December 26, 2013
Secretariat of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment

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

Progress status

◆ The temperatures of the Reactor Pressure Vessel (RPV) bottom and the Primary Containment Vessel (PCV) gas phase of Units 1-3 have been maintained within the range of approx. 20 to 40°C*1 for the past month. There was no significant change in the density of radioactive materials newly released from Reactor Buildings in the air*2. Based on the above, it was judged that the comprehensive cold shutdown condition had been maintained.

*1 The values vary somewhat depending on the unit and location of the thermometer.
*2 The radiation exposure dose due to the current release of radioactive materials from the Reactor Buildings peaked at 0.03 mSv/year at the site boundaries. This is approx. 1/70 of the annual radiation dose by natural radiation (annual average in Japan: approx. 2.1 mSv/year).

◆ Fuel removal from the Unit 4 spent fuel pool commenced on November 18. As of December 24, 110 spent fuel rods and 22 non-irradiated fuel rods had been transferred to the common pool.

Start of removing rubble from the Unit 3 spent fuel pool (SFP)

Toward the removal of spent fuel from Unit 3, the removal of large rubble from the SFP got underway (December 17).

Taking appropriate measures such as preventing rubble dropping during the transfer, the removal work is being conducted prioritizing safety above all.

After the removal of large rubble, a fuel-removal cover will be installed and small rubble will be removed from the SFP. Fuel removal is scheduled to commence when these works are completed.

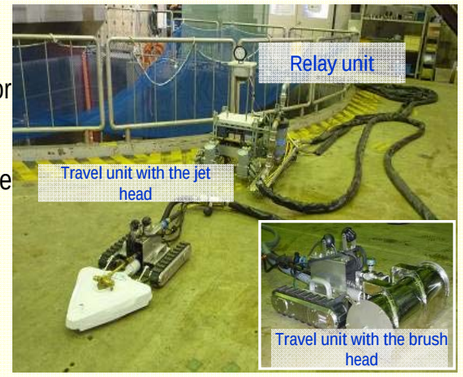
<Status of rubble removal from SFP>

The effect of decontamination on the 1st floor surface of Unit 2 Reactor Building was verified

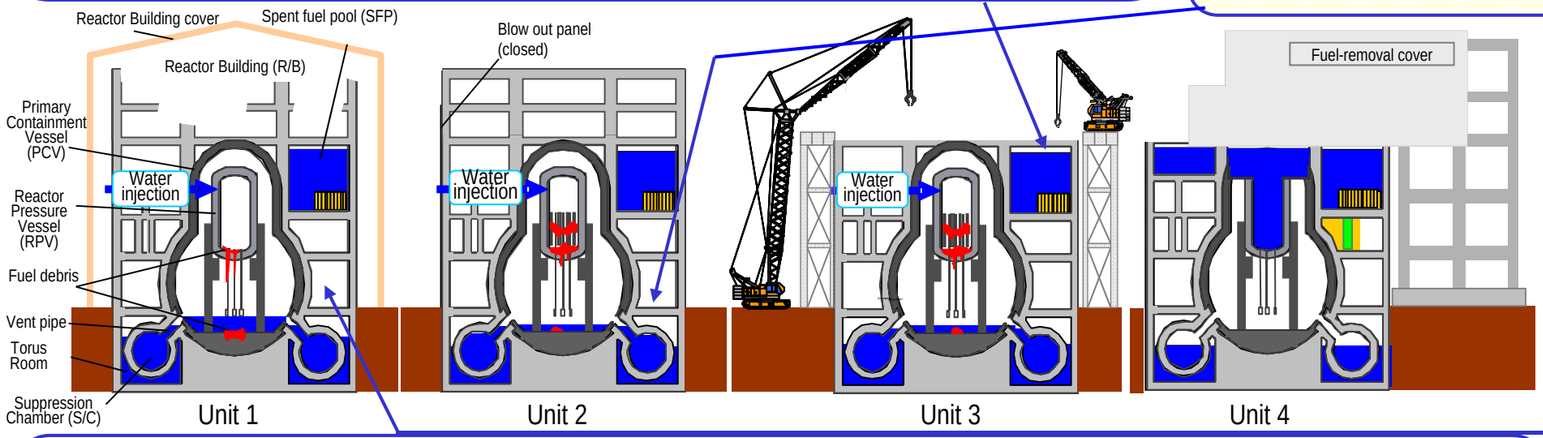
To prevent workers and equipment from being contaminated during the work inside the Reactor Building, decontamination is conducted.

