

May 5, 2011

Nuclear and Industrial Safety Agency

On the Implementation of Measures Filling the Primary Containment Vessel up to the Top of Active Fuel in Fukushima Dai-ichi Nuclear Power Station

On this subject, NISA instructed Tokyo Electric Power Co., Inc. on April 30, 2011, to report, pursuant to Article 67, paragraph 1 of the Act on the Regulation of Nuclear Source Materials, Nuclear Fuel Materials and Reactors, and we received a report from the company today. NISA evaluated the report and gave the company necessary directions as attached.

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On the Implementation of Measures Filling the Primary
Containment Vessel up to the Top of Active Fuel in Fukushima
Dai-ichi Nuclear Power Station

1. Background

Currently, Unit 1 of Fukushima Dai-ichi Nuclear Power Station (NPS) is being cooled by water injection of 6m³ of water every hour. Tokyo Electric Power Co., Inc. (TEPCO) plans to implement measures to bring the water level in the Primary Containment Vessel (PCV) up to the top of the active fuel (hereinafter, “the Flooding Operation”) by increasing the amount of injected water in order to realize a state of “stable cooling.”

For this purpose, pursuant to Article 67, paragraph 1 of the Act on the Regulation of Nuclear Source Material, Nuclear Fuel Material and Reactors (hereinafter, “Nuclear Regulation Act”), regarding the Flooding Operation in the Fukushima Dai-ichi NPS, NISA requested TEPCO to submit a report about the evaluations for safety and for the impact on the reactor’s stable cooling by this operation.

In response to NISA’s above request, TEPCO submitted its report today.

2. Evaluations by NISA

NISA confirmed and evaluated the following about the report submitted by TEPCO about the evaluations for safety and for the impact on the reactor’s stable cooling by the Flooding Operation in the Fukushima Dai-ichi NPS.

2.1 Effect on Reactor’s Stable Cooling

TEPCO indicated the following were the effects on the reactor’s stable cooling by the Flooding Operation:

- The state of cooling inside the reactor was achieved but there was a part of the surface temperature on the Reactor Pressure Vessel (RPV) that was higher than the saturated temperature; and other than the fuel already submerged in the reactor, there is the possibility for the fuel to be partly exposed. Therefore, it

is necessary to implement the Flooding Operation and to stabilize the cooling in the reactor even more.

- TEPCO will increase the stored water that can be used for cooling the reactor inside the PCV and, just in case, even in an unpredictable situation, such as the water injection is disrupted, it will be possible to increase the leeway time, more than the present situation, before the fuel temperature increase shifts.

As to the current state of inside the reactor, from the perspective that it can be considered the possibility of fuel exposure is undeniable, NISA evaluated that the Flooding Operation will have the effect of stable cooling on the reactor.

2.2 Evaluation of Safety

(1) Evaluation of Impact on Structure Strengthening and Seismic Adequacy in relation to Reactor Buildings and the PCV

① PCV

Regarding the PCV including the dry well, suppression chamber, etc., TEPCO conducted evaluations about the impact on structures using design basis seismic ground motion and about seismic adequacy considering the increased volume of water by the Flooding Operation; it was possible to maintain the stored water after the Flooding Operation from the viewpoint of maintaining functionality.

NISA confirmed the following points and determined TEPCO's evaluations were reasonable. As an aside, regarding the support columns of the suppression chamber, from the viewpoint of low tolerance with respect to the acceptable criteria values, in the future, in addition to undertaking improvements for the operational environment within the reactor buildings, NISA considers conducting seismic reinforcements to be desirable, as well.

- Are the settings for the evaluation conditions conservative?

For the condition of increasing the water level up to the vent line exceeding the top of the active fuel, TEPCO set the load condition to be in line with the higher water level.

