# Current Status of “Roadmap towards Restoration from the Accident at Fukushima Daiichi Nuclear Power Station, TEPCO” (Revised edition)

Red colored letter: changed from the previous version, ▼: already reported to the government, Green colored shading: achieved target

## I. Cooling

### (1) Reactor

- **As of Apr. 17**: Fresh water injection
- **Step 1 (around 3 months)**: Circulating water cooling (start) / Injection cooling
- **Step 2 (through the end of this year)**: Nitrogen gas injection (continued)
- **Mid-term issues (around 3 years)**: Maintenance and Continue cold shutdown condition

#### Fresh water injection

- Reliability improvement in injection operation / remote-control operation *ahead of schedule*
- Circulation cooling system (installation of heat exchanger) *partially ahead of schedule*

#### Nitrogen gas injection

- Improvement of work environment

#### Storing water with high radiation level

- Installation of storage / processing facilities

#### Transferring water with high radiation level

- Installation of storage facilities / decontamination processing

#### Storing water with low radiation level

- Installation of storage facilities / decontamination processing

#### (2) Spent Fuel Pool

- Fresh water injection
- Reliability improvement in injection operation / remote-control operation *ahead of schedule*
- Circulation cooling system (installation of heat exchanger) *partially ahead of schedule*

#### Transferring water with high radiation level

- Installation of storage / processing facilities

#### (3) Accumulated Water

- **As of Apr. 17**: Fresh water injection
- **Step 1 (around 3 months)**: Installation of storage / processing facilities
- **Step 2 (through the end of this year)**: Consideration of method of impermeable wall against groundwater
- **Mid-term issues (around 3 years)**: Installation of full-fledged water processing facilities

#### Fresh water injection

- Expansion / consideration of full-fledged processing facilities
- Decontamination / desalination processing (reuse), etc

#### Storing water with low radiation level

- Installation of storage facilities / decontamination processing

#### Mitigation of contamination in the ocean

- Mitigation of contamination in the ocean

#### (4) Groundwater

- **As of Apr. 17**: Fresh water injection
- **Step 1 (around 3 months)**: Installation of impermeable wall against groundwater
- **Step 2 (through the end of this year)**: Design / implementation of impermeable wall against groundwater
- **Mid-term issues (around 3 years)**: Establishment of impermeable wall against groundwater

#### Fresh water injection

- Expansion / consideration of impermeable wall against groundwater
- Consideration of method of impermeable wall against groundwater

#### (5) Atmosphere / Soil

- Dispersion of inhibitor
- Removal / management of debris

#### Mitigate scattering

- Dispersion of inhibitor (continued)
- Removal / management of debris (continued)

#### Installation of reactor building cover (Unit 1)

- Installation of reactor building cover (Unit 1)
- Removal of debris (top of Unit 3&4 R/B)

#### Installation of PCV gas control system

- Installation of PCV gas control system
- Start of installation work of reactor building container

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November 17, 2011
Nuclear Emergency Response Headquarters
Government-TEPCO Integrated Response Office
## Current Status of “Roadmap towards Restoration from the Accident at Fukushima Daiichi Nuclear Power Station, TEPCO” (Revised edition)

**As of Apr. 17**

### Step 1 (around 3 months)
- **Environment Improvement**
  - Measurement, Reduction and Disclosure
  - Continuous environmental monitoring

### Step 2 (through the end of this year) [current status as of Nov. 17]
- **Environmental Improvement**
  - Continuous decontamination

### Mid-term issues (around 3 years)
- **Decontamination**
  - Consideration/start of full-fledged decontamination
  - Continuous decontamination

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<th>Step 2 (through the end of this year) [current status as of Nov. 17]</th>
<th>Mid-term issues (around 3 years)</th>
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<td>Action plan for mid-and-long-term issues</td>
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</table>
Overview of Major Countermeasures in the Power Station as of November 17

Underlined: deleted countermeasures, red colored: newly added countermeasures, □: already reported to the government