After verifying the effect, decontamination will be conducted twice for all areas.

While both brush and jet heads were confirmed as effective, the brush head was considered superior and its use will hence be prioritized over the jet head.



<Remote control decontamination robot: Raccoon>



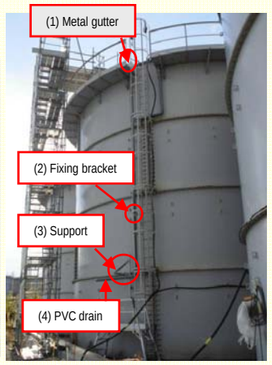
Progress of measures in tank areas

To reduce the risks of rainwater overflowing from fences around the tanks, steel plates are being added to increase the height of the existing concrete fences by approx. 30 cm (to be completed on December 28). A further increase will be made using concrete by around March 2014.

An investigation is also being conducted to check for any leak of rainwater from the fences. The inside surface of the fences is being painted with urethane resin to enhance their waterproofing.

To prevent the inflow of rainwater, which falls onto the tops of tanks, inside the fences where it may cause contamination, gutters are being installed in December in areas where significant contamination within the fences was previously detected.

<Status of height increase using steel plates>



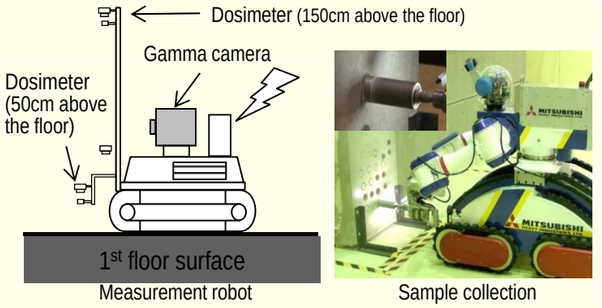
<Status of gutter installation>

Contamination status survey on Unit 1 Reactor Building 1st floor

Toward the implementation of the radiation dose reduction plan and decontamination of the Reactor Building, a radiation-source survey using a gamma camera* is underway on the south side of the Unit 1 Reactor Building 1st floor.

In the next stage, to check for any infiltration of contamination, the floor surface will be excavated to collect samples .

* Gamma camera:
Equipment that measures radiation (gamma rays) from a specified direction and the distance to the subject surface, and through analysis, visualizes surface radioactivity levels.

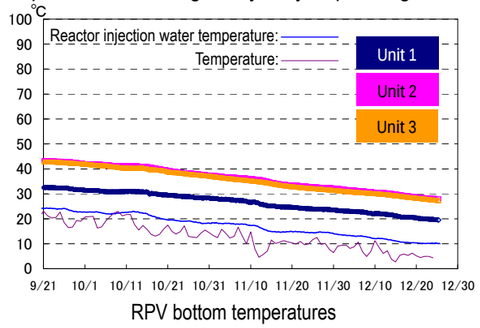


<Image of survey equipment>

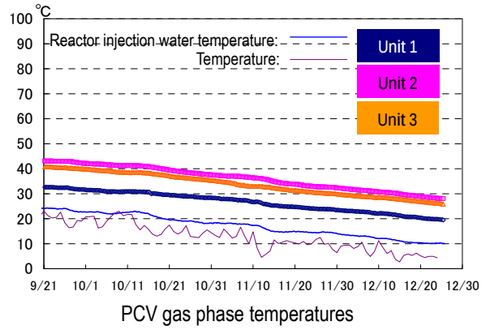
I. Confirmation of the reactor conditions

1. Temperatures inside the reactors

Through continuous reactor cooling by water injection, the temperatures of the Reactor Pressure Vessel (RPV) bottom and the Primary Containment Vessel (PCV) gas phase have been maintained within the range of approx. 20 to 40℃ for the past month, though they vary depending on the unit and location of the thermometer.



