Updated Status of Fukushima Daiichi Nuclear Power Station
～Regulation, Overview, Actions～

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New Regulatory System on Fukushima Daiichi NPS

2011.3.11  The accidents

   Emergency Actions by TEPCO reviewed by former Regulatory Bodies

2011.10.3  NISA’s Safety Directive on Mid-term Safety of Fukushima Daiichi

2011.12.12 TEPCO’s Mid-term Safety Plan was approved by NISA

2012.6.20 Amendment of Nuclear Regulation Law was passed at the Parliament.

2012.9.19 NRA was established.

2012.11.7 NRA designated Fukushima Daiichi NPS as Specified Nuclear Facility and issued “Matters concerning measures to be adopted”.

2013.8.14 TEPCO’s Implementation Plan was approved.
Fukushima Daiichi is under systematic regulatory system regarding Design, Construction, Inspection, Management, etc.
Overview of Fukushima Daiichi NPS
Location of Fukushima Daiichi NPS

Tokyo

300Km

Pacific Ocean

Fukushima Daiichi NPS

google
Molten Cores and Spent Fuels

- Molten cores in RPV and PCV, and spent fuels in SFP have been cooled.
- $\text{H}_2$ concentration in PCV have been much lower than flammability limit.

<table>
<thead>
<tr>
<th></th>
<th>Water Injection to RPV [m$^3$/d]</th>
<th>RPV Bottom Temperature [$^\circ$C]</th>
<th>PCV Temperature [$^\circ$C]</th>
<th>$\text{N}_2$ Injection to PCV [Nm$^3$/h]</th>
<th>$\text{H}_2$ Concentration in PCV [Vol%]</th>
<th>Spent Fuel Pool Temperature [$^\circ$C]</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.02</td>
<td>27</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.06</td>
<td>27</td>
</tr>
<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.1</td>
<td>26</td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27</td>
</tr>
<tr>
<td>E</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27</td>
</tr>
<tr>
<td>F</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>27</td>
</tr>
</tbody>
</table>

**Unit 5 & 6 are cold shutdown.**

As of September 13, 2013
Spent Fuel Pools (Unit 3 & 4)

✓ Fuel Rack and Assembly of SFP of Unit 4 had little damage.
✓ Removal of Spent Fuel in Unit 4 will be started from November, 2013.
✓ Debris over SFP of Unit 3 are being removed.
Treatment System of Contaminated Water

- Contaminated Water in Turbine buildings is treated and injected to RPVs.
- 400m$^3$/d of groundwater inflowing buildings forces capacity of tanks increase.

**Diagram:**
- Reactor building
- Contaminated Water
- Desalination equipment
- Cesium removal devices
- Unsalted Water injection tank
- Surplus water: Approx. 400 m$^3$/day generated

**Key Points:**
- Reactor cooling water: Approx. 400 m$^3$/day injected
- Ground water: Approx. 400 m$^3$/day inflow
- Water with $^3$H storage tanks
- Water with $^3$H removal device
- Sea Water Pipe Trench
- Highly Contaminated Water
- Main process building
  - High-temperature Incinerator building (Temporary storage)
- Test operation currently conducted

**Notes:**
- Reactor (Toshiba)
- 400m$^3$/d of groundwater flows into the buildings, forcing the capacity of tanks to increase.
- Radioactive contamination includes $^3$H and low-level Cs.
## Radioactivity Levels of Contaminated Water

<table>
<thead>
<tr>
<th>Water Type</th>
<th>Radioactivity (Bq/L)</th>
<th>Amount (m³)</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly Contaminated Water</td>
<td>Cs-137: ~10^9</td>
<td>11,000</td>
<td>Sea Water Pipe Trench</td>
</tr>
<tr>
<td>Contaminated Water</td>
<td>Cs-137: ~10^7</td>
<td>90,000</td>
<td>Reactor-Turbine-Processing Buildings</td>
</tr>
<tr>
<td>β and low-level Cs Water</td>
<td>Total β: ~10^7-9, Cs-137: ~10^3-5</td>
<td>280,000</td>
<td>Storage Tank</td>
</tr>
<tr>
<td>Water with H-3</td>
<td>H-3: ~10^7</td>
<td>20,000</td>
<td>Storage Tank</td>
</tr>
</tbody>
</table>

*Note: Numbers are approximate figure. 10^X means 10 to the Xth power.*
Storage Tanks

✓ 340,000 m³ of various levels of contaminated water is stored in the storage tanks.
✓ 280,000 m³ out of total volume is β and low-level Cs water that was treated with reverse osmosis (RO) membrane. It is stored in steel-made cylindrical storage tanks with flange. [Sep.3]

