March 27, 2014

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)

**Small-scale freezing test for frozen impermeable walls began**

A feasibility study has been conducted toward the installation of frozen impermeable walls surrounding Units 1 to 4.

Small-scale freezing test has been in operation since March 14 following the installation of frozen ducts at the test site for impermeable walls.

**Rubble removal operation accomplished in Unit 4 SFP**

Rubble removal from the Unit 4 spent fuel pool (SFP), which has been operated in parallel with spent fuel removal, has been accomplished.

(Large rubble: accomplished on October 2, 2013, small rubble: accomplished on March 8, 2014)

Efforts are sustained toward completion of fuel removal by the end of 2014.

**Demonstration of decontamination equipment at Unit 1**

Demonstration test of the remote-control decontamination equipment was conducted on the 1st floor of the Unit 1 reactor building from January 30 to February 4. The equipment was developed for the fuel debris removal work in future with the subsidy project of the Ministry of Economy, Trade and Industry.

The result showed that the β ray dose rate was reduced by removing dust through vacuuming and the coated surface could be ground by the blast decontamination*.

* Blast decontamination: A method to grind the surface by injecting polygonal steel grains onto the object to be decontaminated (floor surface)

**Increased radioactivity density of outlet water of multi-nuclide removal equipment System B**

On March 18, as the radioactivity density of outlet water increased at multi-nuclide removal equipment System B (gross β: approx. 10^7Bq/L), all Systems were suspended.

It was estimated that the strontium which had traversed the filter remained in the absorption vessel and reached the outlet over an extended period.

From March 24, treatment to clean the transfer pipes was resumed using the healthy Systems A and C.*

* To check for any leak from the manhole on the side of the destination tank, water was filled under monitoring. As water drops were detected by this check, System B was shifted to standby operation. On March 25, the System was resumed after replacing the packing at the relevant part.

* On March 27, as white turbidity was detected in the inlet water of the System A absorption vessel, the system was shifted to standby operation and investigation of the cause is underway.
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. 15 to 35°C for the past month, though they vary depending on the unit and location of the thermometer.

To deal with the increase in accumulated water due to groundwater inflow, fundamental measures to prevent groundwater from the past month, though they vary depending on the unit and location of the thermometer.

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Temperatures of a RPV bottom and a PCV gas phase have been maintained within the range of approx. 15 to 35°C. Following the installation of filters (from March 6-13), the operation was resumed. On March 18, as the radioactive material density in the outlet water increased at multi-nuclide removal equipment (System B (gaps β: approx. 107 Bq/L) all systems were suspended. The estimated cause was that the carbonates, including a high level of strontium which had traversed the filter due to a defect in the same, remained in the absorption vessel and, over an extended period, reached the outlet.

Though System C was suspended in response to the increase in radioactive material density in System B outlet water (from March 18-24), the treatment resumed from March 24.

From March 24, treatment operation of Systems A and C was resumed to clean transfer pipes contaminated by high-density water at System B outlet. To check for any leak from the manhole on the side of the sample tank storing outlet water, water was filled under monitoring. As water drops were detected from the relevant part, System B was shifted to standby operation. On March 25, the System was resumed after replacing the flange packing at the manhole.

Operation of the multi-nuclide removal equipment

Hot tests using radioactive water are in operation (System A: from March 30, 2013, System B: from June 13, 2013, System C: from September 27, 2013). To date, approx. 67,000 m³ has been treated (as of March 25, including approx. 8,000 m³ at System B outlet, in which the radioactive material density is high).

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.

- Replacement of the thermometer at the bottom of Unit 2 RPV
  - As the thermometer installed at the bottom of Unit 2 RPV after the earthquake was broken, it was excluded from the monitoring thermometers (February 19). The temperature of the RPV bottom can be monitored by other thermometers. The broken thermometer will be removed (scheduled in May) and a new one will be installed.

Preventing groundwater inflow to the Reactor Buildings

- At the groundwater bypass pumping well Nos. 5 to 12, gross β and tritium densities are continuously measured. No major variation was detected.

- Toward the installation of the sub-drain facility (by the end of September), drilling in eight of 13 new pits completed as of March 26. For building the sub-drain treatment facility, the base concrete placement was made since February 27 and steel frames were constructed since March 12. Installation of equipment began from March 19.

- Toward the installation of frozen impermeable walls surrounding Units 1 to 4 (a project subsidized by the Ministry of Economy, Trade and Industry), a feasibility study was conducted on site. The freezing test began at the small-scale freezing test site for frozen impermeable walls (approx. 10 m² area) on March 14.

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. 1.4 x 10⁴ Bq/cm³ 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 trend graphs show part of the temperature data measured at multiple points.