- **Reactor building cover (5, 50, 54, 55, 84)**
- **Full-fledged container (50, 56)**
- **Cooling of spent fuel pool by external water injection (18, 22, 28)**
- **PCV gas control (86)**
- **PCV venting (with filtration) (10)**
- **Flooding up to top of active fuel (3, 9)**
- **Installation of heat exchangers (13)**
- **Injection of fresh water with pumps (1)**
- **Processing of sub-drainage water after being pumped up (36)**
- **Sealing the leakage location (6, 16)**
- **Injection of fresh water with pumps (1)**
- **Sampling of steam/pool water and measurement of radioactive materials (19)**
- **Circulation cooling of spent fuel pool (23, 24, 25, 27)**
- **Cooling at minimum water injection rate (7, 12, 14)**
- **Reuse of processed water (45)**
- **Implment circulating water cooling**
- **Processing high radiation-level water (31, 38, 43)**
- **Storage / management of sludge waste etc. (81)**
- **Sealing the leakage location (6, 16)**
- **Prevent contamination of groundwater (66, 67); Consideration of impermeable wall against groundwater (68, 83)**
- **Improvement of living/working environment of workers (74, 75); Improvement of site environment (76)**
- **Enhancement of radiation control and medical system (77, 78, 79, 80); Systematic implementation of staff training / personnel allocation (85)**
- **Install various interconnecting lines of offsite power (8)**
- **Enhance countermeasures against tsunami (69, 70); Consideration of reinforcement work of each Unit (71); Various countermeasures of radiation shielding (72, 73)**
- **Continue/Enhance monitoring (55-62), Consideration / start of full-fledged decontamination (63)**

**Additional Notes:**
- **Storage (including tanks, megafoats, Process: decontamination by zeolite)**
- **Water processing facility**

**Diagram Highlights:**
- **Reactor Building**
- **Primary Containment Vessel (PCV)**
- **Turbine Building**
- **Suppression Chamber**
- **Steam Turbine**
- **Condenser**
- **Centralized Waste Processing Building**

**Key Countermeasures:**
- **Sampling of steam/pool water and measurement of radioactive materials (19)**
- **Circulation cooling of spent fuel pool (23, 24, 25, 27)**
- **Cooling at minimum water injection rate (7, 12, 14)**
- **Reuse of processed water (45)**
- **Processing high radiation-level water (31, 38, 43)**
- **Storage / management of sludge waste etc. (81)**
- **Sealing the leakage location (6, 16)**
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- **Continue/Enhance monitoring (55-62), Consideration / start of full-fledged decontamination (63)**
### Current Status of Countermeasures (1)

**Start of Step 2 (Jul. 17)**

- **<Step 2 (through the end of this year)>**: Release of radioactive materials is under control and radiation doses are being significantly held down.

#### Unit Issues

<table>
<thead>
<tr>
<th>Issues</th>
<th>Unit</th>
<th>Term to keep the amount of accumulated water and to improve reliability</th>
<th>Term to complete measures to improve reliability and reduce the amount of accumulated water</th>
<th>Term to inject enough water for cold shutdown condition without increasing the amount of accumulated water</th>
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<tr>
<td></td>
<td>1</td>
<td><strong>Implementation of circulating water cooling [Countermeasures 12,14,45]</strong></td>
<td><strong>Nitrogen gas injection [Countermeasure 11]</strong></td>
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<td>2</td>
<td><strong>Implementation of circulating water cooling [Countermeasures 12,14,45]</strong></td>
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<td><strong>Implementation of circulating water cooling [Countermeasures 12,14,45]</strong></td>
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#### Legend
- Red frame: progressed countermeasures from the previous version.
- □: already reported to the government.
- Under construction.
- Field work started.
- Field work not started yet.

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**Target [℃]: Cold shutdown condition**

- **Unit 1**
- **Unit 2**
- **Unit 3**

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**Temperatures inside PCV**

**RPV bottom temperatures (upper) and water injection flow rate (lower)**
Current Status of Countermeasures (2)

Start of Step 2 (Jul. 17)

Water injection through normal cooling system [Countermeasure 24]

Cooling by installation of heat exchanger [Countermeasures 25, 27]
- Circulating water cooling operation (from Aug. 10)

Cooling by installation of heat exchanger [Countermeasures 25, 27]
- Circulating water cooling operation (from May 31)

Cooling by installation of heat exchanger [Countermeasures 25, 27]
- Circulating water cooling operation (from Jun. 30)

Restoration of injection through normal cooling system [Countermeasure 24]
- Water injection by installation of alternative system to “Giraffe” (Jun. 17)