### Cylindrical storage tanks
- **Shape**: Cylindrical
- **Junction Method**: Flange
- **Measures against Corrosion**: Exterior: Painting Interior: tar-epoxy resin
- **Contents**: β and low-level Cs Water after RO Unsalted Water after RO Water with ³H after ALPS
- **The number of tanks**: 305

### Square- shaped storage tanks
- **Shape**: Square-shaped
- **Junction Method**: Welding
- **Measures against Corrosion**: Exterior: Painting Interior: tar-epoxy resin
- **Contents**: Water with ³H after ALPS β and low-level Cs Water after RO
- **The number of tanks**: 64

### Horizontal-installation-type storage tanks
- **Shape**: Horizontal-installation-type
- **Junction Method**: Welding
- **Measures against Corrosion**: Exterior: Painting Interior: tar-epoxy resin
- **Contents**: β and low-level Cs Water after RO Unsalted Water after RO
- **The number of tanks**: 217

### Storage Tanks
- **Shape**: Welding
- **Junction Method**: Welding
- **Measures against Corrosion**: Exterior: Painting Interior: FRP
- **Contents**: β and low-level Cs Water after RO or evaporation
- **The number of tanks**: 342

As of August 20, 2013
Recent Issues
Leakage of $\beta$ and low-level Cs Water from Cylindrical Tank(1)

✓ Puddle and Trace of Water flow with $\beta$ were found by TEPCO(August 19, 2013)

Source: TEPCO
Leakage of β and low-level Cs Water from Cylindrical Tank (2)

**Surface dose of mud in draining ditches**

<table>
<thead>
<tr>
<th></th>
<th>β:mSv/h(H70μm)</th>
<th>γ:mSv/h(H1cm)</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>0.016</td>
<td>0.0052</td>
</tr>
<tr>
<td></td>
<td>0.026</td>
<td>0.0035</td>
</tr>
<tr>
<td></td>
<td>0.016</td>
<td>0.0024</td>
</tr>
</tbody>
</table>

Draining Ditches

Sampling Well
- 15m from the Leakage point
- 7m of depth

Ground water
Total β : 2,000Bq/L
³H: 64,000Bq/L

These values are not guaranteed by the NRA.
Modified by the NRA, Original illustrated by TEPCO
Leakage of $\beta$ and low-level Cs Water from Cylindrical Tank(3)

Causes
- Leakage from flange
- Normal open of draining valves
- Delay of detection
  - No water level device
  - Poor patrolling: 2men for 900 tanks/day

INES Level 3 [Tentative]
- Amount of Leaked $\beta$ and low-level Cs Water [Provisional]
  - $^{137}\text{Cs} \ 1.0 \times 10^5 \text{ Bq/cm}^3$
  - $^{134}\text{Cs} \ 4.6 \times 10^4 \text{ Bq/cm}^3 \times 300\text{m}^3 > A\text{ few thousand TBq}\, ^{99}\text{Mo}$
- Total $\beta$ $8.0 \times 10^4 \text{ Bq/cm}^3$
- No remaining safety layer
Hot Spots on the Tanks

H5 Area

Puddle trace (20 cm x 20 cm)

At the point 5cm from the surface of the puddle trace, 230 mSv/h * of β rays was detected by TEPCO on 31 August.

It was found by TEPCO that one drop of water fell every 90 seconds after the cover stuff of the flange was removed, and then this water drop has stopped by TEPCO’s tightening up the bolts of flange on 1 September.

H3 Area

① At the point 5cm from the flange, 220 mSv/h * of β rays was detected by TEPCO on 31 August.
   No water leakage was found around here.

② At the point 5cm from the flange, 2200 mSv/h * of β rays was detected by TEPCO on 3 September.
   No water leakage was found around here.

③ At the point 5cm from the flange, 1800 mSv/h * of β rays was detected by TEPCO on 31 August.
   No water leakage was found around here.

* This value is not guaranteed by the NRA.

Modified by the NRA. Original illustrated by TEPCO
Radioactivity of Seawater near Fukushima Daiichi NPS

✓ Most of all sampled seawater near Fukushima Daiichi NPS were under the detection limits.
✓ No change was observed before and after the leakage from Cylindrical Storage Tanks.