RPV bottom temperatures



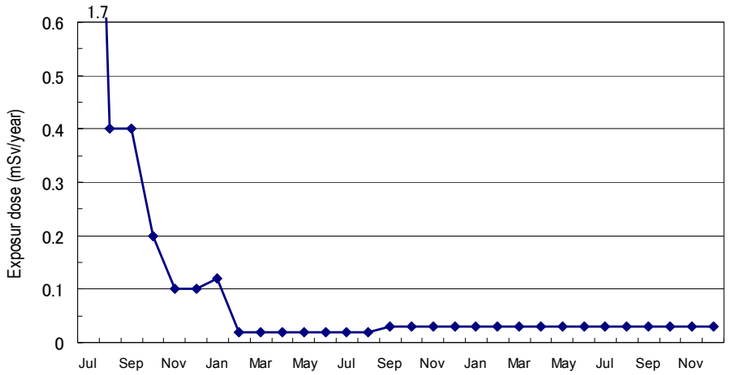
PCV gas phase temperatures

* The trend graphs show part of the temperature data measured at multiple points.

2. Release of radioactive materials from the Reactor Buildings

The density of radioactive materials newly released from Reactor Building Units 1-4 in the air measured on-site boundaries was evaluated at approx. 1.3×10^{-9} Bq/cm^3 for both Cs-134 and -137. The radiation exposure dose due to the release of radioactive materials was 0.03 mSv/year (equivalent to approx. 1/70 of the annual radiation dose by natural radiation (annual average in Japan: approx. 2.1 mSv/year)) at the site boundaries.

Annual radiation dose at site boundaries by radioactive materials (cesium) released from Reactor Building Units 1-4



(Reference)

* The density limit of radioactive materials in the air outside the surrounding monitoring area:

[Cs-134] : 2×10^{-5} Bq/cm^3

[Cs-137] : 3×10^{-5} Bq/cm^3

* Dust density around the site boundaries of Fukushima Daiichi Nuclear Power Station (actual measured 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)

(Note) Different formulas and coefficients had been used to evaluate the radiation dose in the facility operation plan and monthly report. The evaluation methods were integrated in September 2012. As the fuel removal from the spent fuel pool (SFP) commenced for Unit 4, the radiation exposure dose from the Unit 4 has been added to the items subject to evaluation since November 2013.

3. Other indices

There was no significant change in indices, including the pressure in the PCV and the PCV radioactivity density (Xe-135) for monitoring criticality, nor was any abnormality of cold shutdown condition or sign of criticality detected.
Based on the above, it was confirmed that the comprehensive cold shutdown condition had been maintained and the reactors remained in a stabilized condition.

II. Progress status by each plan

1. Reactor cooling plan

The cold shutdown condition will be maintained by cooling the reactor by water injection and measures to complement status monitoring will continue to be implemented

➢ Nitrogen injection into the Unit 2 Suppression Chamber (S/C)

- To check for the presence of residual hydrogen in the upper part of the Suppression Chamber (S/C), a second nitrogen injection test was performed (from October 16 to November 11), which evaluated that there was no hydrogen concentration within the S/C (no further nitrogen injection into S/C will be conducted in future).

2. Accumulated water treatment plan

To deal with the increase of accumulated water due to groundwater inflow, fundamental measures to prevent groundwater from flowing into the Reactor Buildings will be implemented while improving the decontamination capability of the water treatment facilities and preparing facilities to control contaminated water

➢ Preventing groundwater from flowing into the Reactor Buildings

- At the groundwater bypass pumping well Nos. 5 to 12, gross β and H-3 densities are continuously measured. No major variation was detected.
- Toward the installation of frozen soil impermeable walls around Reactor Building Units 1 to 4, on-site surveys, measurements and preparation works have been conducted by “FY 2013 Project Contaminated Water Issue (Large-scale Demonstration Project of Land-side Impermeable Walls Utilizing Frozen Soil Method)” (Agency for Natural Resources and Energy) since November 27.
- Toward the operation to commence the sub-drain facility at the end of September 2014, drilling in three of 11 new pits was completed as of December 24. At the same time, the analysis of water quality in existing pits scheduled for recovery is underway.

➢ Operation of the multi-nuclide removal equipment

- A hot test using water, which includes radioactive materials, also commenced (System A: from March 30, System B: from June 13, System C: from September 27). To date, approximately 34,000 m^3 has been treated (as of December 24).
- System A has been suspended since November 29 to verify the effectiveness of the measures to prevent recurrence of the corrosion detected in June. Based on the investigative results, the effectiveness was confirmed and the treatment resumed on December 19. The next scheduled system suspension will be late January to inspect the power panel.
- System B was temporarily suspended due to modification of all control systems (to enhance operability) on December 11, and resumed on December 13. The next suspension is planned in late January to verify the effectiveness of anti-corrosion measures.
- As for System C, hydrochloric acid seeping from the outlet flange of the hydrochloric acid feeding pump was detected on December 1. The system was shifted to circulating standby operation, and then to treatment operation after replacing the feeding pump on December 6. The system was temporarily suspended due to modification of all control systems (to increase operability) on December 10, and resumed on December 13.

