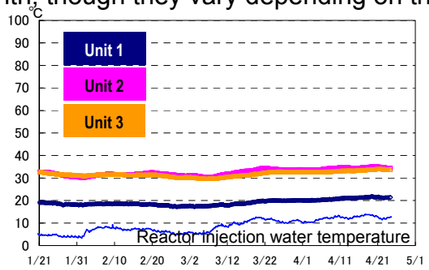
Progress Status and Future Challenges of Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station Units 1-4 (Outline)

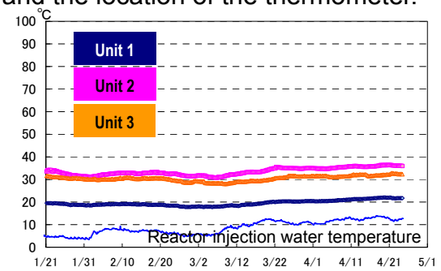
I. Confirmation of Reactor Conditions

1. Temperatures inside the reactors

Through continuous reactor cooling by water injection, the temperatures of the RPV bottom and the PCV gas phase have been stabilized within the range of approx. 15 to 40℃ for the past month, though they vary depending on the unit and the location of the thermometer.



RPV bottom temperatures



PCV gas phase temperatures

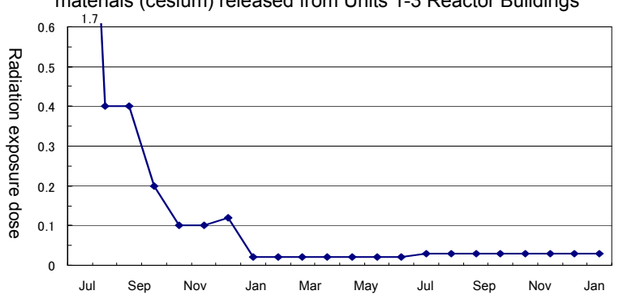
2. Release of radioactive materials from the Reactor Buildings

The radioactivity densities of the air at site boundaries due to the radioactive materials newly released from Units 1-3 Reactor Buildings were evaluated to be approx. 1.5×10^{-9} Bq/cm^3 for both Cs-134 and Cs-137. The radiation exposure dose due to the radioactive materials released was 0.03 mSv/year (equivalent to approx. 1/70 of the annual radiation dose by natural radiation (annual average in Japan: about 2.09 mSv/year).

(Reference)

* The radioactivity density limit of the air outside the surrounding monitoring area:
[Cs-134] 2×10^{-5} Bq/cm^3, [Cs-137] : 3×10^{-5} Bq/cm^3
* Radioactivity density of the dust around the site boundaries of Fukushima Daiichi Nuclear Power Station (actual measurement value)
[Cs-134] ND (Detection limit: approx. 1×10^{-7} Bq/cm^3)
[Cs-137] ND (Detection limit: approx. 2×10^{-7} Bq/cm^3)

Annual radiation exposure dose at site boundaries due to the radioactive materials (cesium) released from Units 1-3 Reactor Buildings



(Note) As for the radiation dose evaluation, different formulas and coefficients were being used for the facility operation plan and the monthly report. The evaluation method has been integrated in

3. Other indexes

There was no significant change with parameters including the pressure in the PCV and the PCV radioactivity density (Xe-135), and no abnormality of cold shut down condition or sign of criticality was detected.

Based on the above, it was confirmed that cold shut down condition has been maintained and the reactors have been in stable condition.

II. Progress Status by Field

1. Reactor cooling

Cold shutdown condition will be maintained and measures to complement status monitoring will be continued to be implemented through reactor cooling by water injection

➢ **Investigation of the inside of Unit 2 RPV and thermometer installation utilizing the TIP guide pipes**

The investigation of the inside of the reactor and permanent thermometer installation will be performed utilizing the TIP guide pipes. As a result of inspecting the inside of the TIP guide pipes (at 4 locations) by a fiberscope (February 25-28), it was confirmed that endoscope and thermocouple cannot be inserted into the guide pipes. Thus, work was terminated and countermeasures were considered. As a result, a method to push up the substances attached inside the guide pipes and obstacles (pushing up the roller with strong force utilizing a wire tip with a wedge attached) was selected. A validity test utilizing a mockup of the inner switch fixture is ongoing to examine the feasibility of the method (April 15-26) (See 1 below). Based on the test results, whether or not to proceed to the next process (manufacture of equipment, training, work at site, etc.) will be determined.