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**Plan to reduce radiation dose and mitigate contamination**

Effective dose reduction at site boundaries 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 densities of cesium and the gross β radioactive materials have been maintained at $10^4$ and $10^6$ Bq/L, respectively. The density of tritium has been decreased since March at Observation Hole Nos. 0-1-2, 0-2 and 0-4, while the density of tritium on the bank is also decreasing. The tritium density in seawater on the North side of Units 1-4 intakes was also decreasing. From Observation Hole No. 0-3-2, pumping of 1 m³/day of water continues.
  - Regarding the groundwater near the bank between the Unit 1 and 2 intakes, both densities of tritium and gross β radioactive materials in water pumped from the well point are high at $10^6$ Bq/L. At the groundwater Observation Hole No. 1-16, the gross β radioactive material density has been maintained at around $10^6$ Bq/L since March 3. At the groundwater Observation Hole Nos. 1-6 and 1-13 near the power supply cable trench, both densities of gross β radioactive materials and cesium 137 are high at $10^6$ Bq/L. Analysis of the boring core identified a high radiation dose near the power supply cable conduit line and in the soil under it (see Figure 3). Water pumping from the well point (approx. 30-40 m³/day) and the pumping well No. 1-16 (P1) (1 m³/day) installed near the Observation Hole No. 1-16 continues.
  - Regarding the groundwater near the bank between Units 2 and 3 intakes, the gross β radioactive material density is high ($10^6$ Bq/L) on the north (Unit 2) side. To check the contamination status on the south side, water sampling from the new groundwater Observation Hole No. 2-8 installed on the southeast side began (from February 26) and it was confirmed that the density was at the same level as at the groundwater Observation Hole No. 2-6 (gross β: $10^6$ Bq/L, tritium: $10^6$ Bq/L). Water pumping from the north side of the well point continues (4m³/day).
  - Regarding the groundwater near the bank between the Unit 3 and 4 intakes, the density of radioactive materials is maintained at low levels at all Observation Holes.
  - 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.
  - In response to the progress of the construction of impermeable walls on the sea side, placement of concrete in water and landfill are underway inside the impermeable walls from the north side (see Figure 4). In conjunction with these works, removal and installation of silt fences, abolition of sampling points inside the impermeable walls ("North side of Units 1 to 4 intakes" and "Unit 1 intake") and set up of a new sampling point inside the impermeable walls ("South side inside Units 1 to 4 intakes (in front of impermeable walls)") were conducted.

**Figure 1: Image of contaminated water treatment and frozen water stoppage of main trench**

**Figure 2: Groundwater density on the Turbine Building east side**

**Figure 3: Result of boring core analysis on Observation Hole No. 1-6 between Units 1 and 2 intakes**

**Figure 4: Progress status of impermeable walls on the sea side**
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 process by around the end of 2014.

- Fuel removal from the Unit 4 spent fuel pool
  - Fuel removal from the spent fuel pool (SFP) commenced on November 18, 2013.
  - As of the end of work on March 26, 564 of 1331 spent fuel assemblies and 22 of 202 non-irradiated fuel assemblies had been transferred to the common pool.
  - On March 26 during preparatory work to remove fuel from the Unit 4, the failure lamp of the overhead crane in the Reactor Building E100 and the crane failed to work. At present the operation is suspended and the cause investigation is underway.
  - Removal of rubble from inside of the pool, which was conducted in conjunction with fuel removal, completed (from August 27, 2013 to March 8, 2014).
  - To reduce the radiation dose during the fuel removal work, a cover for fuel removal on the north (Unit 3) side and shields for the fuel-handling equipment are being installed (completed on by March 25). The next step will involve scheduled verification of the effects and the additional installation of a shield.

- Check of the health of the Unit 4 Reactor Building
  - To check the health of the Reactor Building and the spent fuel pool, the 8th periodical inspection was conducted with the presence of external experts in the field (from March 11-27).

- Main works toward removing spent fuel at Unit 3
  - The removal of rubble such as steel, deck plates, and roof torus is conducted (from December 17). As of March 25, a total of 322 steel pieces, 55 deck plates and 3 roof torus materials were removed. The next step will involve the scheduled removal of masts and fuel exchangers.
  - Measures to reduce the radiation dose (decontamination and shielding) on the Reactor Building 5th floor (operating floor) are underway (commenced on October 15, 2013). At present, decontamination is underway using self-driving and fixed-type decontamination equipment.

- Structure investigation of Unit 1 Reactor Building (3rd and 4th floors)
  - To reflect the result in the seismic safety assessment prior to designing and selecting the cover and container for fuel removal, the 3rd and 4th floors of the Reactor Building were investigated (February 26). Though damage was detected in some parts, no damage was detected in the major seismic structure (shell walls, pool walls and external walls).

5. Fuel debris removal plan

In addition to decontamination and shield installation to improve accessibility to the PCV, technology was developed and data gathered as required to prepare for removing fuel debris (such as investigating and repairing PCV leak locations).

- Contamination status survey and decontamination of Reactor Building Units 1 to 3
  - On the 1st floor of the Unit 1 Reactor Building, the aspiration demonstration and blast decontamination equipment developed in the subsidy project of the Resource and Energy Agency “Development of remote decontamination technology inside the Reactor Building” was conducted (from January 30 to February 4). Regarding β rays, to which the floor surface, a decontamination target, dominantly contributes, the result showed that the dose rate was reduced nearly to the detection limit by aspiration decontamination. It was also confirmed that through the following blast decontamination, the coated surface was shaved and the dose rate was reduced to the detection limit.
  - To ensure the operation route of the robot for collecting floor and wall concrete core on the Unit 2 Reactor Building 5th floor (operating floor), fences on the operation floor were removed using the remote control robot (March 13 and 14). As the robot fell during the operation and the battery became low, the relevant robot could not be collected. Removal of fences was completed and the core was collected within the accessible range (from March 20-26).