➢ Impact caused by water leakage at H4 Area tanks

- Responding to the increase in gross β density at the observation hole E-1 near the tanks, the contaminated soil around E-1 and test water pumped from the well points installed around E-1 was removed to confirm a decrease in both total β and tritium density. As a result of intermittent operation since December 10, it was confirmed that the gross β density remains low (approx. 10,000 to 20,000 Bq/L) and the tritium density had decreased (from approx. 400,000 to approx. 10,000 Bq/L). (See Figure 1)
- Intermittent operation will continue while checking the density.

➢ Rainwater control at Tank Area

- To prevent the overflow of rainwater from the Tank Area, steel plates are being added to increase the height of existing concrete fences by 30 cm (scheduled for completion on December 28). The inner surface of the fences are being painted by urethane resin to increase their waterproofing.
- Gutters are being installed on the top plate of tanks in places where significant contamination was detected inside the fences previously (scheduled for completion on December 27).
- Rainwater leaks from the fences were detected at H5 and G6 Tank Areas (December 21 and 22). In addition, declining water levels inside the fences at H4 and H4 East Tank Areas (December 24), and leaking rainwater from the fences at H4 Tank Area (December 25) was also detected. In each of these cases, rainwater inside the fences was promptly pumped up, while joints regarded as prone to leakage were waterproofed. In addition to the waterproofing applied at similar points as an emergency measure (to be continued until December 27), urethane is being applied by painting onto the concrete foundation according to the plan. (Scheduled for completion in early February) (See Figure 2)

➢ Treatment and removal of contaminated water from Main Trenches

As for the Main Trench Units 2 and 3, treatment of contaminated water using the second absorption tower commenced on December 17. Toward contaminated water removal from April 2014, drilling of camera observation holes commenced on December 24 and drilling of holes for frozen ducts will commence in January.

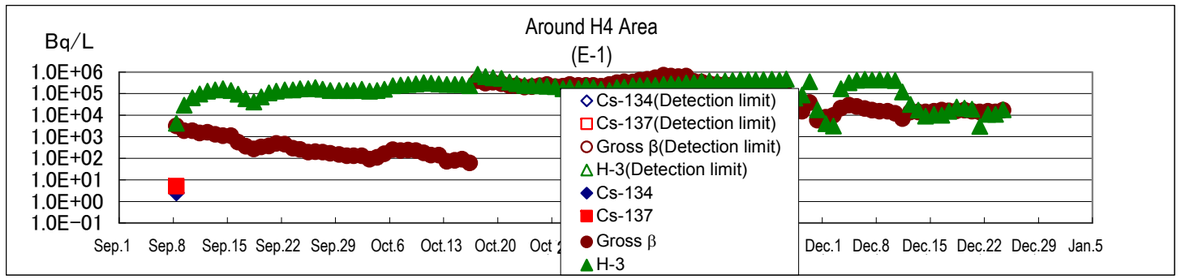


Figure 1: Radioactive material density of Observation Hole E-1

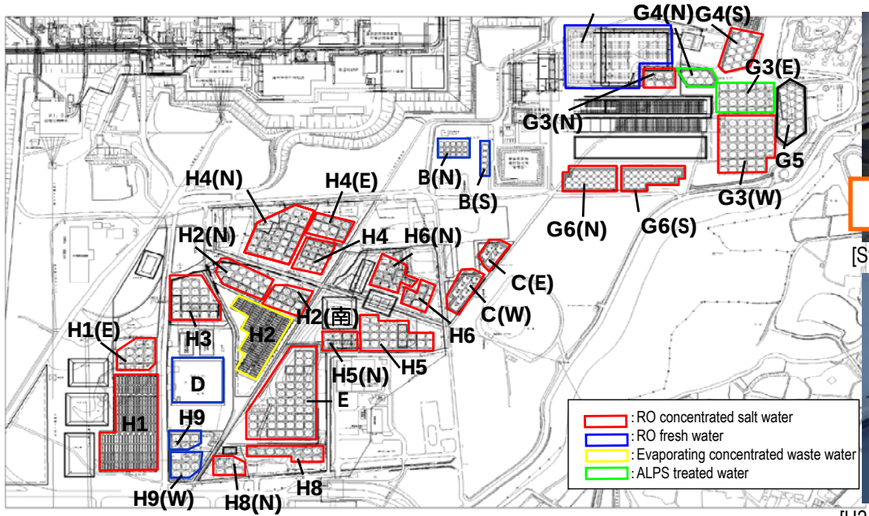


Figure 2: Countermeasures to rainwater at Tank Areas

[Status of repair inside H5 Tank Area fences]