➢ **Nitrogen injection into the suppression chamber (S/C) for the purpose of mitigating hydrogen- related risks**

The residual air with high hydrogen concentration in the upper part of the S/C which was generated in the early stage of the accident was purged to reduce hydrogen-related risks. Though the estimated hydrogen concentration was reduced to below the flammability limit*1 at Unit 1, nitrogen injection is continued for the purpose of understanding the status of residual hydrogen (December 7-26, January 8-24, February 26-March 19, April 2-23 and from May 8 (planned). As for Unit 2, the design and production (December 25-March 12) and installation (March 13-17) of the injection equipment have been completed and nitrogen injection is planned to start in mid May. As for Unit 3, no increase in the hydrogen concentration has been detected in the PCV gas control system and the condition inside the S/C is considered to be stable. Changes in the parameters are being monitored.

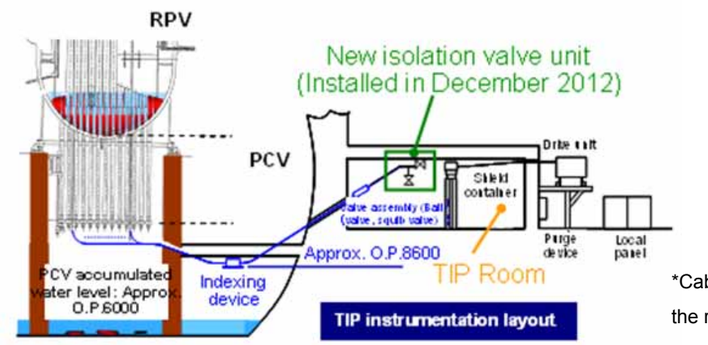
*1 The flammability limit represents the limit allowing for combustion (4% or more hydrogen and 5% or more oxygen need to be present). Combustion does not necessarily occur once the hydrogen concentration exceeds 4%.

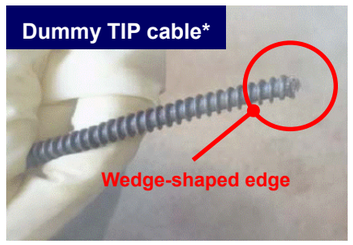
➢ **Suspension of Unit 3 spent fuel pool alternative cooling system**

While installing a wire mesh to prevent the entry of small animals (as a recurrence measure in response to the power supply failure occurred on March 18) in the current carrying area, a ground fault (power leakage to the ground) occurred due to a piece of wire touching the terminal block by accident (April 5) and the spent fuel pool alternative cooling system was suspended as a result. Based on factor analysis results, the following necessary measures will be implemented.

(Examples)

- Create procedure manuals for operations performed by TEPCO (except for routine work such as patrol) regardless of work contents. The manuals (including the contents of preliminary safety evaluation) will be reviewed by senior personnel.
- Additional measures will be implemented based on the review results by the newly established "Emergency Response Headquarters for Reliability Improvement at Fukushima Daiichi Nuclear Power Station".





*Cable used for preliminary check before inserting the real TIP detector during construction.

1. Inspection inside the TIP guide pipes

2. Accumulated water treatment

As a countermeasure for the increasing amount of accumulated water due to groundwater flowing in, a drastic measure to prevent groundwater from flowing into the Reactor Building will be implemented while improving the decontamination capability of the water treatment facilities and preparing facilities for contaminated water treatment

➢ **Preventing groundwater from flowing into the Reactor Building**

A system to prevent groundwater from flowing into buildings by pumping the groundwater flowed from the mountain side in the upstream side of the buildings (groundwater bypass) is being built. The installation of system A has been completed and trial operation and water quality test have been performed (March 31-April 23). As for systems B and C, the installation has been completed and trial operation and water quality test are ongoing (system B: to be completed in late May, system C: to be completed in mid May). As a result of water quality test performed on system A, the densities of Cs-134, 137, Sr-89, 90, tritium, all α and all β were confirmed to be sufficiently low. The system will be put in operation once agreement is gained from the parties concerned.

