Regarding the Assessment of a Report on Maintaining Water Injection into Units 1, 2 and 3 Reactors at Fukushima Dai-ichi Nuclear Power Station, Tokyo Electric Power Co., Inc.

August 4, 2011
Nuclear and Industrial Safety Agency

1. Background

Water injection into the reactor is being performed in Units 1, 2 and 3 at Fukushima-Dai-ichi Nuclear Power Station (hereinafter referred to as "Fukushima Dai-ichi") of Tokyo Electric Power Co., Inc. in order to secure stable cooling of nuclear reactors, using a system of water injection into the reactor that ensures multiple means of water injection as well as unusual events countermeasures (hereinafter referred to as "water injection system"; see attached sheet).

Since maintaining water injection into reactors is also important in terms of preventing radiological impact on the surrounding environment as a result of water injection being halted due to system malfunction and other causes, NISA instructed Tokyo Electric Power Co. (hereinafter referred to as "TEPCO") to submit a report pursuant to the provision of Article 67, paragraph 1 of the Nuclear Regulation Act, in order to verify the validity of the emergency measure related to water injection into Fukushima Dai-ichi reactors based on Article 64, paragraph 1 of the same Act.

2. Safety assurance measures and Nuclear and Industrial Safety Agency's assessment

(1) Structural integrity and seismic safety

The water injection system is considered to be an equivalent of emergency core cooling system, and therefore categorized as class-2 equipment and seismic S class. However, as an emergency measure, the system needed rapid design and procurement. As a result, general-use industrial items including JIS-rated products were used, with maximum operating pressure and temperature, as well as flow speed inside the piping, being considered in the design. For this reason, possible system damage from earthquakes and other causes are assumed, and measures in (4) planned.

(2) Cooling capability

Ample water injection performance has been secured, given that the system has been structured to enable water injection exceeding the flow needed to remove decay heat currently generated by fuel inside the reactor, and the temperature inside reactor pressure vessel has steadily dropped to under 140℃ (approx. 93℃ for Unit 1, approx. 124℃ in Unit 2, approx. 108℃ for Unit 3 in the lower portion of the pressure vessel) in the course of current water injection into reactors (approx. $4m^3/h$ for Units 1 and 2, approx. $9m^3/h$ for Unit 3).

(3) Operations management and maintenance management

Flow meter and pressure gauge have been installed on piping near the pump outlet on high ground as well as near the turbine buildings of each reactor, and the system operation status including tank water level is being tracked using monitors installed in the Seismic Isolated Building in order to detect unusual signs for a preemptive response. These indicate a design that enables appropriate operations management. In addition, the creation of a manual and implementation of the necessary training for emergency response indicate that an appropriate response will be mounted.

Maintenance management is also assessed as being carried out properly, with replacement parts for pressure hose and flexible tubing secured to enable quick replacement whenever damage is confirmed, in addition to replacements for consumable items.

(4) Measures in event of loss of function

1) Measures in event of pump malfunction

In the event of pump malfunction, water injection is set to resume in approximately 30 minutes through switchover to a standby pump or to a pump operating on emergency diesel generator power.

2) Measures in event of injection line damage

In the event of damage to the injection line from the usual buffer tank to the reactor building, water injection is set to resume in approximately 30 minutes through switchover to a water injection from the pure water tank.

3) Measures in the event of power supply loss

In the event of loss of power supply to the pump being used, water injection is set to resume in approximately 30 minutes through a parallel deployment of the dedicated emergency diesel generator to power the pump for water injection, and of a fire engine for water injection.

4) Measures in event of water supply loss

In the event that the usual buffer tank cannot be used, water injection is set to resume in approximately 30 minutes by rerouting the system to be supplied by the filtrate tank. Furthermore, if water cannot be supplied by the filtrate tank, injection is set to resume in approximately 1 hour following fire hose switchover to the new supply, an underground raw water tank.

5) Measures in event of loss of function across multiple systems

In order to ensure water injection resumption even in the event of loss of function across multiple systems, additional fire engines will be deployed, injection lines rerouted according to the state of damage to the water supply and on-site situation, and the water rejection set to resume

The time from start of operations to resumption of water injection is assumed to be approximately 3 hours. However, since this time will vary according to on-site situation and other factors, ample volume of feed water will be secured to ensure fuel cooling in case recovery turns out to be a lengthy one. There is 12 or more-hour leeway until fuel temperature rises to the point that the zirconium in the fuel cladding reacts with water to produce hydrogen and water in significant way, and the operator will secure water volume sufficient for cooling even in the event that such a reaction does take place. In doing so, the operator plans to check that nitrogen has been injected, and adjust the flow while monitoring parameters such as temperature and pressure, in order to prevent the hydrogen generated from combusting.

