Proceedings of the 18th International Symposium on the Packaging and Transportation of Radioactive Materials
PATRAM 2016
September 18-23, 2016, Kobe, Japan

Paper No.3031

Improved Safety Plan of New LLW Transport Ship

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Abstract

Nuclear Fuel Transport Co., Ltd. ("NFT") owns three ships for transporting low-level radioactive waste ("LLW") and spent fuel ("SF"), and NFT has been transporting such cargo safely without any accidents on account of the crew's ability to sail the ships and navigation management groups' earnest safety efforts. The Seiei-maru, an LLW transport ship, has transported over 280,000 LLW drums over 25 years.

NFT decided construction of the new LLW transport ship which will be completed in March 2019 and to retire the Seiei-maru from service by September 2019.

Based on lessons learned from the tsunami attack by the Great East Japan Earthquake, the new ship has more improved specification for emergency evacuation from port than the Seiei-maru has. The new ship has the following features. Also the new ship must conform to the KAISA 450 requirements, which are requirements specific to Japanese government for LLW transport ships.

The new ship's features include:

- Main engine and main shaft: twin engines and twin shafts
- Propeller: controllable pitch propeller
- Steering: joystick controller for instinctive navigation
- Side thruster: increased thrust
- On-board crane: improved tightening method

Introduction

LLW generated at nuclear power stations throughout Japan is sealed tightly in drums and stored temporarily at the power stations. Transport containers, which hold eight LLW drums, are of heavy-duty construction that is stronger than large cargo containers in order to ensure safe transport by stably fixing and protecting these drums. Therefore, any risk involving radioactive materials is very low during LLW transport.

NFT transports the LLW packagings from nuclear power stations to the LLW Disposal Center in Rokkasho Village, Aomori Prefecture, and the Seiei-maru is used for marine transportation.

NFT decided that the new LLW transport ship is completed by March 2019 so that NFT can continue to fulfil its obligation of safe LLW transport after the Seiei-maru is retired from service.

As will be explained, the new ship has improved specification for emergency evacuation from port, which is based on the lessons learned from the tsunami attack by the Great East Japan Earthquake. Also LLW transport ships must conform to the KAISA 450 requirements, which are requirements specific to Japanese government for LLW transport ships. An explanation is also provided about these requirements.

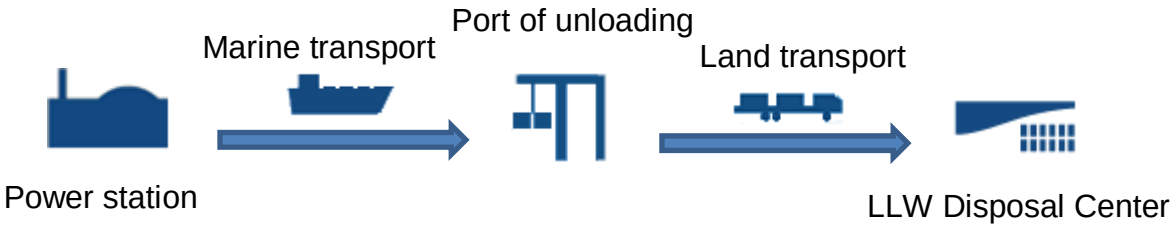

Figure 1 Flowchart of LLW transport

Reflection on the Lessons Learned from the Earthquake

It is said that when a tsunami attacks, it is most effective action that ships are evacuated from port where a tsunami height is low than port and no obstacle such as a quay to save human lives, packagings and ships. The Seiei-maru was unloading LLW packagings at port when the earthquake occurred. As the tsunami was descending on the coastline, the cooperation of navigation management groups as well as the captain and crew's strenuous efforts to execute an emergency evacuation made it possible for the Seiei-maru to put out of a port, although some small damage was sustained to the bulbous bow.

(1) Investigation about Emergency Evacuation from Port

To consider about improved specification for emergency evacuation from port, NFT heard to the navigation company about Seiei-maru's operation and investigated about the specification of the other ships. The results are indicated in Table 1. It becomes clear that there are points to be improved in tightening of on-board crane and propulsion system.