- Is the input seismic ground motion appropriately set?
The standard seismic ground motion lay down pursuant to the “Regulatory Guide for Reviewing Seismic Design of Nuclear Power Reactor Facilities” (decided by the Nuclear Safety Commission on September 19, 2006, hereinafter the “New e Guide for Seismic Design”) were input.
- Are the selected evaluation methods and standards appropriate?
NISA confirmed that TEPCO conducted FEM analysis and applied not only standards for nuclear power facilities, but also the standards, etc. for general commercial facilities, and that TEPCO evaluated the maintenance of functionality by a realistic, strengthening of ability.
- Are the computed values for the stress evaluation points the below acceptable criteria values?
Regarding the dry wells, suppression chambers, and the supporting columns, the computed value for the stress arising from the external supporting column, which was the most strictly evaluated portion, was 0.923 times the acceptable criteria values, but all the acceptable criteria values were met, and regarding the bellows, NISA confirmed the FEM analysis (elasticity analysis) considering the broad-range evaluation of the horizontal change of position was computed to be 26.3mm, and the amount of change in position of the design (46.32mm) was enveloped.

② Reactor Buildings

Based on the weight condition considering the partial damage to the buildings and its falling down as well as the significant amount of increased water by the Flooding Operation, TEPCO conducted evaluations about the impact on the structures using design basis seismic ground motion and about their seismic adequacy; since there is sufficient leeway with respect to the acceptable criteria values for shear strain, TEPCO confirmed that there would be no significant impact

on the PCV by the reactor buildings.

Regarding this evaluation, NISA confirmed the following points and determined that they were reasonable:

- Is an appropriate evaluation policy is set?

With respect to the standard seismic ground motion based on the New Guide for Seismic Design, TEPCO evaluated that the reactor buildings would not have any after-effects on the equipment important for seismic safety such as the PCV built inside the reactor buildings.

- Are the evaluation conditions conservative?

Considering the conditions of the evaluation for seismic safety, which came to light by the New Guide for Seismic Design (hereinafter, “Seismic Safety Back Check”), in addition to reflecting the damage situation from the hydrogen explosion, etc., as the water level was increased to the vent line which exceeds the top limit of the active fuel, TEPCO distributed and set the mass incrementals according to the increase of water. Furthermore, within the standard seismic ground motion, for the evaluation of the Seismic Safety Back Check of the reactor buildings, TEPCO used the buildings having significant impact for the input of seismic ground motion.

- Are appropriate methods for evaluation and permissible values selected?

TEPCO applied the same methods as the Seismic Safety Back Check, and from the perspective of having the equipment important for seismic safety not to incur any impact that would cause a breakdown, the shear strain responding to the ultimate limit of the seismic walls with iron joints made of concrete are within permissible values.

- Do the seismic adequacy evaluation results satisfy the standard values?

The shear strain arising from the seismic-resistant walls of the reactor buildings would be at most 0.12×10^{-3} , which is well within the acceptable criteria values (4.0×10^{-3}).

(2) Impact of Rising Pressure inside PCV

TEPCO extracted the cause for the rising pressure inside the PCV from the increase in the water level, and thus, evaluated that a state of equilibrium could be obtained by leaking the gaseous phase even if the pressure rises and the pressure required by the dry well vent is not reached.

The state when it is possible for the PCV pressure to rise can entail rises in the rate of occurrence for vapor from the hydrogen, oxygen, steam, etc., change in the rate of the PCV's leakage, and decrease in the capacity of the gas inside the PCV accompanied by the water level increasing. So NISA evaluated that TEPCO's reviewing the possibility of the following points is reasonable:

- ① Part of the reactor core that did not come into contact with water should be exposed to water, and the rate of occurrence for steam will rise;
- ② The sites of leakage for the PCV should be submerged to lower the leakage rate; and
- ③ The capacity of the gas inside the PCV should be reduced accompanied by the rising water level inside the PCV

Moreover, NISA evaluated that, from the rate of leakage for the PCV observed when nitrogen was injected, it was difficult to believe that the pressure within the PCV would rise.

(3) Evaluation of Impact on Stagnant Water Inside Buildings due to Leakage from PCV

TEPCO assumed that the PCV would incur damage along with the Flooding Operation, and that water from the PCV would leak; and thus, confirmed that water would not overflow the pit of the trench due to no external leakage from the opening of the Unit 1 reactor buildings while the water level of the Unit 1 reactor buildings and the Unit 2 turbine buildings, etc. rising; and the planned transferring of the stagnant water in the Unit 2 turbine buildings to the Radioactive Waste Treatment Facilities.