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

- Status of management of rubble and trimmed trees
  - As of the end of February the total storage volume of concrete and metal rubble was approx. 81,100 m³ (+11,200m³ compared to at the end of January) the area occupation rate: 61%). The total storage volume of trimmed trees was approx. 77,600 m³ (+5m³ compared to at the end of January) (area occupation rate: 60%). From February, the rubble storage area was expanded. The increase in metal rubble is mainly attributable to removal of scrapped vehicles to install tanks and construction of a large rest house.

- Status of management of secondary waste from water treatment
  - As of March 25, the total storage volume of waste sludge was 597 m³ (area occupation rate: 85%). The total storage number of spent vessels and storage containers of multi-nuclide removable equipment (HIC) was 844 (area occupation rate: 34%).

- Assessment on long-term storage of secondary waste from water treatment
  - Assessment on long-term storage of spent absorption vessels from the cesium absorption equipment (KURION) and waste sludge from the decontamination equipment (AREVA) was conducted as a project entrusted by the Ministry of Economy, Trade and Industry.
  - Regarding cesium absorption vessels, the result showed that the hydrogen concentration was maintained below the explosion limit (4%) during long-term storage, and the risk of localized corrosion by radiation was reduced if zeolite was placed together.
  - Regarding the temporary waste sludge storage, the result showed that during long-term storage, generation of hydrogen cyanide, a toxic substance, was below the detection limit (< 5ppm), and the risk of leak from penetration due to corrosion was low.

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 quarter from November to January was approx. 9,000 (TEPCO and partner company workers), which exceeds the monthly average number of workers (approx. 6,700). Accordingly, sufficient people are registered to work on site.
  - It was confirmed that the estimated manpower necessary for the work in April (approx. 4,200 per day) to TEPCO and partner company workers’ would be secured. The average numbers of workers per day for each month of this fiscal year (actual value) have been maintained with approx. 3,000 to 4,000 per month since August (See Figure 5) * Workers with whom contract procedures have not yet been completed are excluded from the total for each month.
  - As of February, the local employment ratio (TEPCO and partner company workers) was approx. 50%.

- Efforts to improve the labor environment
  - A temporary rest house (three-story, capacity: approximately 1,000 workers) is currently under construction outside the site (scheduled to begin operation in early April).

- Outbreak status of influenza and norovirus
  - As of March 14, 176 persons were infected with influenza and 30 persons, with norovirus. Thorough infection-control measures will be continued. (Accumulated totals last year were 204 for influenza and 37 for norovirus patients).

8. Others

- Progress status of emergency safety measures of Fukushima Daiichi Nuclear Power Station
  - Based on the findings suggested by the Nuclear Regulatory Commissioner, TEPCO reported to the Commissioner the progress status of the emergency safety measures formulated in November 2013 (March 20). These emergency safety measures will also be promoted strongly at the Fukushima Daiichi Decommissioning Promotion Company which will be launched in April 2014.

- Achievement in FY2013 and plan for FY2014 for R&D
  - For each R&D project, progress and achievements in FY2013 to date and proposed plans for FY2014 were collected, based on which FY2014 projects will be launched accordingly.
## Status of efforts on various plans (Part 1)

### As of March 27, 2014

#### Challenges
- Maintenance and monitoring of the cold shut down condition of nuclear reactor: daily continuous monitoring on the continuation of measurements.
- Water injection and parameters including temperature etc., preservation and improvement of reliability through maintenance and management.

### Reactor cooling plan

<table>
<thead>
<tr>
<th>Phase 1 (no later than 2 years after the completion of the current efforts)</th>
<th>Phase 2 (Early period)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>2013</td>
</tr>
<tr>
<td>Maintenance and monitoring of the cold shut down condition of nuclear reactor: daily continuous monitoring on the continuation of measurements.</td>
<td>Narrowing down of candidate systems for inserting alternative thermometer in Unit 1 RPV*</td>
</tr>
<tr>
<td>Installation of thermometer in Unit 2 RPV (including inspection in nuclear reactor)</td>
<td>Narrowing down of candidate systems for inserting alternative thermometer in Unit 3 RPV</td>
</tr>
<tr>
<td>Partial observation</td>
<td>Remote visual check of the PCV, direct measurement/evaluation of temperature etc.</td>
</tr>
<tr>
<td>Improvement of the reliability of the circulating water injection cooling system (water intake from the turbine building)</td>
<td>Water source: Condenser water storage tank for Units 1 to 3</td>
</tr>
<tr>
<td>Reliability improvement measures for the lines taking water supplies from the condensate water storage tanks of Units 1 to 3</td>
<td>Review on water take from reactor building (or from the bottom of the PCV) - Construction work</td>
</tr>
<tr>
<td>Review on water take from reactor building (or from the bottom of the PCV) - Construction work</td>
<td>Review on the method for inserting alternative thermometer in Unit 3 RPV*</td>
</tr>
<tr>
<td>Water source: Condenser water storage tank for Units 1 to 3</td>
<td>Water source: Condenser water storage tank for Units 1 to 3</td>
</tr>
<tr>
<td>Upgrade of water intake equipment</td>
<td>Upgrade of water intake equipment</td>
</tr>
<tr>
<td>Review on the method for inserting alternative thermometer in Unit 3 RPV*</td>
<td>Construction work</td>
</tr>
<tr>
<td>考虑/准备进行下阶段的去污和屏蔽工作</td>
<td>考虑/准备进行下阶段的去污和屏蔽工作</td>
</tr>
<tr>
<td>Fuel removal</td>
<td>Fuel removal</td>
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</tbody>
</table>