Table 1 Result of Investigation about Emergency Evacuation from Port

Result of Investigation	Points to be Improved	
It is necessary to be tightened on-board crane for LLW packagings during sailing, and it takes half the time of evacuation time to leave a shore.	Tightening of on-board crane	Tightening method
The Seiei-maru equips side thruster which support sideways movement and rarely in cargo ships, but propulsive force is small in three NFT owned ships.	Propulsion system	Increase thrust
All crews are busy with work for evacuation from port when a tsunami attacks.		Possible to navigate instinctively
Navigation officers have to navigate corresponds to the situation which changes every moment When a tsunami attacks.		Easier to speed control
The ship has to be a propulsion system so as not to navigate impossibility by debris because she sailed in the debris with a tsunami.		Ensure redundancy to main engine and main shaft

(2) Improved Specification for Emergency Evacuation from Port

NFT considered reflection to the specification of the new ship and made her improved specification for emergency evacuation from port.

a) Tightening of On-board Crane

- By tightened on-board crane besides the ordinary stop position, when emergency evacuation from port, moving time to tighten position is reduced.
- It is under consideration about the method to reduce time and the number of crews necessary to tightened crane.

b) Propulsion System

As it indicated in Table 2, the new ship improved specification for emergency evacuation from port.

Table 2 Specification about Propulsion System

Equipment	Specification	Characteristic
Main engine and main shaft	Twin engines and Twin shafts	By ensure redundancy, reduce a possibility to drift and aground caused by a breakdown.
Propeller	Controllable pitch propeller	It is possible to change from advance to sternway and adjust speed by change the angle of the wing in the fixed the direction of the shafts rotation.
Navigation equipment	Equip controls with a joystick controller	Joystick controller equipment is the system to integrate operation of propulsion system such as engines, propellers and rudders into a joystick controller. Therefore, it is easy to change of speed and direction.
Side thruster	Twice propulsive force of the Seiei-maru	Japan Institute of Navigation recommend that it is very effective to be equipped side thruster for emergency evacuation from port.

Conformance with Special Requirements for LLW Transport Ships

LLW transport ships must conform to the KAISA 450 requirements, which are requirements specific to Japanese government for LLW transport ships, in addition to regulations for general cargo ships. The new ship will be much safer than a general cargo ship because hull structure and equipment requirements indicated in KAISA 450 will be reflected in design.

(1) Hull Structure Requirements

LLW transport ships must have a double hull structure with two complete layers of hull on the sides and bottom. This is a strict requirement that is only imposed on ordinary domestic tankers which haul hazardous liquids. The double hull structure prevents LLW from flowing out of the ship.

Also LLW transport ships must comply with stricter requirements for damage stability than general cargo ships. Damage stability means the capability of a ship to float without sinking when there is an inrush of sea water due to a collision or running aground. Damage stability is evaluated using one of methods in Table 3. Both methods correspond to INF Code Class 3, which are the international regulations governing ships transporting SF and other such materials, and LLW transport ships are required to maintain damage stability so that they do not easily sink.

Table 3 Overview of Damage Stability Required by KAISA 450

	Deterministic Method	Probabilistic Method
Requirement	Maintain a certain level of stability when sustaining damage to a specified extent.	Considering all possible collisions, the entire ship shall have a certain probability of surviving.

(2) Equipment Requirements

LLW transport ships must be equipped with a firefighting system for the cargo hold, life-saving devices, emergency power supplies and other such equipment in the event an accident or equipment failure occurs. The new ship satisfies these requirements and is considered to be even safer in terms of its detailed design.

- Firefighting system for cargo holds:
  A spray nozzle is operated by remote control from the navigation bridge. Water may be sprayed onto the upper deck and hatch covers to halt a rise in the cargo hold temperature.
- Life-saving devices:
  In an emergency, human life is preserved by getting off the ship and boarding a life-raft.
- Emergency power supplies:
  When there is a loss of power, an emergency generator promptly supplies power to operate navigation equipment and other important equipment for more than 18 hours, thereby preventing a shipwreck due to the inability to control the ship.
- Cargo fastening equipment:
  The LLW packagings are fastened in place by means of cell guides in the hold. This will prevent the packagings from moving or overturning even if they sustain massive impact during transport. Also these packagings are not loaded on the deck because the ship has a high center of gravity and would become unstable.