➢ **Installation of multi-nuclide removal equipment**

Multi-nuclide removal equipment is being installed for the purpose of further reducing the densities of the radioactive materials (except for tritium) contained in the accumulated water in the power station site. As an approval was given from the Nuclear Regulation Authority to start hot test for system A, hot test utilizing radioactive water has been started on March 30. As of April 24, approx. 2,668m^3 of radioactive water has been treated. Samples of treated water are currently being analyzed. As a result of simplified measurement, the densities of most nuclides (of γ nuclides, Sr-90) were below the detection limits though small amounts of radioactive materials were detected (Sr-90, cs-137, etc.). Overall, the radioactive materials are confirmed to have been reduced to below the density limit specified by Reactor Regulation. The capacity to remove radioactive materials will continue to be evaluated while adjusting setting conditions for the pretreatment process (iron coprecipitation, carbonate coprecipitation). The evaluation results are planned to be summarized at the following timings. γ nuclides: around early May, Sr and all α: around late May, nuclides difficult to be measured (Tc, Ni, etc.): around mid June.

➢ **Leakage from the underground reservoirs and countermeasure implementation**

After leakage from the underground reservoir No.2 was found (April 5), a small amount of leakage was found at the underground reservoirs No.1 and 3 as well (No.1: April 13, No.3: April 7). In response to this incident, a decision has been made not to use any of the underground reservoirs. The water stored in the underground reservoirs is being transferred to the tanks located above ground (from April 16 to June (the timing of water transfer is being discussed for No.4 where water from Units 5-6 is stored)). For the time being, as a measure to prevent the leaked water from spreading, the leaked water in the leakage detection holes is returned to the reservoirs in order to reduce the water pressure in the leakage detection holes. Also, boring holes are to be drilled in locations such as around the underground reservoirs (drilling has been completed and monitoring has been started at 21 out of 30 locations as of April 23) to perform sampling of groundwater. As of April 23, all β densities in the existing observation holes (at 7 locations including the groundwater bypass pump wells) have been confirmed to be below the detection limit. Cause investigation and consideration of countermeasures will be continued.

➢ **Committee on countermeasures for contaminated water treatment**

The “Committee on countermeasures for contaminated water treatment” was established at the third meeting of the Council for the Decommissioning of TEPCO Fukushima Daiichi Nuclear Power Station on April 19, 2013 for the purpose of verifying all the countermeasures implemented up until now for the risks of contaminated water treatment at Fukushima Daiichi Nuclear Power Station and discussing measures to fully resolve the issues regarding contaminated water treatment as well as the measures to be implemented in the event of contaminated water leakage. The first meeting of the Committee is planned to be held on April 26, 2013 to discuss the future direction of measures to prevent groundwater inflow. The results (first phase) will be summarized by the end of May.

3. Radiation dose reduction and contamination mitigation

Effective dose reduction at site boundaries (aiming to achieve 1 mSv/year by the end of FY 2012) and purification of the water in the port for the purpose of mitigating radiation impact on the outside environment

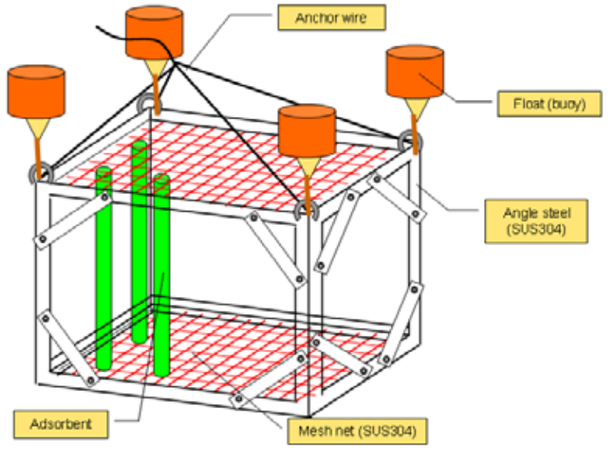
- **Closure of the blow out panel (BOP) opening at Unit 2 Reactor Building**
  Work to close the BOP opening was performed. For the purpose of further mitigating the radiation release from the Reactor Building, ventilation facility/ducts and a closure panel have been installed (March 11). The ventilation facility is now in full-scale operation (since April 1). As a result of evaluating the amount of wind inflow/outflow and the release of radioactive materials at the opening on the first floor of the Reactor Building, it was confirmed that the amount of radioactive materials released from Unit 2 Reactor Building had decreased substantially (to about 1/70) after the BOP opening was closed.

