May 23, 2011
Nuclear and Industrial Safety Agency


Pursuant to the provision of Article 67 paragraph 1 of the Act on the Regulation of Nuclear Source Materials, Nuclear Fuel Materials and Reactors (Act No. 166, 1957), NISA requested Tokyo Electric Power Co. Inc. (hereinafter referred to as “TEPCO”) to submit a report on the installation of an alternative cooling and clean-up system (hereinafter referred to as “circulation cooling system”) for the spent fuel pool of Unit 2 at Fukushima Dai-ichi Nuclear Power Station (NPS), in order to consider the plan’s validity as an emergency measure under Article 64, paragraph 1 of the same Act (information released May 20). NISA duly received the report on May 21, and evaluated that the installation constituted was a valid and unavoidable emergency measure. This is to inform the public.

(History)
1. TEPCO plans to install a circulation cooling system consisting of a temporary heat exchanger, cooling tower and other components in the Radioactive Waste Treatment Building, etc., contiguous to the reactor building, as a part of the measure in the “Roadmap for Immediate Actions (Issues / Targets / Major Countermeasures) revised 5/17”, which it published on May 17.

2. In order to confirm that the installation of a circulation cooling system in its currently-proposed form is both necessary and unavoidable for the cooling of the spent fuel pool, NISA requested details of the installation plan, its effectiveness towards the stable cooling of spent fuel inside the spent fuel pool, as well as the results of a safety assessment on
the structural integrity and other aspects of the facilities that will
comprise the circulation cooling system, pursuant to the provisions of
Article 67, paragraph 1 of the Act on the Regulation of Nuclear Source
Materials, Nuclear Fuel Materials and Reactors (Act No. 166 of June 10,

3. Following the receipt of the report from TEPCO on May 21 and an
evaluation process, NISA has determined, as outlined in the appendix,
that this constitutes a valid and unavoidable emergency measure under
Article 64 paragraph 1 of the Act.

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1 Background

Unit 2 of Fukushima Dai-ichi NPS has been continuing its cooling operation with water supplied from the outside through a fire hose connected to the fuel pool cooling and clean-up system (hereinafter referred to as “FPC system”) piping, due to the loss of function for FPC, which removes decay heat generated the spent fuel stored in the spent fuel pool. In response to this situation, TEPCO plans to install a system that achieves cooling by circulating the water in the spent fuel pool (hereinafter referred to as “the circulation cooling system”), as a more appropriate cooling method.

NISA made a request, dated May 20, to TEPCO to report the details of the installation plan, its effectiveness towards the stable cooling of spent fuel inside the spent fuel pool, as well as the results of a safety assessment, pursuant to the provisions of Article 67 of the Act on the Regulation of Nuclear Source Materials, Nuclear Fuel Materials and Reactors (hereinafter referred to as “Reactor Regulation Act”).

TEPCO responded to the request with a report on May 21, 2011.

2 NISA’s Evaluation

The report submitted by TEPCO on the installation of the circulation cooling system for the spent fuel pools of Unit 2 at Fukushima Dai-ichi NPS were verified and assessed as follows.

2.1 Content of the Installation Plan

TEPCO states that the circulation cooling system would involve connecting a newly-installed heat exchanger to existing FPC piping. It has been verified, based on facility integrity survey and investigation of the work environment, that this method has
both the capacity to be implemented as rapidly as possible, and to minimize the number of temporary facilities.

2.2 The effectiveness towards the stable cooling of spent fuel inside the spent fuel pool

TEPCO states that temperature increase is an inevitable function of pool water evaporation when cooling through water injection into the spent fuel pool, while the circulation cooling system is capable of lowering the temperature of the pool water by circulating water cooled with a heat exchanger. According to TEPCO, this enables:

✓ Heat-induced deterioration of concrete used in the spent fuel pool to be brought under control
✓ The improvement of environment inside the reactor building, which has been adversely affected by vapors that contain radioactive substances
✓ Longer response time in event of loss of cooling function, due to the capability to maintain the spent fuel pool at a low temperature
✓ The risk of fuel exposure due to drop in pool water level, as well as the risk of more discharge of radioactive substances as a result of such exposure, to be reduced

NISA evaluates the above as valid.

2.3 Safety Evaluation

(1) Structural integrity and seismic safety of facilities that comprise the circulation cooling system

The following points were verified and judged to be valid:

➢ Has the integrity of the existing facilities been verified?

TEPCO states that for the accessible sections of the existing facilities to be used, an on-site visual observation was employed. For facilities within the reactor building situated in high-radiation environment, TEPCO verified through the state of water injection into the spent fuel pool via the FPC lines that boundary function was being maintained.
Do the facilities have sufficient structural strength and seismic resistance?