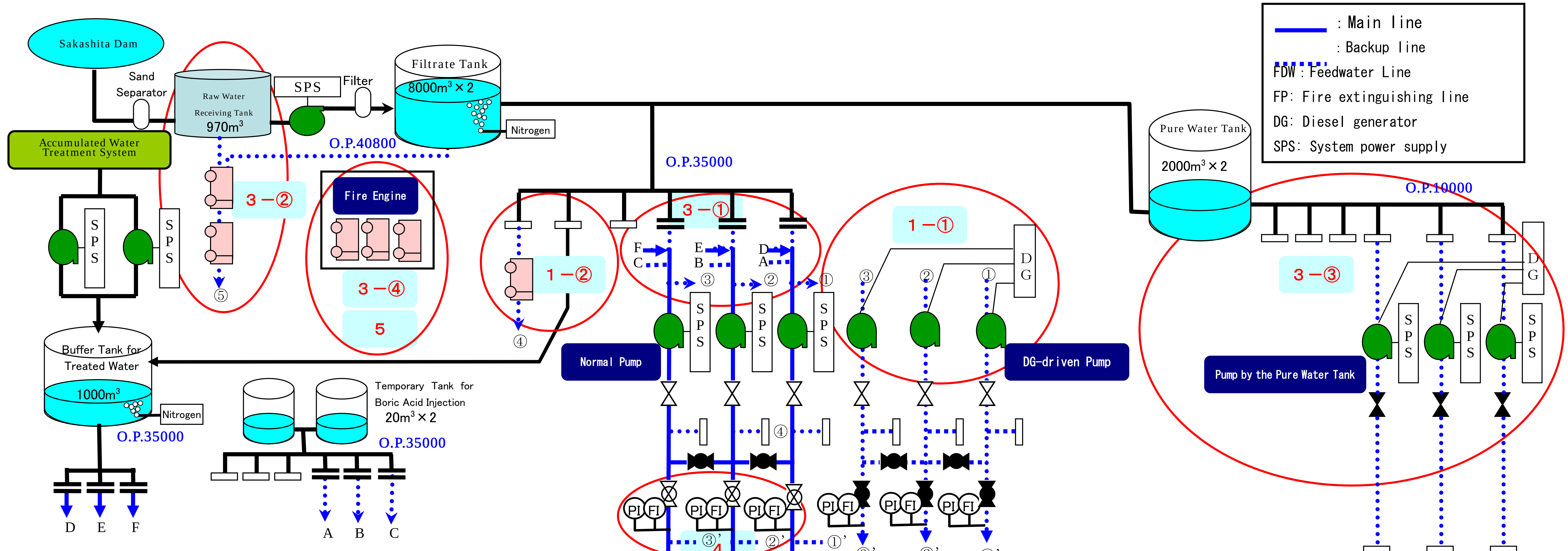
In terms of these measures, the necessary training is being implemented on a rolling basis, so that a situation-based response can be amounted in accordance with a manual, through the monitoring of flow, pressure and water level in the tank.