Cooling by installation of heat exchanger [Countermeasures 25, 27]
- Circulating water cooling operation (from Jul. 31)

Legend:
- Green: Implemented (monitored by government as necessary)
- Red frame: progressed countermeasures from the previous version
- Circle: Safety check by government (reported)
- Red triangle: Under construction
- Yellow: Field work started
- Orange: Field work not started yet

Desalination of Spent Fuel Pool water (from Aug. 20)

Desalination of Spent Fuel Pool water

Step 2 (through the end of this year): Release of radioactive materials is under control and radiation doses are being significantly held down

Target [No] More stable cooling

Current status (as of Nov. 17)
Current Status of Countermeasures (3)

II. Mitigation

Accumulated Water

Elimination, continuous processing and system enhancement of accumulated water in the building [Countermeasure 43]

- Construction of Cesium adsorption facilities (SARRY) [Receiver tanks for processed water]
  - Processing start (Aug. 18)
  - Installation (term) (Jun. 17)
  - Capability of processing (term) (Oct. 10)

- Preparation for desalination facilities (distillation) (term) (Sep. 17)
  - Test operation (term) (Oct. 9)

- Installation work of desalination facilities (reverse osmosis) (term) (Jul. 20)
  - Capability of processing (Jul. 20)

Consideration of full-fledged water processing facilities [Countermeasure 82]

- Storage / management of sludge waste etc. [Countermeasure 81] (term)
  - Storage and management at existing tanks
  - Design of additional storage facility
  - Preparation

- Secure sufficient storage place [Countermeasures 42]
  - Receiver tanks for high radiation level water
    - Installation of 2,800 t (Sep. 17)
    - Receiver tanks for processed water
    - Approx. 20,000 t/month

- Treatment of contamination in the ocean [Countermeasure 64]
  - Circulating decontamination of the seawater
  - Installation of steel pipe sheet pile (Sep. 28)

Target [a] Decrease the total amount of accumulated water

Current status (as of Nov. 17)

<Step 2 (through the end of this year)>: Release of radioactive materials is under control and radiation doses are being significantly held down

- Term to keep the amount of accumulated water and to improve reliability
- Term to complete measures to improve reliability and reduce the amount of accumulated water
- Term to inject enough water for cold shutdown condition without increasing the amount of accumulated water

Red frame: progressed countermeasures from the previous version, □: already reported to the government

Legend
- Implemented (monitored by government as necessary)
- Safety check by government (reported)
- Under construction
- Field work started
- Field work not started yet

- Target: Low level
- Target: High level

- Decrease the total amount of accumulated water

- Field started
- Field not started yet

- Term to complete measures to improve reliability
- Term to inject enough water for cold shutdown condition without increasing the amount of accumulated water

- Term to keep the amount of accumulated water and to improve reliability

- Term to complete measures to improve reliability and reduce the amount of accumulated water

- Term to inject enough water for cold shutdown condition without increasing the amount of accumulated water

- Term to keep the amount of accumulated water and to improve reliability

- Term to complete measures to improve reliability

- Term to inject enough water for cold shutdown condition without increasing the amount of accumulated water

- Term to keep the amount of accumulated water and to improve reliability

- Term to complete measures to improve reliability and reduce the amount of accumulated water

- Term to inject enough water for cold shutdown condition without increasing the amount of accumulated water

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- Term to complete measures to improve reliability

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- Term to keep the amount of accumulated water and to improve reliability

- Term to complete measures to improve reliability

- Term to inject enough water for cold shutdown condition without increasing the amount of accumulated water

- Term to keep the amount of accumulated water and to improve reliability

- Term to complete measures to improve reliability

- Term to inject enough water for cold shutdown condition without increasing the amount of accumulated water
### Current Status of Countermeasures (4)

**Issues**
- Implementation of preventions against expansion of groundwater contamination [Countermeasure 67]
  - Restoration of sub-drainage pumps with expansion of storage / processing facilities
- Design of impermeable wall against groundwater [Countermeasure 68]
- Confirmation of solidification of inhibitor [Countermeasure 52]
- Removal / management of debris [Countermeasure 53, 87]
  - Collected debris (Volume of approx. 900 containers (as of Nov. 17))
  - Management of collected debris etc. in storage areas
- Installation of reactor building cover (Unit 1) [Countermeasures 54, 55]
  - Completed (Oct. 28)
- Removal of debris at the upper parts of reactor buildings (Unit 3&4) [Countermeasures 84]
  - Started debris removal at the upper parts of reactor buildings (Unit 3: Sep. 10, Unit 4: Sep. 21)