[H2 South Tank Area after urethane painting]

3. Plan to reduce radiation dose and mitigate contamination

Effective dose-reduction at site boundaries (reduced 1 mSv/year by the end of FY 2012) and purification of the water in the port to mitigate the impact of radiation on the outside environment

➢ Status of groundwater and seawater on the east side of Units 1 to 4 Turbine Buildings

- Regarding the groundwater near the bank on the north side of the Unit 1 intake, the latest overall radioactive material density of tritium is below the detection limit at 10^5 Bq/L, while that of gross β is also below the detection limit at 10^2 Bq/L. Additional observation holes have been installed to determine the origin of the detected tritium. Though 1 to 2 m^3/day of water has been pumped up from Observation Hole No. 0-3-2 in the lower layer where significant tritium was detected, no decrease was confirmed (from December 11-13, and from December 16, now underway). Pumping is continued near the bank where significant density was detected.
- Regarding the groundwater near the bank between the Unit 1 and 2 intakes, the latest overall radioactive material density of tritium is 10^2 to 10^5 Bq/L while that of gross β is below the detection limit at 10^6 Bq/L. Though 1 to 2 m^3/day of water has been pumped up from Observation Hole No. 1-16 (December 13 and 16) where the gross β radioactive material density is being increased, the pumping was suspended due to insufficient groundwater volume. Another collection well is scheduled to be installed.
- Ground improvement on the seaside near the bank between Units 2 and 3 intakes has been completed (December 12). Regarding the groundwater, the latest overall radioactive material density of tritium is 10^3 Bq/L, while that of gross β is 10^1 to 10^4 Bq/L. As the gross β radioactive material density is being increased at the groundwater Observation Hole No. 2-6 (10^4 to 10^5 Bq/L), pumping was conducted (2 m^3/day (from December 4-8) and 5 m^3/day (from December 10-12)) on the north side of the well points where significant radioactive material density was detected, and the pumped-up water was transferred to the Turbine Building Unit 2. However, with the gross β density remaining high, pumping of 2 m^3/day was continued.
- Regarding the groundwater near the bank between Units 3 and 4 intakes, the latest overall radioactive material density of tritium is below the detection limit at 10^3 Bq/L and that of gross β is also below the detection limit at 10^1 Bq/L, and no change was detected.
- Within the port, no significant change in the radioactive material density of seawater was detected in recent data for the past month, nor any significant increase in offshore measurement results, as was the case a month ago.

➢ Status of drainage within the site

- Responding to the radioactive materials detected in Drainages B and C, measurements were conducted on the upper side of Drainages B and C and Shallow Draft Quay Drainages A and K. As a relatively high degree of radioactive materials were detected in some places, the Drainages are being cleaned to remove radioactive materials.

4. Plan to remove fuel from the spent fuel pools

Work toward removing spent fuel from the pool is steadily progressing while ensuring seismic capacity and safety. The removal of spent fuel from the Unit 4 pool commenced on November 18, 2013 and efforts are being made to complete the removal by around the end of 2014.

➢ Fuel removal from the Unit 4 spent fuel pool

- Removal of fuel from the spent fuel pool (SFP) commenced on November 18.
- As of December 24, 110 spent fuel assemblies and 22 non-irradiated fuel assemblies had been transferred to the common pool.
- To examine the treatment of the fuel assembly (one assembly), the handle/channel boxes of which had been deformed by mistake in 1982, within the on-site transportation container, the degree of deformation will be checked (December 26 and 27).

➢ Confirmation of health regarding Reactor Building Unit 4

- The seventh regular inspection was conducted (from November 26 to December 18), to confirm that both the Reactor Building and the SFP were in a healthy condition.