Regarding this evaluation, NISA confirmed the following points and determined that they were reasonable:

- TEPCO extracted the assumed locations for the external

leakage from the buildings possibly connected to the Unit 1 reactor buildings, assuming the leakage into the Unit 2 turbine buildings, and evaluated the possibility for leakage from the Unit 1 pit of the trench and the Unit 2 pit of the trench.

- As an assumption when evaluating the possibility of external leakage from the pit of each trench, TEPCO conducted its evaluation based on the assumed conditions that the water levels of the stagnant water in the Unit 1 reactor buildings and in the Unit 2 turbine buildings would become highest, by presuming that the water level rises up to the vent line exceeding the top of the active fuel, etc.,. Furthermore, TEPCO assumed that leakage could gradually arise or arise suddenly, and evaluated the water level rises in either assumption.
- The evaluation about the water level rising by leakage of stored water would reach 10.127mm (O.P.) in the Unit 1 reactor buildings, which would not leak out because the opening is at a height of 10.200mm (O.P.) Furthermore, considering the possibility for the Unit 1 reactor buildings and the Unit 2 turbine buildings to be connected, the water level in the Unit 2 turbine buildings would reach 3.958 (O.P.), which would not leak out because the opening is at a height of 4.000 (O.P.)
- Even considering the amount of water leaked out from the Unit 1 PCV increased by the Flooding Operation, TEPCO evaluated that the tank's capacity for the high-level radioactivity sewage processing system is not insufficient.

(4) Other Safety Issues related to Implementation of the Flooding Operation

TEPCO evaluated and confirmed the following points regarding the other safety issues related to the Flooding Operation:

- Possibility of a hydrogen explosion
- How to respond if unpredictable plant behavior arises
- Impact of discharged radioactive materials by the Flooding Operation
- Monitoring method for flooding, controlling method for

the water level

Among the above, regarding a possible hydrogen explosion, nitrogen has been continuously injected since April 7 and it will be continuously injected from now on, and so, the risk for a hydrogen explosion has been largely reduced; as to the discharging of radioactive materials, the pressure in the PCV will not rise due to the Flooding Operation, and so, it was confirmed that it could be predicted the discharged amount of radioactive materials would not increase.

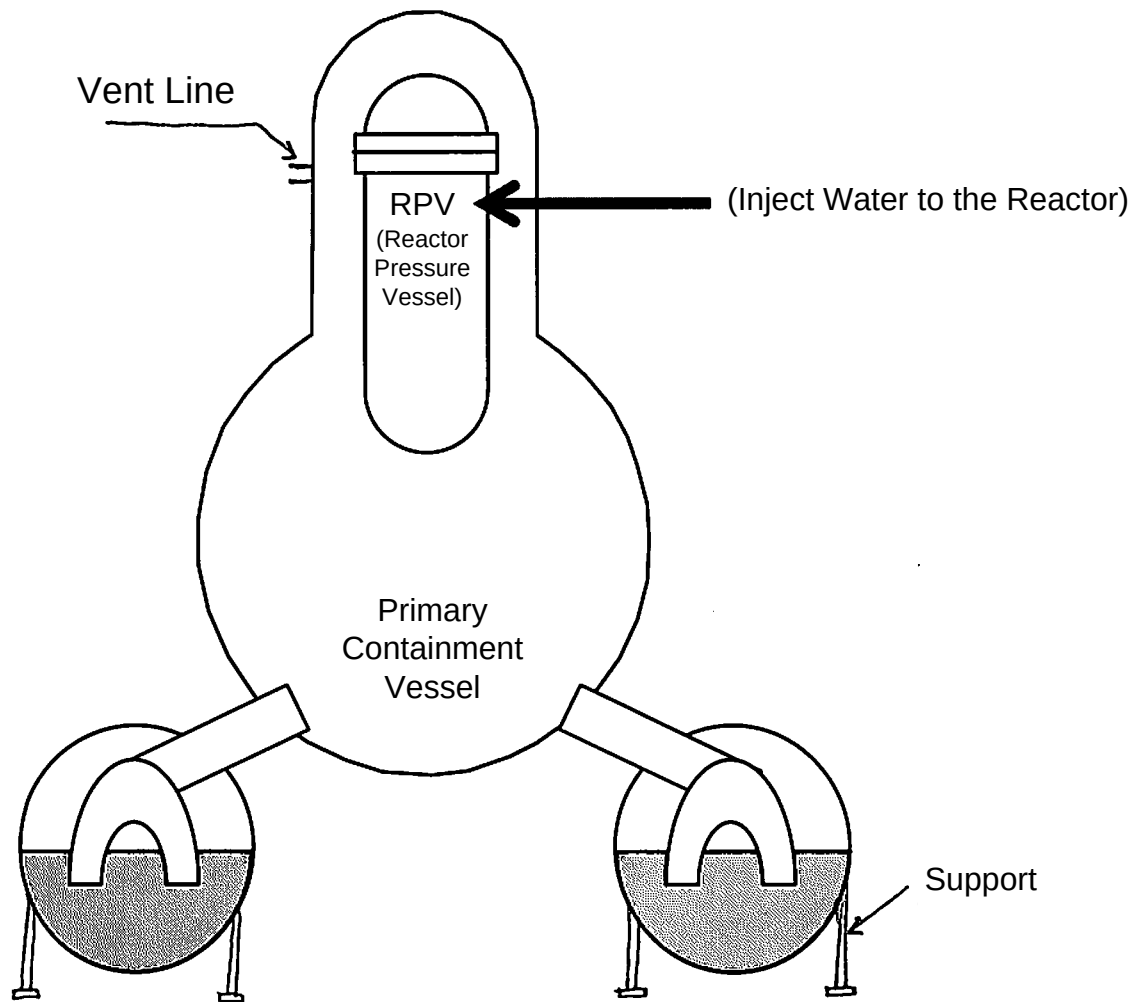
Finally, regarding how to respond if unpredictable plant behavior arises, a monitoring method when flooding, and a controlling method for the water level, TEPCO's considering these before the Flooding Operation will be started, and preparing response measures in advance were evaluated as appropriate.