#### Unit 1
-池内冷却系统（维持/改善可靠性，通过维护管理，设施更新等）
-审查 alternate thermometer insertion method in Unit 1 RPV*

#### Unit 2
-考虑/准备进行下阶段的去污和屏蔽工作
-池内冷却系统（维持/改善可靠性，通过维护管理，设施更新等）

#### Unit 3
-备品工作/去污工作
-设计和制造燃料拆卸设备
-设计和制造冷却/燃料处理设备

#### Unit 4
-设计和制造冷却/燃料处理设备
-审查/准备进行下阶段的去污和屏蔽工作

### Change from last month
- Selection of a fuel/debris removing plan
- Selection of a fuel/debris removing plan
- Selection of a fuel/debris removing plan

### Green frame
- Selection of a fuel/debris removing plan
- Selection of a fuel/debris removing plan
- Selection of a fuel/debris removing plan

### Field work/R&D/Review
- Field work
- R&D
- Review

### Main processes
- Sub-main processes

#### As of March 27, 2014

* The time for executing the installation work will be determined after on-site studies etc., on the basis of the status of environmental improvement by means of decontamination and shielding.

* Completed

**Selection of a fuel/debris removing plan**

**Selection of a fuel/debris removing plan**

**Selection of a fuel/debris removing plan**
### Status of efforts on various plans (Part 2)

<table>
<thead>
<tr>
<th>Challenges</th>
<th>Phase 1 (no later than 2 years after the completion of the current efforts)</th>
<th>Phase 2 (Early period)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2012</td>
<td>2013</td>
</tr>
<tr>
<td>Decontamination of the inside of the building</td>
<td>Review on decontamination technology/development of remote decontamination equipment</td>
<td>Development of remote-contamination investigation technologies (1)</td>
</tr>
<tr>
<td>Measures to reduce overall dose</td>
<td>Formulation of a comprehensive plan for exposure reduction</td>
<td>Decontamination, shielding, etc. in the building (Work environment improvement (1))</td>
</tr>
<tr>
<td>Inspection/repair of leaking locations of the PCV</td>
<td>R&amp;D for inspection/repair of leaking locations of the PCV (including stop leakage between buildings)</td>
<td>Development of inspection/repair technologies (including stop leakage between buildings)</td>
</tr>
<tr>
<td>Fuel debris removal</td>
<td>R&amp;D toward the removal of fuel debris (to be continued to address long term challenges including internal R&amp;D of equipment etc.)</td>
<td>Development of fuel debris removal equipment (including on-site demonstration of development results)</td>
</tr>
<tr>
<td>Stable storage, processing/disposal of fuel debris after removal</td>
<td>Research on development of mock-up processing/disposal technologies</td>
<td>Development of mock-up storage processes, review on storage systems/development of safety evaluation technique etc.</td>
</tr>
<tr>
<td>Others</td>
<td>Development of criticality evaluation and detection technologies</td>
<td>TO BE CONTINUED</td>
</tr>
</tbody>
</table>
### Status of efforts on various plans (Part 3)

#### Plan for maintaining and continuing the steady state of plant

- **Objective:** Implement the measures to improve the reliability of the current facilities
  - Improving the reliability of the current facilities, etc. (to improve the reliability of transfer, processing, and storage facilities).
  - Replacement of high/pressure hoses with PE pipes.
  - Treatment of retained water by water treatment facilities with improved reliability.
  - Groundwater bypass installation work.
  - Sub-drain restoration work.
  - Monitoring of ground water and seawater (implemented on an ongoing basis).

#### Plan for preventing the spread of marine pollution

- **Objective:** Reduction of the risk of spreading marine contamination during the leakage of contaminated water
  - Monitoring of ground water and seawater.
  - Seawater circulation purification.
  - Land and marine environmental monitoring.

#### Gas/liquid waste

- **Objective:** Control the radiation dose at the site boundary caused by radioactive substance etc. additionally released from the entire power plant at 1 mSv/year or less.
  - Reducing the radiation dose by the purification of contaminated water etc.
  - Land and marine environmental monitoring.

#### Site decontamination plan

- **Objective:** Systematic implementation of decontamination in the site of power generation plant
  - Decontamination is implemented in stages beginning with the areas where workers frequently enter and exit in parallel with the reduction in off-site radiation dose.
  - The first step (work area: 5 μSv/h in Main roads; 30 to 20 μSv/h in Main roads)