➢ Main works toward removing spent fuel at Unit 3

- The removal of rubble from the SFP commenced on December 17. By early February 2014, removal of reinforcing steels and deck plates will be completed. The next step will involve scheduled removal of masts, roof torus and fuel-handling machines.
- As for the drop of water camera (November 28) during the preparation for the removal of rubble within the pool, the cause was investigated and recurrence prevention measures (addition of an alarm function, etc.) were implemented (completed on December 10).
- Before installing a fuel-removal cover, the frame of the Reactor Building is currently being investigated (from December 19 to late January) following the removal of rubble from the operating floor. If any new damage is detected by this investigation, additional assessment will be conducted.

➢ Investigation on the frame of Reactor Building Unit 1 (around the equipment hatch)

- To reflect the investigative results in the seismic safety assessment and examine the method to remove fuels, videos were taken of the Reactor Building frame around the equipment hatch using a remote-controlled camera, to confirm no serious damage was detected on the walls of each floor (December 4 and 5). (See Figure 3)

Figure 3: Unit 1, on the west-side walls facing the equipment hatch (center part) (from left, 4th, 3rd and 2nd floors)

5. Fuel debris removal plan

In addition to decontamination and shield installation to improve accessibility to the PCV, development of technology and gathering of data necessary to prepare for removing fuel debris (such as investigating and repairing PCV leak locations) are conducted

➢ 3D laser scanning at Units 1 and 2 Reactor Buildings

- To utilize in the interference assessment and plans for decontamination and shield installation required for works inside Units 1 and 2 Reactor Buildings, 3D laser scanning was conducted using remote-controlled self-propelled equipment with measurement equipment mounted to collect 3D data within the Reactor Buildings. (Unit 1 Reactor Building 1st floor: from December 16 to mid-January, Unit 2 Reactor Building 1st floor: from December 9 to late January, Unit 2 Torus Room: from early to late January)

➢ Decontamination and shield installation of Units 1 to 3 Reactor Buildings 1st floors

- To prevent the contamination of workers and equipment during the work inside the Reactor Building, decontamination is underway in Unit 2 Reactor Building 1st floor (from November 28). Based on results to verify the decontamination effect, decontamination is planned to be conducted twice for all areas. While both brush and jet heads were confirmed as effective, the use of the brush head, which was confirmed as slightly more effective, will be prioritized over the jet head, while the latter will be used depending on circumstances.

➢ Contamination status survey on Units 1 to 3 Reactor Buildings 1st floors

- Toward the future implementation of a radiation dose-reduction plan and decontamination, a radiation source survey using a gamma (γ) camera is underway on the south side of Unit 1 Reactor Building 1st floor (December 22-24).

➢ Request for Information (RFI) on alternative fuel debris removal methods

- To widely collect information concerning the design of alternative methods and related technology required, an "RFI on alternative fuel debris removal methods" has been posted at the International Research Institute for Nuclear Decommissioning (IRID). Based on information received by January 31, items and specifications of the Request for Proposal (RFP) will be examined.

6. Plan to store, process and dispose of solid waste and decommission reactor facilities

Promoting efforts to reduce and appropriately store waste generated and R&D toward adequate and safe storage, processing and disposal of radioactive waste

➢ Management status of rubble and trimmed trees

- As of the end of November, the total storage volume of concrete and metal rubble was approx. 71,000 m^3 (area occupation rate: 77%). The total storage volume of trimmed trees was approx. 71,000 m^3 (area occupation rate: 56%).

➢ Management status of secondary waste from water treatment

- As of December 24, the total storage volume of waste sludge was 597 m^3 (area occupation rate: 85%). The total storage number of spent vessels was 708 (area occupation rate: 28%).

➢ Mid-and-Long-Term Waste Analysis Plan

- Toward the "Formulation of a basic concept concerning the treatment and disposal of solid waste (by the end of fiscal 2017)," analysis of 50 samples per year is planned where the detection limits will be decreased to conduct detailed analysis.

7. Plan for staffing and ensuring work safety

Securing appropriate staff for the long-term while thoroughly implementing workers' exposure dose control. Improving the work environment and labor conditions continuously based on an understanding of workers' on-site needs.

➢ Staff management

- The monthly average number of people registered for at least one day per month to work on-site during the past 3 months from August to October, 2013 was approx. 8,400 (TEPCO and partner company workers), which exceeds the monthly average number of workers there (approx. 6,200). Accordingly, sufficient people are registered to work on-site.
- It was confirmed that the estimated manpower necessary for the work in January (approx. 3,510 per day: TEPCO and partner company workers)* would be secured. The average numbers of workers per day in each month this fiscal year (actual value) are as shown in the figure below, with approx. 3,000 to 3,500 per month. (See Figure 4)

* Workers with whom contract procedures have not yet been completed are excluded from the total for each month.