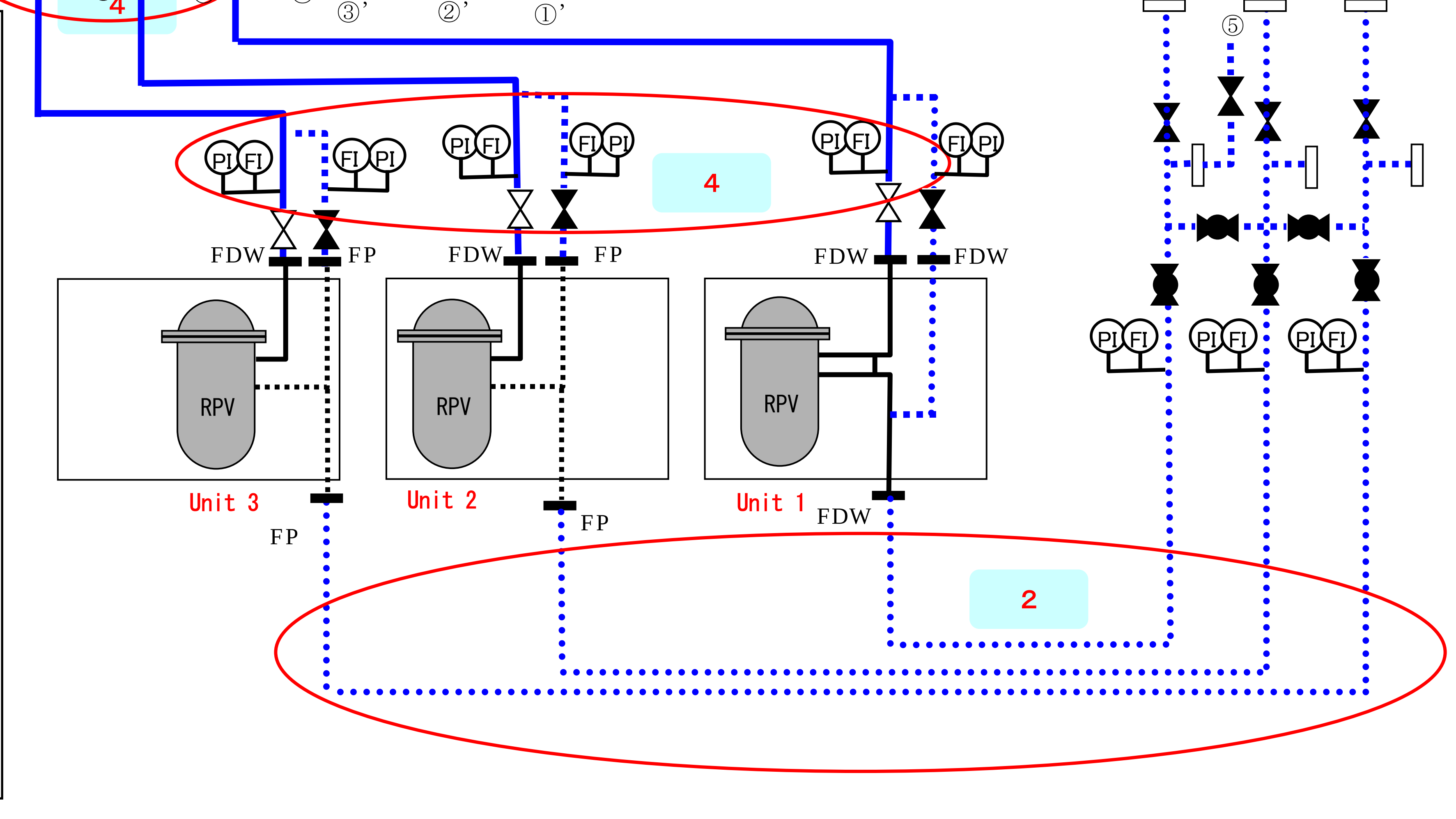
In addition, regarding the exploration into measures in the event of loss of function across multiple systems at TEPCO, NISA instructed Japan Nuclear Energy Safety Organization (JNES) to conduct an impact assessment, to ensure that the appropriateness of these measures is verified. The results of this assessment have been summarized in “Regarding the Status of Safety Assurance at Tokyo Electric Power Co.’s Fukushima Dai-ichi Nuclear Power Station Reactor Facilities (Assessment Following Completion of Step 1)”. This assessment examined the impact following 5 hours, 10 hours and 15 hours of water injection interruption, and found that even when there was fuel remaining in the core, with non-oxidized cladding left, temperature rise could be halted by resuming injection with a flow of $60m^3/h$, enabling control over the amount of radioactive materials released into the environment. As for water injection of over $60m^3/h$ into reactors, TEPCO has accomplished this in the past using 2 fire engines. Even in the event that resumption proves time-consuming, a response using the aforementioned measures will be mounted to prevent radiological impact on the surrounding environment.

Based on the above and with regard to the report submitted by TEPCO, NISA finds the currently-installed water injection system to be an appropriate emergency measure under Article 64 paragraph 1 of the Nuclear Regulation Act.

3. Future Response

In the future, NISA will continue to verify the implementation status of measures reported by TEPCO, such as the water injection system's operational status as well as the training for the response to be mounted by TEPCO in the event that water injection is interrupted, through on-site presence of Operational Safety Inspectors as needed.





<Ensuring redundancy of reactor water injection facilities and measures against tsunami>

1. Ensuring redundancy of power source for water injection
   1－①If a normal pump fails or the system power source for the pump is lost, water is injected by starting up the DG-driven pump which is constantly connected.
   1－②If the DG-driven pump cannot be started up, water is injected by fire engines as backup.
2. Ensuring redundancy of water injection line
   If a hose for the water injection line using the normal pump is damaged, water is injected via another injection line with the pure water tank as water source.
3. Ensuring redundancy of water source
   3－①The buffer tank for treated water is the normal water source; if the supply of treated water is disrupted, filtrate water is injected from the filtrate tank.
   3－②If the buffer tank for treated water and the filtrate tank are damaged, water is injected by fire engines with the raw water receiving tank as water source.
   3－③In addition, water can be injected from the pure water tank that lies downstream of the filtrate tank for a certain period of time.
   3－④If the above actions cannot be taken, sea water is injected by fire engines.
4. Monitoring of water injection status
   Flow indicators (FI) and pressure indicators (PI) are installed at the end of the motor-driven pumps and in the middle of the water injection lines to monitor the water injection status.
   An alarm is sent to the Seismic Isolation Building if the motor-driven pump fails.
5. Measures against tsunami
   Normal pumps, DG-driven pumps, and power source facilities are installed on a hill.
   If the facilities are damaged by a tsunami, water is injected by rearranging the fire engines and fire hoses deployed on a hill.

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