**II. Mitigation**
- Preparation for Unit 3 (Removal of debris on the ground, maintenance of road for crane etc.)
- Preparation for Unit 4 (Removal of debris on the ground, maintenance of road for crane etc.)
- Consideration of reactor building container [Countermeasure 50]

**Implementation of preventions against expansion of groundwater contamination [Countermeasure 67]**
- Restoration of sub-drainage pumps with expansion of storage / processing facilities

**III. Monitoring / Decontamination**
- Continue to assess current release of radioactive materials from PCVs [Countermeasures 60, 61]
  - The current release rates (Cesium) from PCVs of Units 1 to 3 were assessed based on the airborne radioactivity concentration (dust concentration) at the upper parts of the reactor buildings, etc.
  - The current total release rate from Units 1-3 based on the assessment this time is estimated at approx. 0.06 billion Bq/h at the maximum which is 1/13,000,000 of that at the time of the accident.
  - The radiation exposure per year at the site boundaries is assessed at approx. 0.1 mSv / year at the maximum based on the aforementioned release rate (The target is 1 mSv / year. Excluding the effect of the radioactive materials already released up until now).

**Consideration / start of full-fledged decontamination [Countermeasure 63]**
- Detailed monitoring has begun at the area where the government shall implement decontamination based on the “Act on Special Measures concerning the Handling of Environment Pollution by Radioactive Materials” (Nov. 7).
- “Decontamination model project at the Restricted Area or the Deliberate Evacuation Area, etc.” has begun (Nov. 8).

**Legend**
- **Implemented (monitored by government as necessary)**
- **Safety check by government (reported)**
- **Under construction**
- **Field work started**
- **Field work not started yet**
### Current Status of Countermeasures (5)

<table>
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<th>Issues</th>
<th>Start of Step 2 (Jul. 17)</th>
<th>&lt;Step 2 (through the end of this year) Release of radioactive materials is under control and radiation doses are being significantly held down</th>
<th>Current status (as of Nov. 17)</th>
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<tr>
<td>IV. Reinforcement, etc.</td>
<td>(Unit 4) Installation of supporting structure under the bottom of the fuel pool [Countermeasure 26] (Jul: 30)</td>
<td>Consideration of reinforcement work of each Unit [Countermeasure 71] - Evaluation of seismic resistance has been completed (Aug.26)</td>
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<td>Continue various countermeasures for radiation shielding [Countermeasure 73]</td>
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<tr>
<td>V. Environment improvement</td>
<td>Continuation and enhancement of improvement of workers' living / working environment [Countermeasure 75] - Accommodations for approx. 1,600 people have been prepared. Approx. 1,200 people have already moved in (as of Nov. 1) -20 on-site rest stations have been established (approx. 4,750m² in size with a capacity to accommodate approx. 1,600 people) (as of Nov. 1)</td>
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<td>Continuous improvement of radiation control [Countermeasure 78] - Reinforcement of radiation control by NISA - Expansion of whole-body counters, implementation of monthly internal exposure measurement - Automated recording of personal radiation dose, written notification of exposure dose, introduction of workers' certificates with photos - Consideration of long-term healthcare such as enhancement of safety training for workers and establishing database etc.</td>
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<td>Continuous reinforcement of medical system [Countermeasure 80] - Install new emergency medical facility, establish organization with resident specialists (on call 24 hours a day), speedy transportation of patients - Intensive preventive measures against heat stroke (trainings for new workers), countermeasures for mental health, conducting medical examination, prevention and mitigation of flu - Establish industrial hygiene system such as preventive healthcare</td>
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<td>Systematic staff training and personnel allocation [Countermeasure 85] - Promote human resources training in conjunction with the government and TEPCO</td>
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Current Status (as of Nov. 17)

- Target [16] Mitigation of disasters
- Target [17] Mitigation of disasters
- Target [18] Enhancement of environment improvement
- Target [19] Enhancement of healthcare
- Target [20] Exhaustive radiation dose

Legend
- : Implemented (monitored by government as necessary) - : Safety check by government (reported) - : Under construction - : Field work started - : Field work not started yet