- As of November, the local employment ratio (TEPCO and partner company workers) was approx. 50%.

➢ Efforts to improve the labor environment

- A survey on the overall labor environment was conducted for workers (from October 9 to November 12), to which 3,304 workers responded (collection rate: 84.3%). Major opinions include "concern about decreased work performance due to full-face masks" and "requests to improve the dietary environment." This feedback will be addressed by "specifying the zones around the Tank Areas as areas where full-face masks are not required (as of the end of fiscal 2015)" and "establishing a meal-service center (as of the end of fiscal 2014)," respectively.

➢ Outbreak status of influenza and norovirus

- As of December 20, 1 person was infected with influenza and 9 persons, with norovirus during this fiscal year. Thorough infection-control measures will be continued. (Accumulated totals are 204 for influenza and 37 for norovirus patients)

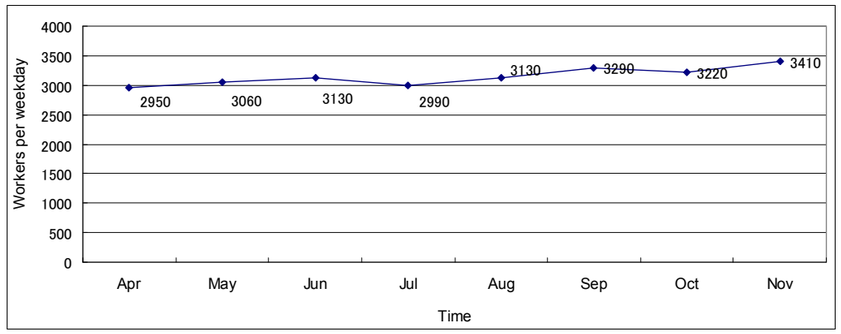


Figure 4: Changes in average number of workers per day for each month in fiscal 2013 (actual values)

8. Others

➢ Emergency safety measures of Fukushima Daiichi Nuclear Power Station

- Regarding the "Emergency safety measures of Fukushima Daiichi Nuclear Power Station" announced on November 8, the progress was published, including the on-site decontamination plan and the examination status toward exposure dose-reduction during fuel removal at Unit 4 (December 11).
- Regarding the comprehensive measures in both terms of hardware and software to enhance on-site motivation (e.g. establishing a provisional administrative office building (from June 2014) and a large rest house (from December 2014), these will be promptly implemented in order of priority.

➢ Workshop concerning the R&D plan and basic research toward decommissioning

- Based on the mid- to long-term roadmap, regarding the workshop (co-organized by the Ministry of Education, Culture, Sports, Science and Technology and IRID), aiming to identify and create the basic research expected to be conducted by universities and research institutes, the 6th Kansai and West Japan Region meeting (2) (December 20) was held in Kobe and the 7th Chubu and Hokuriku Region meeting (December 25), in Fukui Prefecture. The 8th meeting (Nagoya, January 8) and 9th Kanto Region meeting (3) (January 22) are scheduled (a total of 9 meetings).

➢ IAEA review mission on work toward the decommissioning

- To review efforts toward the decommissioning of the Fukushima Daiichi Nuclear Power Station, the second mission of the International Atomic Energy Agency (IAEA) visited Japan (from November 25 to December 4). Compared to the previous mission in April, the review mission evaluated that the Government of Japan and TEPCO had increasingly adopted a more proactive attitude and approach toward addressing the many difficulties in the site.

➢ Additional preventive and multi-layered measures concerning contaminated water and decommissioning issues

- In line with the basic policy decided in September this year, it was decided to formulate additional preventive and redundant measures within this year. Also, with technological proposals (780 ideas) submitted from across Japan and abroad in mind, a report was prepared by the Committee on countermeasures for contaminated water treatment (December 10), which was discussed at the Team Meeting for Contaminated Water and Decommissioning Issue (December 18) and approved at the Nuclear Emergency Response Headquarters (December 20). Risks regarding the contaminated water were identified, and for each of the measures to "remove" contaminated water, "isolate" water from contamination sources, and "prevent leakage" of contaminated water, the additional measures and technology to be implemented were selected. With financial measures by the government also taken into consideration for technologically difficult items, the report provided an overview of the measures.