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### Challenges

<table>
<thead>
<tr>
<th>Year</th>
<th>2012</th>
<th>2013</th>
<th>2014</th>
<th>2015</th>
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<tbody>
<tr>
<td><strong>Retained water treatment plan</strong></td>
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<tr>
<td>Retained water treatment</td>
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<tr>
<td>Treatment by means of existing treatment facilities</td>
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<tr>
<td>Improving the reliability of the current facilities, etc. (to improve the reliability of transfer, processing, and storage facilities).</td>
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<tr>
<td>Replacement of high/pressure hoses with PE pipes</td>
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<tr>
<td>Measures to prevent the expansion of tank leakage (Reinforced concrete, prevention of contamination by closed conduits, etc.) to be taken sequentially along with the installation of tanks</td>
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<tr>
<td>Consideration of reducing the radiation dose</td>
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</table>

| **Site decontamination plan** | | | | |
| Systematic implementation of decontamination in the site of power generation plant | | | | |
| (Decontamination is implemented in stages beginning with the areas where workers frequently enter and exit in parallel with the reduction in off-site radiation dose) | | | | |
| The first step (work area: 5 μSv/h in Main roads; 30 to 20 μSv/h in Main roads) | | | | |
### Status of efforts on various plans (Part 4)

<table>
<thead>
<tr>
<th>Challenges</th>
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<th>As of March 27, 2014</th>
<th>The Phase 2 (Early period)</th>
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<tbody>
<tr>
<td>Cask for both transport and storage</td>
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<tr>
<td>Dry storage cask</td>
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<td>Harbor</td>
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<td>Common pool</td>
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<td>Temporary cask storage facility</td>
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<td>R&amp;D</td>
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<tr>
<td>Installation of reactor building</td>
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<tr>
<td>Preservation of the integrity of RPV/PCV</td>
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<tr>
<td>Storage and management plans for solid wastes</td>
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<tr>
<td>Processing/disposal plans for solid wastes</td>
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<tr>
<td>Decommissioning plans for reactor facilities</td>
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<tr>
<td>Implementation system and personnel procurement plan</td>
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<tr>
<td>Plan to ensure the safety of work</td>
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#### Details:
- **2012**
  - Cask manufacturing
  - Dry storage cask
  - Harbor
  - Common pool
  - Temporary cask storage facility
  - R&D
  - Installation of reactor building
  - Preservation of the integrity of RPV/PCV
  - Storage and management plans for solid wastes
  - Processing/disposal plans for solid wastes
  - Decommissioning plans for reactor facilities
  - Implementation system and personnel procurement plan
  - Plan to ensure the safety of work

- **2013**
  - Cask manufacturing
  - Dry storage cask
  - Harbor
  - Common pool
  - Temporary cask storage facility
  - R&D
  - Installation of reactor building
  - Preservation of the integrity of RPV/PCV
  - Storage and management plans for solid wastes
  - Processing/disposal plans for solid wastes
  - Decommissioning plans for reactor facilities
  - Implementation system and personnel procurement plan
  - Plan to ensure the safety of work

- **2014**
  - Cask manufacturing
  - Dry storage cask
  - Harbor
  - Common pool
  - Temporary cask storage facility
  - R&D
  - Installation of reactor building
  - Preservation of the integrity of RPV/PCV
  - Storage and management plans for solid wastes
  - Processing/disposal plans for solid wastes
  - Decommissioning plans for reactor facilities
  - Implementation system and personnel procurement plan
  - Plan to ensure the safety of work

- **2015**
  - Cask manufacturing
  - Dry storage cask
  - Harbor
  - Common pool
  - Temporary cask storage facility
  - R&D
  - Installation of reactor building
  - Preservation of the integrity of RPV/PCV
  - Storage and management plans for solid wastes
  - Processing/disposal plans for solid wastes
  - Decommissioning plans for reactor facilities
  - Implementation system and personnel procurement plan
  - Plan to ensure the safety of work

### Notes:
- **Main processes**: Red
- **Sub-main processes**: Blue
- **Review**: Green
- **Field work**: Yellow
- **Plan until last month**: Grey
- **Change from last month**: Green frame

- **Completed for FY2013**: Development of R&D plan for safety processing ( Radiation protection and management of radioactive wastes)
- **Evaluation of applicability of processing of radioactive materials in Japan and foreign countries**: Establishment of the evaluation capability and technology
- **Waste characterization (radiochemical analysis, assessment of volume etc.)**: Establishment of decommissioning scenario
- **Reduction in generation amount/optimization of storage**: Improvement of waste storage management plan
- **Establishment of vehicle maintenance shops**: Improvement of waste reducing management policy
- **Corrosion protection (Reduction in dissolved oxygen contained in reactor cooling water by means of nitrogen bubbling)**: Improvement of waste storage management plan
- **Development of evaluation technology for integrity against corrosion of RPV/PCV**: Development of evaluation technology for integrity against corrosion of RPV/PCV
- **Reduction of radiation dose in the rest area of the main office building, rest area in front of the important quake-proof building, and the important quake-proof building**: Systematic cultivation/deployment of personnel, including the cooperative companies, and implementation of measures to stimulate motivation etc.
**Immediate target**

<table>
<thead>
<tr>
<th>Commence fuel removal from the Spent Fuel Pool (Unit 4, November 2013)</th>
</tr>
</thead>
</table>

**In the Mid- and Long-Term Roadmap, the target of Phase 1 was to commence fuel removal from inside the spent fuel pool (SFP) of the 1st Unit within two years of completion of Step 2 (by December 2013). On November 18, 2013, fuel removal from Unit 4, or the 1st Unit, commenced and Phase 2 of the roadmap started.**

In the SFP, 1,933 fuel assemblies (1,331 of which spent and 202 new) are currently stored. The removed fuel will be transferred to the common pool and completion is scheduled for around the end of 2014.