Based on all the above, NISA determined that TEPCO's implemented emergency measures pursuant to Article 64, paragraph 1 of the Nuclear Regulation Act are the required measures to prevent damage by exposure.

3. Future Action

NISA instructs TEPCO to undertake the following regarding the Flooding Operation for Unit 1 of Fukushima Dai-ichi NPS.

- Regarding the water level inside the PCV and the leakage from the PCV, in addition to carefully monitoring the process, TEPCO will implement appropriate response measures determined in advance such as controlling the injection amount, etc.
- Regarding the support columns of the suppression chamber, which have little leeway with respect to acceptable criteria values, from the presumption that aftershocks will continue to arise from now on, TEPCO will review how to further strengthen the seismic resistance of the NPS and make improvements for its operational environment.



Primary Containment Vessel of Unit 1 in Fukushima Dai-ichi NPS
Schematic Diagram

Ministry of Economy, Trade and Industry

05.05.2011 Nuclear Number 1

May 5, 2011

Tokyo Electric Power Co., Inc.
President Masataka Shimizu

Nuclear Industrial Safety Agency
Ministry of Economy, Trade and Industry
Director General Nobuaki Terasaka
NISA-151d-11-12

Regarding the Implementation of Measures Filling the Primary
Containment Vessel up to the Top of Active Fuel in Fukushima Dai-ichi
Nuclear Power Station (Directive)

On April 30, 2011, in 04.30.2011 Nuclear Number 1, NISA requested your company to report the implementation of measures to fill the water of the PCV up to the top of the active fuel in Unit 1 of the Fukushima Dai-ichi NPS, pursuant to the provisions of Article 67, paragraph 1 of the Act on the Regulation of Nuclear Source Materials, Nuclear Fuel Materials and Reactors (1957, Law No. 166).

Today, NISA received a report regarding implementation of these measures from your company, and as a result of confirming the content of the report, NISA evaluated that said content are reasonable and unavoidable as emergency measures.

For the implementation of these measures, since it is necessary to ensure absolute safety, NISA requests that your company implements the following with certainty.

Required Items

1. Regarding the water level inside the PCV and the leakage from the PCV, in addition to carefully monitoring the process, implement appropriate response measures determined in advance such as controlling the injection amount of water, etc.
2. Regarding the support columns of the suppression chamber, which have little leeway with respect to the acceptable criteria values, from the presumption that aftershocks will continue to arise from now on, review how to further strengthen the seismic resistance of the NPS and make improvements for its operational environment.