- **Construction of impermeable walls**
  Impermeable walls will be built to prevent contamination from spreading to the sea (planned to be completed by mid FY2014). At present, preliminary drilling is being performed on the bedrock in the area where steel pipe sheet piles are to be installed (from June 29, 2012). The installation of steel pipe sheet piles has been started on April 2 (See 2 below).

- **Radioactivity density of the seawater in the port**
  As of March, the radioactivity densities (Cs-134, 137) of the samples obtained in the inside of Unit 3 water intake channel were above the density limit stipulated by the Reactor Regulation. While preventing further contamination of the seawater in the open duct, fiber adsorbent has been installed on the inside of Unit 3 silt fence. Purification is planned to be started in mid May or later (The manufacture of equipment is taking a substantial amount of time) (See 3 below). As for Sr, purification implementation plan utilizing techniques which can be applied at the site is being considered.

- **Establishment of a review committee consisting of experts**
  For the purpose of examining the factors contributing to the fact that the radioactivity density of seawater in some locations of the port is not decreasing to below the density limit stipulated by the Reactor Regulation and verify the measures implemented by TEPCO, a review committee consisting of experts has been established. The first committee meeting is to be held on April 26. The verification results will be announced in a reliable manner by the end of May.

2. Installation of steel pipe sheet piles for impermeable walls



3. Fiber adsorbent purification equipment

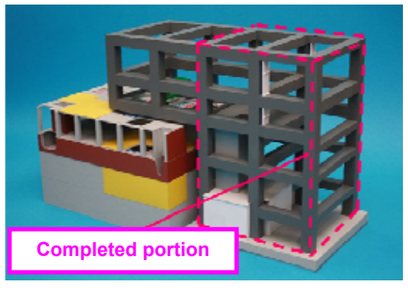
4. Fuel removal from the spent fuel pools

Work towards spent fuel removal is being steadily progressed while ensuring seismic capacity and safety. In particular, efforts are being made to achieve the early start and completion of Unit 4 spent fuel removal (Planned to be started in November 2013 and completed at around the end of 2014)

- **Work towards spent fuel removal at Unit 4**
  The cover installation for fuel removal is ongoing (to be completed around mid FY 2013). In addition to the foundation work, the steel frame construction was started on January 8. The steel frame except for the part which sticks out to the upper part of the fifth floor of the Reactor Building has been completed (April 10). The entire steel frame is planned to be completed around June 2013 (see Figure 4 below).

- **Work towards spent fuel removal at Unit 3**
  The platform installation was completed (March 13) and debris removal from the upper part of the Reactor Building is ongoing. As the area surrounding the pool has been cleaned up, protection (lid to cover the pool) is being installed over the pool. After the protection installation is completed in May, the debris in the upper part of the operation floor will be removed.

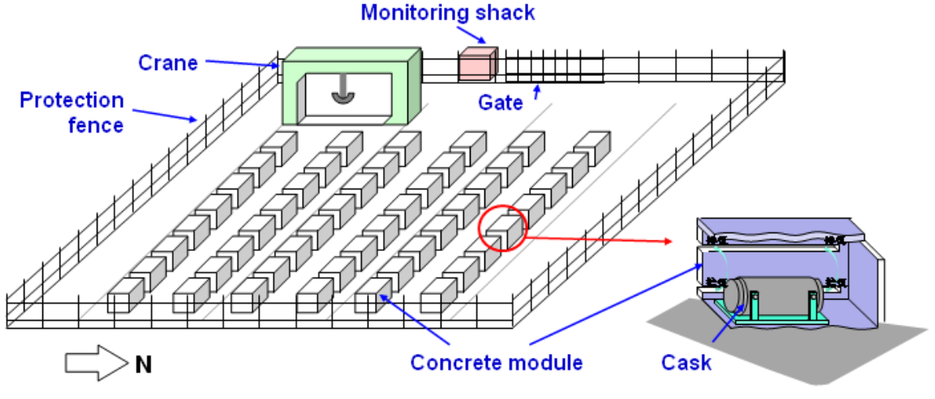
- **Temporary dry cask storage facility in operation**
  A dry storage cask which had been inspected in the Common Pool Building at Fukushima Daiichi Nuclear Power Station was transported to the temporary dry cask storage facility (April 4). The temporary dry cask storage facility has been put in operation on April 12 (See 5 below).