**Solid measures for risks, careful checks and safety first**

**Steps toward fuel removal**

<table>
<thead>
<tr>
<th>Removal of rubble on the roof of the Reactor Building</th>
<th>Installation of cover for fuel removal</th>
</tr>
</thead>
</table>

**Check of the health of the Reactor Building**

Since May 2012, regular quarterly inspections have been conducted, which have confirmed that the health of the Reactor Building has been maintained.

**Units 1 and 2**

- **Regarding Unit 1,** to remove rubble on the top of the operating floor, demolition of the cover over the Reactor Building is planned. Prior to the demolition, the ventilation system of the cover was suspended (September 17, 2013). The next step will involve scheduled construction of a yard for operating large heavy machines and demolition of the Reactor Building cover will commence from the 1st half of FY2014.
- **Regarding Unit 2,** based on the progress of decontamination and shielding within the Reactor Building, the facilities will be inspected and a concrete plan examined and prepared.

**Common pool**

An open space will be maintained in the common pool (Transfer to the temporary dry cask storage facility)

**Temporary dry cask storage facility**

- **Progress to date**
  - The common pool has been restored to a condition whereby it can re-accommodate fuel to be handled (November 2012)
  - Loading of spent fuel stored in the common pool to dry casks commenced (June 2013)
  - Fuel removed from the Unit 4 spent fuel pool began to be received (November 2013)

**Storage area**

- **Open space**
  - An open space will be maintained in the common pool (Transfer to the temporary dry cask storage facility)

**Reference**

March 27, 2014
Secretary of the Team for Countermeasures for Decommissioning and Contaminated Water Treatment

**Glossary**

1. **Operating floor**
   - During regular inspection, the roof over the reactor is opened while on the operating floor, fuel inside the core is replaced and core internals are inspected.

2. **Equipment hatch**
   - A through-hole used to carry equipment in and out of the PCV.

3. **Cask**
   - Transportation container for samples and equipment including radioactive materials.
Progress toward decommissioning: Works to identify the plant status and toward fuel debris removal

**Immediate target**
Identify the plant status and commence R&D and decontamination toward fuel debris removal

**Demonstration of aspiration and blast decontamination equipment**
- Prior to formulating a decontamination plan inside the Reactor Building toward the future removal of debris, demonstration test of the remote-control decontamination equipment was conducted on the 1st floor of the Unit 1 reactor building from January 30 to February 4. The equipment was developed for the fuel debris removal work in future with the subsidy project of the Ministry of Economy, Trade and Industry.
- The result showed that the $\beta$ ray dose rate was reduced by removing dust through aspiration decontamination and the coated surface was shaved by the following blast decontamination*.
  
  * Blast decontamination: A method to shave the surface by injecting polygonal steel grains to the object to be decontaminated (floor surface)

**Response related to the reactor water injection system**
- At Unit 1, to ensure the reliability of continuous water injection to the reactor by the core spray system, emergency injection points will be installed on the pipes used to inject nitrogen into the RPV (within FY2014). Examination toward the installation of reactor water injection points, which can be constantly used, is underway (from FY2015 to around FY2016).

**Unit 1**

- **Air dose rate inside the Reactor Building:** Max. 5,100mSv/h (1F southeast area) (measured on July 4, 2012)
- **Nitrogen injection flow rate into the RPV:** 28.19N/m³/h
- **Temperature inside the PCV:** approx. 16°C
- **Temperature at the triangular corner:** 32.4-32.6°C (measured on September 20, 2012)
- **Water level of the PCV:** approx. 2.8m
- **Water level of the PCV bottom:** approx. 2.8m
- **Water level inside the PCV:** approx. 2.0m
- **Water level of the torus room:** approx. 20-23°C
- **Water level of the turbine building:** approx. 2.74m

**Status of equipment development toward investigation inside PCV**

Prior to fuel debris removal, to check the conditions inside the Primary Containment Vessel (PCV), including the location of the fuel debris, investigation inside the PCV is scheduled. For Unit 1, where fuel debris may spread to the outside of the pedestal, the focus will be placed on the investigation on the external side.

**Investigation outline**
- Inserting equipment from Unit 1 X-100B penetration*5 to investigate in clockwise and counter clockwise directions.

**Investigation route inside the PCV (draft plan)**

![Investigation route inside the PCV (draft plan)](image)

- **Investigation route and the scope depend on the situation**

**Status of investigation equipment development**
- Crawler-type equipment with a shape-changing structure which allows it to enter the PCV from the narrow access entrance (bore: ø100mm), and stability travel on the grating is currently under development. A field demonstration is scheduled for the 2nd half of FY2014.

**Glossary**
- *(1) SFP (Spent Fuel Pool)*
- *(2) RPV (Reactor Pressure Vessel)*
- *(3) PCV (Primary Containment Vessel)*
- *(4) CRD (Core Region Decontamination)*
- *(5) Penetration: Through-hole of the PCV*
Progress toward decommissioning: Works to identify the plant status and toward fuel debris removal

Immediate target
Identify the plant status and commence R&D and decontamination toward fuel debris removal

Installation of RPV thermometer and permanent PCV supervisory instrumentation

(1) Replacement of RPV thermometer
- As the thermometer installed at Unit 2 RPV bottom after the earthquake had been broken, it was excluded from the monitoring thermometers (February 19).
- The broken thermometer will be removed (scheduled in April) and a new one will be installed (scheduled in May).

