Regarding the Installing a Cover for the Reactor Building and its associated Facilities of Unit 1 at Fukushima-Daiichi Nuclear Power Station, Tokyo Electric Power Co., Inc.

June 24, 2011
Nuclear and Industrial Safety Agency

1. Background

The reactor building of the Unit 1 at Fukushima Dai-ichi Nuclear Power Station (NPS), Tokyo Electric Power Co., Inc. (TEPCO) was severely damaged by hydrogen explosion. As the results, it was lost the function of confining radioactive materials. In response, TEPCO announced that it intends to restore the confining function by installing a new building (container) in a middle period. For the period until a new building is installed, TEPCO plans to install a tent-shaped reactor building cover that is comprised of a steel frame structure and film materials as well as associated facilities including a ventilation facility (hereinafter refer to as the "reactor building cover") to prevent the diffusion of radioactive materials,.

Accordingly, the Nuclear and Industrial Safety Agency (NISA) requested that TEPCO submit a report in order to evaluate the effectiveness of the installation of such a reactor building cover with respect to containing the diffusion of radioactive materials, and the evaluation of safety for the installation of the cover and others, pursuant to the provisions of Article 67 of the Act on the Regulation of Nuclear Source Materials, Nuclear Fuel Materials and Reactors (the Nuclear Regulation Act).

2. Evaluation by NISA

NISA has confirmed and evaluated as shown in the followings on the report submitted by TEPCO regarding the installation of the reactor building cover at Unit 1 of the Fukushima-Daiichi NPS:

2.1 Content of the installation plan

The effects of the installation of the reactor building cover were confirmed to include preventing the diffusion of radioactive materials and shutting off rain water into the reactor building.

NISA also confirmed that: the cover as designed is comprised of a steel-frame main structure, roof, and walls covered with film materials; the film materials are made of the most airtight material possible in order to prevent the diffusion of radioactive materials; and the installation techniques that will be used to insert the pre-manufactured member joints in order to reduce the exposure dose as well as minimize the number of man-hours required for assembly.

Based on the above, NISA evaluates that this plan is imperative as an emergency measure based on the necessity to consider the requirements of design and construction techniques in order to install the cover as quickly as possible.

2.2 The effects to prevent the diffusion of radioactive materials with the reactor building cover

To prevent the diffusion of radioactive materials, such materials are guided from the suction opening installed on the roof inside the cover of the reactor building through the exhaust air duct to the filter unit outside the cover.

The 45,000 m^3 space above the operating floor inside the cover is ventilated in approximately one hour by a filter unit capable of ventilating ca. 40,000m^3/h. The filter unit (with a charcoal filter that removes 90% of the iodine and a high-performance particle filter that removes 97% of the cesium) reportedly reduces the discharge of over 90% of the radioactive materials. This evaluation therefore concludes that the effects to prevent the diffusion of radioactive materials can be expected.

The report envisages measurement points designated at, for instance, the upper portion of the spent fuel pool inside the cover and around the hatches of operation floor components. NISA evaluated that such measurement is an appropriate measure for assessing the state of the diffusion of radioactive materials from the reactor building.

2.3 Evaluation of safety

(1) Impact of changes in temperature and humidity on the work environment

In the report, a maximum temperature of approximately 39 °C and humidity of approximately 58% are estimated for the interior of the reactor building after installing the cover, assuming an external temperature of 28.5 °C and no decrease in the water temperature of the spent fuel pool, which is controlled by the circulation cooling system.

TEPCO's temperature and humidity estimations are based on conservative estimates. The report proposes taking measures as necessary, such as installing spot coolers near the working area in order to improve the local working environment. Limitations on working time are also proposed; these measures should be confirmed going forward.

(2) Structural strength and its spill-over impact on the reactor building

It is stated that the design of the cover is in accordance with the Building Standards Acts. All of the stress intensities resulting from wind pressure and seismic force on the steel beams and posts (i.e., axial forces, bending, and shearing) are reportedly within the range of allowable stress intensities. The structural strength and seismic safety are equal to those of common buildings. The impact of tsunami is to be addressed by the tide embankment, which is planned to be built before the completion of the reactor building cover.

Even in the event of strong-than-expected storms and earthquakes, the pillars of the reactor building cover, which are mounted in the ground, will slide before the steel frames structure collapses, ultimately bringing the cover structure into contact with the reactor building and supporting its load thereby. Since the cover is sufficiently lightweight (approximately 4% of the building's weight), the possibility of spill-over impact is expected to be negligible small.

A separate seismic safety analysis of a situation in which the reactor building damaged by a hydrogen explosion endured the standard seismic ground motion Ss-1 and Ss-2 found a sufficient safety margin, as the estimated shear strain of the seismic wall was 0.12×10^{-3} against the standard value of 4×10^{-3}. Hence, no impact on the seismic safety of the reactor building is anticipated even if the cover comes into contact with the building.

(3) Fire prevention measures and the spill-over impact of fires

The report states that there are no any flammable materials in the reactor building cover. Thus, even if a fire breaks out, the cover, which is made of fire-retardant film materials, will not have any spill-over impact on the reactor building. The fire safety of the foil is confirmed by its certification as "fire retardance grade 2" as defined in JIS A 1322-1966 "Testing Method for Incombustibility of Thin Materials for Buildings."

As the shutter built into the cover of the reactor building can be opened in the event of a fire to allow water to be sprayed inside, the risk resulting from fires was assessed to be small.

(4) Impact on injections into the spent fuel pool and monitoring of the operating floor

The injector pipe is installed in the roof of the reactor building cover, thereby enabling water to be injected from outside. A camera is installed inside the cover to allow remote monitoring of the state of the operating floor. Therefore, NISA assessed that the installation of the reactor building cover does not interfere with observation of the spent fuel pool, water injections thereto, or with the monitoring of the condition of the operating floor.

(5) Others

a. Countermeasures of hydrogen

The report noted that conservative estimates were adopted to assess the volume of hydrogen generated by the radiolysis of cooling water. 100% damage to the spent fuel was assumed to be on the safe side for the assessment although the reactor fuel is 100% damaged and the fuel inside the spent fuel pool is undamaged. The report also noted the relatively low possibility of the retention of hydrogen inside the cover, since generated hydrogen constitutes merely a tiny portion (approximately 0.01%) of the space above the operating floor inside the ca. 45,000m^3 cover. Taking into account the constant monitoring of hydrogen concentration by reading meter, NISA concluded that there is no risk of a hydrogen explosion.

b. Impact on the working environment around ventilation facilities

The report estimated the maximum air dose rate from the radioactive materials present in air exhausted by the exhaust air duct of the reactor building's cover to be 8.6×10^{-3} mSv/h (or 8.6 μSv/h). This figure is

sufficiently low in comparison to the June 4 measurement of 1 to 20 mSv/h the surrounding area of the Unit 1 building at the Fukushima-Daiichi NPS. In the event that work will be performed on-site near the exhaust pipe, NISA confirmed that appropriate equipment will be used in accordance with environmental conditions, including the concentration of radioactive materials and dose rate.

In consideration of the above, in order to prevent radiation hazards, NISA determined that TEPCO's installation of a reactor building cover is a necessary emergency measure pursuant to Article 64, paragraph 1 of the Nuclear Regulation Act.

3. Further response

Operational Safety Inspectors will verify as required that TEPCO properly conducts the installation as well as subsequent operation and maintenance of the reactor building cover as specified in its report.