Simulated image of completed steel frame

Progress of steel frame construction (Photo taken on April 23)

4. Cover installation for fuel removal at Unit 4



5. Temporary dry cask storage facility

5. Fuel debris removal

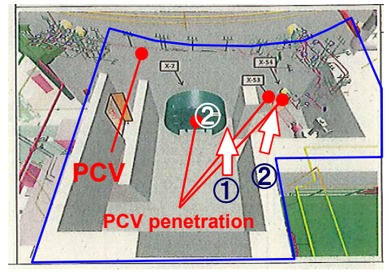
In addition to decontamination and shield installation being carried out for improved accessibility to the PCV, technology development and data acquisition necessary to prepare for fuel debris removal (such as investigating and repairing the leakage location of the PCV) are being advanced

- **Investigation of Unit 2 Torus Room**
  Towards the development of the leakage location detection equipment, etc., the investigation of the Torus Room in the Reactor Building basement (radiation dose, temperature, accumulated water level and images acquired) is being performed. As for Unit 2, hole drilling was performed (March 24 and 25) and the investigation of the Torus Room was performed (April 11-12). As a result, the accumulated water level was OP approx. 3,260mm (Depth: approx. 5.3m), the water temperature was approx. 25℃, the radiation dose was 134mSv/h (max.) and no major damage was found with the structures. Sampling of the accumulated water and sediments was performed to analyze the radioactivity densities of all α, all β, Sr-89, 90 etc. (in late May) and γ nuclides contained in the sediments (in late June). As for Unit 3, the investigation will be performed after decontamination, etc. since the radiation dose inside the building is too high.

- **Investigation and repair of the leakage location of the PCV**
  For the purpose of obtaining useful inputs for the investigation of the PCV and repair method, the access routes to the PCV are being investigated utilizing a robot. As for Unit 1, the personnel access lock (entrance to the PCV) on the first floor of the Reactor Building was investigated (April 9) (See 6 below). As for Unit 2, the MSIV Room (reactor main steam isolation valve room) in the Reactor Building was investigated (April 16).

- **Investigation of the inside of Unit 2 PCV**
  Though investigation equipment was inserted from the PCV penetration (X-53) to investigate the inside of Unit 2 PCV, the equipment was unable to reach onto the control rod drive (CRD) replacement rail. As the guide pipe got stuck (March 19), work to remove the guide pipe is being performed (from April 24).

- **Announcement of technical investigation results towards the expansion of the technical catalog**
  For the purpose of contributing to research and development towards the decommissioning measures, etc. implemented at TEPCO Fukushima Daiichi Nuclear Power Station, the operation to expand the “Technical catalog for the development of equipment to prepare for fuel debris removal” developed in FY 2011 is ongoing. Technical proposals were newly collected from inside and outside of the country (in addition to those investigated in FY 2011) in order to expand element technologies while organizing the element technologies included in the technical catalog. The investigation results are to be announced in the Ministry of Economy, Trade and Industry website.



Appearance of the personnel access lock


Investigation results ①


Investigation results ②

6. Investigation of the personnel access lock room in Unit 1 Reactor Building

6. Reactor facilities dismantling and radioactive waste processing / disposal

Installation of radioactive waste storage facility with high shielding capability and adequate and safe storage of radioactive waste

- **Dose reduction measures for debris and felled trees**
  Debris and felled trees are being covered by soil in order to reduce radiation dose attributable to the radioactive materials released from the radioactive waste generated after the accident. For the first and the second soil-covered type temporary debris storage facilities, soil cover installation has been completed (March 25). As for the temporary storage facility for felled trees, the installation of the soil cover has been completed on March 29. (See 7 below)

- **Processing/disposal of the secondary waste generated from contaminated water treatment**
  - By performing nuclide analysis on the samples collected before and after water treatment, the radioactivity density of the secondary waste generated from the water treatment process is evaluated. The analysis has been completed for about 30 nuclides contained in 9 out of 12 samples. Part of the analysis results (including provisional results) of cesium, etc. contained in 3 samples has been obtained. The entire analysis results of all nuclides contained in these 3 samples will be available at the end of June.
  - The property of secondary waste was investigated and a corrosion test was performed on the storage container materials, etc. for the purpose of providing inputs for long-term storage of secondary waste generated from water treatment.


