	Bolts Maintenance	Yes
	NMM-4	Bolt Hole Maintenance	Yes
	NMM-5	Valves Maintenance	Yes
	NMM-6	Lid and Flange Maintenance	Yes
	NMM-7	Shock Absorber Maintenance	No
	NMM-9	Silicon Sealant Filling	Yes
	NMM-10	Trunnion Maintenance	Yes
	NMM-11	Lid Lifting Lug Maintenance	Yes
	NMM-12	Fusible Plug Maintenance	Yes
	NMM-13	Decontamination	Yes
	NMM-14	Measurement of Cask Internal Dose Rate	Yes
	NMM-15	Cask Main Body Maintenance	Yes
	NMM-16	Confirmation of Resin Cover Internal Integrity	Yes

Repairing	NMR-1	Rust Tripping on Cask Outer Surface	Yes
	NMR-2	Flaw Repairing on Cask Outer Surface	Yes
	NMR-3	Repairing of Parts filled by Silicon Sealant	Yes

### 3.2. Content of Course 2 (for all personnel engaged in cask maintenance)

#### 3.2.1. Classroom Education

In order to engage in cask maintenance work, all personnel must acquire a variety of knowledge about cask maintenance such as the NFT cask components, cask structure specifics, maintenance requirements, safety and radiation management, tool handling, and so on. Therefore, classroom education using educational materials, as shown in Table 2, is provided by well experienced personnel skilled in cask maintenance to instruct trainees in cask maintenance, devoting approximately one hour per lecture item.

Table 2. Contents of Classroom Education

No.	Lecture	Content
1	Laws and Regulations	Laws, Regulations and Technical Criteria relating to NFT Casks
2	SAR	Safety Analyses of Nuclear Fuel Package
3	Technical Know-How	Calculation Methods for Safety Analysis
4	Structure	Manufacturing Procedures, Materials and Components
5	Handling Manual	How to Handle NFT Casks at Nuclear Power Plants
6	Periodic Maintenance Procedures	Details of Each Maintenance Requirements and Precautions
7	Safety Management	Basics of Industrial Accident Prevention
8	Radiation Management	Basics of Radiation Management and Exposure
9	Equipment and Tools	How to Use Each Equipment and Tool
10	Maintenance Schedule	Basic Schedule of Cask Maintenance
11	Previous Non-Conformities	Non-Conformities that Previously Occurred in Cask Maintenance
12	Non-Destructive Test (NDT)	Basic Knowledge and Work Procedures

#### 3.2.2. Practical Training

Table 3 shows the content of practical training that is provided by an instructor, who is a skilled worker, using the cask mock-up so that participants may acquire a variety of technical skills. With training items No. 1 to 4, participants may improve their technical skills in a short time by repeatedly practicing each operation. With training items No. 5 to 8, participants can experience the specific conditions that arise when some problems occur, as necessary.




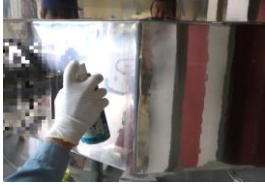


As mentioned in section 3.1, the training covers most maintenance requirements and leads to compensate the recent loss of cask maintenance opportunities, which, as a result, helps participants improve their technical skills in cask maintenance.

Table 3. Contents of Practical Training and the Related Technical Skills

No.	Practical Training	Related Technical Skills
1	Valves and Trunnion Handling	Disassembling and Reassembling
2	Silicon Sealant Filling	Sealant Filling
3	Bolt Repairing and Bolt Hole Insert Replacing	Repairing
4	Lid Handling	Finishing Touches and Recovering
5	Inspections and Confirmations	Visual Inspection and Observation
6	Leak Tightness Inspection and Seal Performance Confirmations	Operating Leak Tightness Inspection Device and Judging Pass/Fail
7	Penetrant Testing, Magnetic-Particle Testing, and Ultrasonic Testing	NDT and Observation
8	Seal Performance Confirmation of Welded Part on Resin Cover	Bubble Check and Observation

Moreover, work procedure sheets (see Table 4) for each training item have been prepared and are utilized to aid technical guidance provided by an instructor, which leads to clarify important points to be checked during actual work.

Table 4. Example of Work Procedure Sheet (Penetrant Testing of Welded Part on Resin Cover)

No.	Procedure	Work	No.	Procedure	Work
1		Temperature measurement and cleaning with washing solvent	2		Coating with penetrant
3		Removing penetrant after 10 minutes	4		Spraying developing solvent
5		Observation after 10-30 minutes	6		Removing developing solvent

### 3.3. Personnel Competence Evaluation

Evaluating the level of participants' technical skills is as important as offering the education and training program. During classroom education, confirmation test is conducted at the end of the course to evaluate trainees' knowledge acquisition. On the other hand, during the practical training, the instructor, who is well skilled in the work, evaluates each trainee's technical skills based on the

individual's work quality. However, consideration is still being given to finalizing the most appropriate methodology for comprehensive evaluation and the frequency at which personnel should undergo the training depending on the individual's competence.

#### **4. Future perspective**

##### **4.1. Validation and Enhancement of Program Contents**

It is true that the education and training program using the cask mock-up explained in this paper is expected to contribute to preservation and improvement of technical skills for cask maintenance. However, the program just started in FY2019, so it is necessary to confirm its effectiveness, deduce any issues, and continuously improve the program.

Also, enhancement of program contents is one critical issue. In the future, in addition to the courses mentioned in section 3.1, more advanced courses, such as an emergency action course, should be incorporated. During transport of spent fuels or cask maintenance work, problems or unexpected contingencies are likely to arise, therefore it is very important to train personnel not only ordinary maintenance work but also emergency actions, such as urgent welding work on a damaged part.

##### **4.2. Application to NFT's Cask Maintenance Inspector Certification System**

At NFT, all personnel conducting performance inspections during cask maintenance must hold a required in-company inspector certification for cask maintenance. Based on past results, it takes about two years to certify someone as a cask maintenance inspector. Therefore, when there are few qualified cask maintenance inspectors after personnel reshuffle, current inspectors are forced to work long hours at cask maintenance sites due to the shortage of inspector. In this respect, we can expect that utilizing this education and training program using the cask mock-up will shorten the estimated amount of time required for inspector certification because participants will be able to acquire knowledge and technical skills at almost the same level as working on actual NFT casks.

#### **5. Conclusion**

NFT constructed the NFT cask mock-up, developed the education and training program for cask maintenance that uses this cask mock-up, and initiated this program at the beginning of FY2019. The cask mock-up structure is almost the same as that of an actual NFT cask. Therefore, this education and training program compensates for the loss of cask maintenance opportunities and has been very helpful for personnel who are engaged in cask maintenance to train and improve their technical skills applicable to maintenance and repair work.

Preservation and improvement of technical skills is, without a doubt, an ongoing challenge for NFT. In order to achieve safe and secure transport for many years to come, NFT will continuously work to maintain and improve technical skills. In this respect, the education and training program using the NFT cask mock-up will greatly contribute to this challenge.

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