Overview of the New Ship

Principal dimensions of the new ship are given in Table 4 and a bird's-eye view in Figure 2. The new ship takes into account the condition of power station ports, and is equivalent in size to the Seiei-maru. The new ship is being designed so that it can transport some of the waste from the dismanteled reactor units in addition to the LLW drums, which have been previously transported.

The schedule for production the new ship is given in Table 5. NFT contracted with a shipyard for the new ship in April 2016. Design and construction will take about 3 years, and the ship is scheduled to be completed by March 2019.

Table 4 Principal Dimensions of the New Ship

Overall length	Approx. 100m
Breadth	Approx. 16.5m
Depth	Approx. 8.2m
Draft	Approx. 5.4m
Deadweight	Approx. 3000 metric tons
Gross tonnage	Under 5000 metric tons

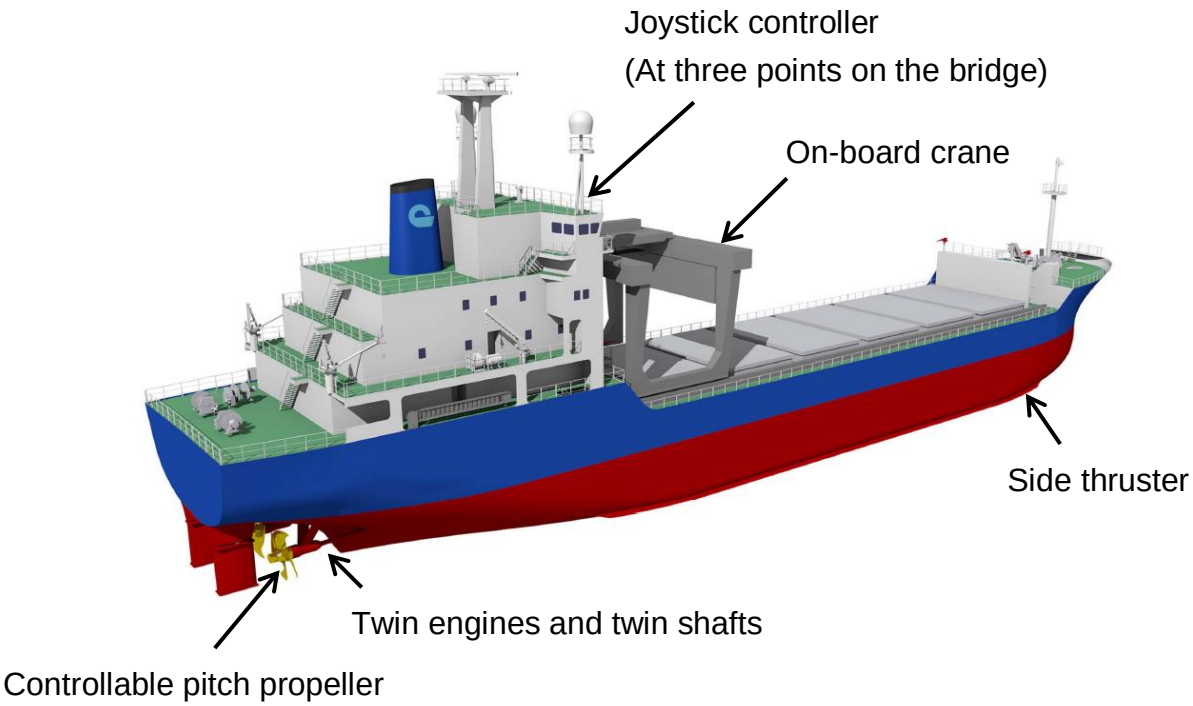

Figure 2 Bird's-eye View of the New Ship

Table 5 Production Schedule

2016									2017												2018												2019		
4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
▽ Contract																																			
Design									Regulation authority review									Laying of keel (Construction begins) ▽			Launch ▽											Completion ▽		
																		Construction																	

Conclusion

Based on the lessons learned from the tsunami attack by the Great East Japan Earthquake, NFT configured specifications that improve safety, including the ship's manoeuvrability for emergency evacuation from port. Also the new ship must conform to KAISA 450.

NFT will improve safety even further during the detailed design stage and plans to attend all inspections to guarantee that the new ship is constructed reliably.

Acknowledgments

We would like to express our gratitude to the NFT Engineering Department members for their guidance in preparing this article.