TEPCO states that while it can achieve sufficient structural strength for normal operations, the situation on the ground and the radiation environment of the site may make it difficult to carry out construction work capable of achieving sufficient seismic resistance.

Therefore, we verified the presence of both system shutdown capability based on signal of seismic acceleration high and interlocks that isolate systems, which were assumed earthquake damage to the circulation cooling system, to control cooling water leakage, while also ensuring that there were measures in place to prevent escalation into outside leakage, such as damming.

In addition, TEPCO plans to switch to feedwater supplied by a fire engine on standby on the east side of the Seismic Isolated Building, when the circulation cooling system is inoperable. For these reasons, NISA's evaluation is that cooling will be maintained.

(2) Cooling capability of the circulation cooling system

The following points were verified and judged to be valid:

- Does it have the necessary cooling capability?

TEPCO estimates the decay heat of spent fuel based on the burn-up of the fuel currently stored in the spent fuel pool, using a computer code with a record of being utilized in safety evaluations for licensing. In terms of the heat exchanger performance, it has been verified that the heat exchange capacity sufficiently exceeds the estimated decay heat.

(3) Measures to prevent leakage of cooling water from the circulation cooling system

The following points were verified and judged to be valid:

- Is there an appropriate measure in place in the event of a cooling water leakage from the primary system?
TEPCO states that the in/out valves of the heat exchanger unit will detect the difference between the in/outflow of the primary heat exchanger as well as any increase in the water level in the drain pot of the heat exchanger unit (a device that integrates the heat exchanger, pumps and other equipment), both of which can be expected in the event of a leak, and shut down automatically. In terms of a leak from primary to secondary system, TEPCO states that a radiation monitor will be installed on the secondary system, to trigger an alarm. In addition, TEPCO has plans to prevent cooling water leakage to the outside in the event that the pool water leaks from piping and other sites, by means of dams and other barriers.

- Was the assessment that there would be no leakage to the outside performed appropriately?

TEPCO makes an appropriate assessment based on the surface area of the leak site and dam height, regarding the judgment that systems from the skimmer surge tank can be isolated with interlocks such as leak detection, and that no leakage to the outside of the building will take place even in the event of a cooling water leakage.

Furthermore, TEPCO states that while secondary systems situated outdoors (cooling tower, etc.) may be vulnerable to tsunami damage because of its outside location, the probability of an effect spreading to a primary system facility containing radioactive pool water (heat exchanger, etc.) is low due to the use of flexible tubing as connectors.

(4) Measures in the event of loss of function for the circulation cooling system:

The following points were verified and judged to be valid:

- Is there an appropriate measure in place in event of loss of cooling or pool water supply function?

TEPCO states that it will install 2 separate systems
of heat exchanger units, cooling towers and other equipment, with a switchover being made in event of an anomaly.

Furthermore, even assuming the loss of cooling function due to earthquake or tsunami, an assessment finds that it takes approximately 29 days until water level drops to 2 meters above the top of active fuel. In this event, TEPCO states it will switch to feedwater supplied by a fire engine on standby on the east side of the Seismic Isolated Building. For these reasons, the threat of fuel damage can be assessed as low. In terms of the switchover to a fire engine, TEPCO states it will prepare a manual ahead of time and organize the necessary framework.

(5) Radiological protection

The following points were verified and judged to be valid:

➢ Is irradiation sufficiently low for installation workers and workers who will be in the vicinity after the system commences operation?

In terms of the installation work for this system, TEPCO states that because it involves working in high-radiation dose environment, the company will integrate equipment such as heat exchangers and pumps in order to shorten the installation time as much as possible.

TEPCO also states that once the system begins operating, it will set up shielding as needed since radioactive pool water will be moving through the heat exchanger and piping. TEPCO also states that other measures will be put in place, such as performing system operations by remote control using a control panel located away from the heat exchanger unit.

(6) Fitness-of-service management for the circulation cooling system

The following points were verified and judged to be valid:
Is there appropriate operations management as well as maintenance management?

TEPCO states that in terms of operations management, it will abide strictly by a preset manual, perform the control operations via operating and control panels, remotely monitor the state of systems including water level and temperature from within the seismically-isolated high-priority building, and shut down these systems if necessary.

In terms of maintenance management, TEPCO states that for the primary system, it will replace consumable supplies when appropriate, and replace or otherwise service the heat exchanger unit according to circumstances.

Based on the above, NISA determined that TEPCO’s installation of these systems as an emergency measure under Article 64, paragraph 1 of the Nuclear Regulation Act constitutes a necessary measure in preventing radiation hazards.

3 Future Actions

Regarding the installation and subsequent operation of a circulation cooling system in the spent fuel pool of Unit 2 at Fukushima Dai-ichi NPS, NISA inspectors will verify that TEPCO is implementing the reported plan in an appropriate manner, on an as-needed basis.