<table>
<thead>
<tr>
<th>Sampling Date</th>
<th>Radioactivity of sea water (Bq/L)</th>
<th>Cs-137</th>
<th>total β</th>
<th>H-3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug. 14</td>
<td>ND(1.4) ND(18) ND(4.7)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Aug. 27</td>
<td>ND(0.49) ND(17) ND(2.0)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sep. 3</td>
<td>ND(0.58) ND(16) ND(1.8)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sampling Date | Radioactivity of sea water (Bq/L) | Cs-137 | total β | H-3 |
Aug. 14        | ND(1.1) ND(18) ND(2.9)            |        |         |     |
Aug. 27        | ND(0.69) ND(17) ND(2.0)           |        |         |     |
Sep. 3         | ND(0.69) ND(16) ND(1.8)           |        |         |     |
Radioactivity Concentration in Harbor

✓ Area A, within harbor and outside silt fence and East breakwater: under Legal limit.
✓ Area B, within silt fence and East breakwater: over Legal limit.

Sampling point

Legal limit outside site

\(^{90}\)Sr: 30 Bq/L
\(^{3}\)H: 60,000 Bq/L
\(^{137}\)Cs: 90 Bq/L

Unit: Bq/L

This value is not guaranteed by the NRA.

Modified by the NRA, Original illustrated by TEPCO
Contamination in Groundwater

✓ High Contamination in Groundwater was found near the Leakage Point on April 2, 2011.
✓ Groundwater with $^3$H were also found.

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**Sea Side**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Beta</th>
<th>$^3$H</th>
<th>$^{137}$Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>160</td>
<td>38,000</td>
<td>2.1</td>
</tr>
<tr>
<td>2</td>
<td>1,100</td>
<td>1,100</td>
<td>63</td>
</tr>
<tr>
<td>3</td>
<td>500,000</td>
<td>310,000</td>
<td>180</td>
</tr>
<tr>
<td>4</td>
<td>29</td>
<td>380</td>
<td>0.82</td>
</tr>
</tbody>
</table>

**Turbine Buildings Side**

<table>
<thead>
<tr>
<th>Unit</th>
<th>Beta</th>
<th>$^3$H</th>
<th>$^{137}$Cs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1,500</td>
<td>370,000</td>
<td>5.7</td>
</tr>
<tr>
<td>2</td>
<td>820</td>
<td>23,000</td>
<td>110</td>
</tr>
<tr>
<td>3</td>
<td>21,000</td>
<td>200,000</td>
<td>24</td>
</tr>
<tr>
<td>4</td>
<td>220</td>
<td>540</td>
<td>0.7</td>
</tr>
</tbody>
</table>

This value is not guaranteed by the NRA.
Modified by the NRA, Original illustrated by TEPCO
Highly Contaminated Water in Underground Trenches and Conduits (1)

✓ Highly Contaminated Water was estimated to move through the crushed stone layer.

Highly Contaminated Water was found in April 2011

Leakage Point of Highly Contaminated Water on April 2, 2011

Sea Water pipe trench filled with Highly Contaminated Water

Source: TEPCO
Highly Contaminated Water in Underground Trenches and Conduits (2)

- Sea Water pipe trench filled with Highly Contaminated Water
- Turbine building
- Shaft D
- power cable trench
- Shaft C
- Pump room
- Screen
- Shaft A
- seawater pipe trench
- Shaft B
- Leakage Point of Highly Contaminated Water on April 2, 2011
- Highly Contaminated Water was found in April 2011
Sealing Wall embracing Contamination

✔ Sealing Wall and Facing embracing contaminated water is under construction.

Groundwater Level inside the wall is lower than outside.

Source: TEPCO
NRA Actions(1)

1. Guidance for TEPCO
   a. Identification
      • Leakage point, causes, flow-out pathway including underground, soil contamination, level of underground water under the storage tank.
   b. Prevention and Mitigation
      • Facilitation to replace the flange-type storage tanks with welding-type of tanks.
      • Early detection of leakage.
   c. Radiation Monitoring
      • Underground water, the drainage, seawater in and near the Harbor.
   d. Risk reduction of β and low-level Cs water
      • Prompt treatment of β and low-level Cs water by multiple nuclides removal facilities (ALPS), increase of the processing capacity of ALPS
   e. Prompt development and implementation of countermeasures against highly contaminated water in the trenches and turbine buildings, and countermeasures against inflow of underground water.
2. Technical supports for TEPCO’s radiation measurement

Technical advisors employed by the NRA have been working on teaching TEPCO the way of radiation monitoring and advising TEPCO to map an on-site radiation distribution.

3. Enhancement of safety inspection

Safety inspection has been enhanced by the NRA and JNES (a technical support organization to the NRA).
Thank you

Information related to Fukushima Daiichi NPS such as regulatory activities of the NRA, radiation monitoring and incidents is available at the NRA’s website.

URL   http://www.nsr.go.jp/english