(2) Reinstallation of PCV thermometer and water-level gauge
- Some of the permanent supervisory instrumentation for PCV could not be installed in the planned locations due to interference with the existing grating (August 13, 2013).
- Based on the field situation, the relevant supervisory instrumentation will be reinstalled by trained workers (in mid-May).

Investigation of the contamination status of the Reactor Building 5th floor

- To investigate the contamination status of the Reactor Building 5th floor, investigative equipment (gamma camera, radiation dose gauge, optical camera) will be suspended through holes drilled in the building roof. In addition, core samples on the 5th floor are collected using remote-control robot.
- To ensure the operation route of the robot for collecting floor core samples, fences on the operating floor were removed using the remote control robot (March 13 and 14).
- As the robot fell during the operation and the battery became low, the relevant robot could not be collected. Removal of fences was completed and the core was collected within the accessible range (from March 20-26).

Status of equipment development toward investigation inside the PCV

Prior to removing fuel debris, to check the conditions inside the Primary Containment Vessel (PCV) including the location of the fuel debris, investigations inside the PCV are scheduled. For Unit 2, where possibility of fuel debris spreading outside the pedestal is low, the focus will be placed on investigating the inside.

Investigation outline
- Inserting the equipment from Unit 2 X-6 penetration and accessing the inside of the pedestal using the CRD rail to conduct investigation.

[Status of investigative equipment development]
- Based on the issues confirmed by the CRD rail status investigation conducted in August 2013, the investigation method and equipment design are currently examined. The demonstration is scheduled in the field in the 2nd half of FY2014.

Issues of investigation inside the PCV and equipment configuration (draft plan)

1. Removal of existing shield in front of the penetration
2. Installation of alternative shield
3. Boring in the penetration hatch
4. Removal of inclusion of the penetration
5. Avoiding the deposit on the rail
6. Crossing over the space between rail and platform
7. Avoiding rail holding tool
8. Travel on the grating

* Indices related to plant are values as of 11:00, March 26, 2014

Reference:
(*1) Penetration: Through-hole of the PCV
(*2) SFP (Spent Fuel Pool)
(*3) RPV (Reactor Pressure Vessel)
(*4) PCV (Primary Containment Vessel)
(*5) S/C (Suppression Chamber): Suppression pool; used as the water source for the emergency core cooling system.
(*6) Operating floor: During regular inspection, the roof over the reactor is opened while on the operating floor, fuel inside the core is replaced and core internals are inspected.
Progress toward decommissioning: Works to identify the plant status and toward fuel debris removal

### Immediate target
Identify the plant status and commence R&D and decontamination toward fuel debris removal

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**Water flow was detected from the Main Steam Isolation Valve**

**Room**

On January 18, the flow of water flow from around the door of the Steam Isolation Valve room in the Reactor Building Unit 3 1st floor northeast area to the nearby floor drain funnel (drain outlet) was detected. As the drain outlet connects with the underground part of the Reactor Building, there is no possibility of outflow from the building.

Based on the analytical results of temperature and radioactive materials of the water flow, and examination by drawings, there is a high likelihood of accumulated water, for which an indoor investigation will be conducted.

* Main Steam Isolation Valve: A valve to shut off the steam generated from the Reactor Building.

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**Unit 3**

- Reactor Building
  - SFP\(^{\text{(*2)}}\) temperature: 14.5°C
  - Temperature of the RPV bottoms approx. 22°C
  - Nitrogen injection flow rate into the PCV\(^{\text{(*3)}}\): 16.64Nm³/h
  - Reactor feed water system: 2.0m³/h
  - Core spray system: 2.5m³/h
  - Temperature inside the PCV: approx. 20.4°C
  - Water level inside the PCV: unconfirmed
  - Water level at the triangular corner: OP3,150 (measured on June 6, 2012)
  - Water level of the Turbine Building: OP2,675

Air flow rate inside the Reactor Building: Max. 4,780m³/h (1st northeast area, in front of the equipment hatch) (measured on November 27, 2012)

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**Status of equipment development toward investigation inside the PCV**

Prior to fuel debris removal, to check the conditions inside the Primary Containment Vessel (PCV), including the location of the fuel debris, investigation inside the PCV is scheduled. For Unit 3, where the possibility of fuel debris spreading outside the pedestal is low, the focus will be placed on investigating the inside. As the water level inside the PCV is high and the penetration which is scheduled for use in Units 1 and 2 may sink in the water, another method need to be examined.

**Steps for investigation and equipment development**

1. Investigation from X-53 penetration
   - Following decontamination, a field investigation is scheduled in the areas around X-53 penetration to determine the policy for conducting the inside investigation and equipment specifications.
2. Investigation plan following the investigation of X-53 penetration
   - Based on the measurement values of hydraulic head pressure inside the PCV, X-6 penetration may sink. It is estimated that access to X-6 penetration is difficult.
   - For access from another penetration, approaches such as “further downsizing the equipment” or “moving in water to access the pedestal” are necessary and will be examined.