1st soil-covered type temporary debris storage facility (Photo taken on March 27)


2nd soil-covered type temporary debris storage facility (Photo taken on March 25)


Temporary storage area G for felled trees (Photo taken on April 2)

7. Dose reduction measures for debris and felled trees

7. Staffing plan and work safety securement

Secure long-term staffing while thoroughly implementing workers' exposure radiation control. Continuously improve working environment and work conditions based on the understanding of needs among workers at site

➢ **Staff management**

- The number of cooperative company/TEPCO workers who are registered is approx. 8,600 (monthly average for December 2012-February 2013). The number of workers who actually engaged in work was approx. 5,900 (average). Thus, there are a sufficient number of registered workers.
- The estimated number of workers (TEPCO/cooperative companies) who will engage in work at Fukushima Daiichi Nuclear Power Station in May is approx. 1,900 per day (approx. 1,700 workers will engage in work related to Units 1-4). Thus, there will be a sufficient number of workers available for restoration work.
- The local employment rate of cooperative company workers was approx. 50% as of February The rate has decreased as a result of extending the target population from 9 main contractors to all companies.

➢ **Measures for ensuring appropriate work conditions**

- For 26 out of 31 main contractors registered in the disaster restoration safety promotion association for Fukushima Daiichi Nuclear Power Station and currently engaged in the restoration work at Fukushima Daiichi Nuclear Power Station, a survey on the measures implemented by main contractors for ensuring appropriate working environment (identifying the employers of the workers and the subcontract structure, clarification of working conditions, etc.) was performed (Survey period: December to March).
- 2 or more workers were randomly selected for each subcontractor (total: 58) for the survey. As a result, it was confirmed that the employer, subcontract structure, working conditions, etc. are clarified for the workers selected.
- Since the method to confirm the employer and working conditions varies by company, more effective measures (confirmation of documents related to employment insurance and the Notice of Employment) will be shared and implemented among the contractors.
- In order to achieve employment contract conclusion with workers' understanding and consent, the revision of the current contract provisions is being considered (to be summarized by the end of May).
- The survey will be performed on a regular basis for the purpose of continuously monitoring improvements in working conditions.

➢ **Expansion of areas not requiring full-face mask**

The area not requiring full face mask is being expended while implementing adequate radiation control measures for the purpose of reducing burden on workers and improving workability. The multi-nuclide removal equipment construction area (April 8), the temporary cask storage facility construction area (April 8) and a part of the Cooperative Company Building within the power station site (April 15) have been designated as the area not requiring full face mask. The parking areas inside and outside the power station site and the incinerator facility construction area are planned to be designated as the area not requiring full-face mask according to the progress of construction after tree trimming and surface soil removal (in late April and late May, respectively).

➢ **Measures to improve working environment**

A survey on the overall working environment was performed for workers (Survey period: February-March). Responses from 3,198 workers (collection rate: 80.9%) were collected and the results are currently being summarized. The survey results will be announced in May and necessary countermeasures will be implemented.

8. Others

➢ **IAEA peer review mission**

The IAEA peer review mission was invited (from April 15 to 22, 2013) to evaluate the overall plan of the mid-and-long-term roadmap and individual challenges as well as to provide advice. The finalized report will be submitted in a month and will be incorporated into the revised mid-and-long-term roadmap.

➢ **Measures towards reliability improvement at Fukushima Daiichi Nuclear Power Station**

- At TEPCO, measures such as replacing temporary facilities to permanent facilities and improving facility reliability to withstand long-term usage are being implemented based on the "Implementation plan of reliability improvement measures" for the purpose of ensuring long term safety at power stations.
- Furthermore, in response to the recent power supply failure and the contaminated water leakage, the "Emergency Response Headquarters for Reliability Improvement at Fukushima Daiichi Nuclear Power Station" led by our President Naomi Hirose as the Head was established on April 7, 2013. The Headquarters is comprised of 6 specialized teams (Electrical equipment countermeasure team, mechanical equipment countermeasure team, contaminated water countermeasure team, etc.) responsible for determining and implementing necessary reliability improvement measures (for facilities/equipment and operational management) in times of emergency. Necessary measures are being implemented while the design documents are reviewed and site inspection is carried out. Measures implemented are planned to be announced in detail by the end of May.