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**Glossary**

- SFP (Spent Fuel Pool)
- RPV (Reactor Pressure Vessel)
- PCV (Primary Containment Vessel)
- TIP (Traversing Incore Probe System)

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**Notes**

- \(^{\text{(*1)}}\) SFP (Spent Fuel Pool)
- \(^{\text{(*2)}}\) RPV (Reactor Pressure Vessel)
- \(^{\text{(*3)}}\) PCV (Primary Containment Vessel)
- \(^{\text{(*4)}}\) TIP (Traversing Incore Probe System)

Measures neutrons by moving the detector up and down inside the core.

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* Indices related to plant are values as of 11:00, March 26, 2014

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Robot for investigating the contamination status (gamma camera mounted)
Work to improve the reliability of the circulation water injection cooling system and pipes to transfer accumulated water.

- Operation of the reactor water injection systems using Unit 3 CST as a water source commenced (from July 5, 2013). Compared to conventional systems, in addition to the shortened outdoor line, the reliability of the reactor water injection systems was enhanced, e.g., by increasing the amount of water source storage and enhancing durability.
- By newly installing RO equipment inside the Reactor Building by the end of FY2014, the reactor water injection loop (circulation loop) will be shortened from approx. 3km to approx. 0.8km.
- New RO equipment will be installed on Unit 4 T/B operation floor*1.

Current line (used as backup after commencing circulation in the Building) • Length: approx. 1,500m • Amount of frozen soil: approx. 70,000 m³

Hence, the entire length of contaminated water transfer pipes approx. 2.1km, including the transfer line of surplus water to the upper height (approx. 1.3km).

Status of multi-nuclide removal equipment

- Hot tests using radioactive water are underway (System A: from March 30, 2013, System B: from June 13, 2013, System C: from September 27, 2013).
- On March 18, as the radioactive material density of outlet water increased at System B, all Systems were suspended. The estimated cause was that the strontium which had traversed the filter remained in the absorption vessel and, over an extended period, reached the outlet.
- From March 24, treatment for the purpose of cleaning transfer pipes resumed using healthy Systems A and C. To check for any leak from the manhole on the side of the sample tank, water was filled under monitoring (March 24). As water drops were detected by this check, System B was suspended. On March 25, the System was resumed after replacing the packing at the relevant part.
- Regarding additional and high-performance multi-nuclide removal equipment, work to remove obstacles, drill, improve the ground improvement, and construct foundations is underway.

*1 Unit 4 T/B operation floor is one of the installation proposals, which will be determined after further examination in future based on the work environment.
*2 A detailed line configuration will be determined after further examination in future.

Legend

- Groundwater level
- Water level
- Land-side impermeable wall
- Sub-drain impermeable wall
- Pumping well

Water pumping

* Length approx. 1,500m
* Amount of frozen soil approx. 70,000 m³

Installing frozen impermeable walls around Units 1-4 to prevent inflow of groundwater into RB
Progress toward decommissioning: Work to improve the environment within the site

Immediate target

- Reduce the effect of additional release from the entire power station and radiation from radioactive waste (secondary water treatment waste, rubble, etc.) generated after the accident, to limit the effective radiation dose to below 1mSv/year at the site boundaries.
- Prevent contamination expansion in sea, decontamination within the site

Expansion of non full-face mask required area

Operation based on the rules for mask wearing according to radioactive material density in air and decontamination ionization rules was defined, and the area is being expanded.

As it was confirmed that the density of radioactive materials in air is under the level for non full-face mask required area in some parts on the 2nd and 3rd floors of the common pool building, these areas will be set as non full-face mask required area, to reduce burden on workers and improve productivity (from March 10).

Entry control facility was established

An entry control facility near the main gate of the Fukushima Daiichi Nuclear Power Station commenced operation from June 30, 2013, where contamination tests, decontamination, switching on and off of protective equipment, and distribution collection of dosimeters are being conducted.

Installation of impermeable walls on the sea side

To prevent contamination expansion into the sea when contaminated water leaks into groundwater, impermeable walls are being installed (scheduled for completion in September 2014). Installation of steel pipe sheet piles temporarily completed by December 4, 2013 except for 9 pipes. The next stage will involve installing steel pipe sheet piles outside the port, landfilling within the port, and installing a pumping facility to close before the construction completion.

Reducing radioactive materials in seawater within the port

- The analytical result for data such as the density and level of groundwater on the east (sea) side of the site.
- Building identified that contaminated groundwater was leaking into seawater.
- No significant change has been detected in seawater within the port for the past month, nor was any significant change detected in offshore measurement results as of last month.
- To prevent contamination expansion into the sea, the following measures are being implemented:
  1. Preventing leakage of contaminated water
  2. Underground soil improvement behind the bank protection to prevent expansion of radioactive materials.
  3. Purification and removal of contaminated water in the main trench (Unit 2: Purification commenced on November 14, 2013; Unit 3: commenced on November 15, 2013)
  4. Reducing radioactive materials in seawater outside the port
     - Pumping of groundwater in contaminated areas (from August 9, scheduled to commence sequentially)
     - Removal and closure of contaminated water such as branch trench (completed on September 19, 2013)

Non full-face mask required area

Installation status of impermeable walls on the sea side

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