The Leakage of Contaminated Water at TEPCO’s Fukushima Daiichi Nuclear Power Station and the Safety of Fishery Products (provisional translation)

Mar. 2014
Fisheries Agency of Japan
May 2013, a high level of tritium was detected in ground water at the seawall area between intakes of unit 1 and unit 2 (※) of Fukushima Daiichi Nuclear Power Station (F1NPS). TEPCO investigated this case and confirmed that the contaminated water had leaked into the port of F1NPS in July 2013.

Though a certain level of radionuclides was detected in the seawater within the port, the level in outside is below detection limit at most sampling points. No significant influence of the contaminated water has been detected outside of the port.

In order to prevent the contaminated fish in the port moving outside, TEPCO constructed the fence and net at the port entrance. TEPCO also have been catching the fish in the port (ref. TEPCO HP).

Comparison of the amount of radionuclides in the contaminated water leaked in Apr.2011 with that in the contaminated water leaked from May.2011 to Aug.2013, which was estimated by TEPCO.

<table>
<thead>
<tr>
<th>radionuclides</th>
<th>the amount of radionuclides in the contaminated water leaked in Apr.2011</th>
<th>the amount of radionuclides in the contaminated water leaked since May.2011, which was estimated by TEPCO</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>leak periods</td>
<td>leak amount (unit: Bq)</td>
</tr>
<tr>
<td>cesium134+137</td>
<td>6days</td>
<td>ca.1.8 x 10^13</td>
</tr>
<tr>
<td>cesium137</td>
<td>6days</td>
<td>ca.9.4 x 10^13</td>
</tr>
<tr>
<td>strontium-90</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>tritium</td>
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</tr>
</tbody>
</table>

Note: 3.5 Bq/L (6/20 sampling) and 0.36 Bq/L (6/26) for strontium-90 were detected at the entrance of the port and the point near the south discharge channel, respectively.
### Concept of standard limit

- The current standard limits were established with full consideration of the influence to human health from both radioactive Cs (134+137) and radionuclides other than Cs (i.e., Sr-90, Ru-106, Pu) because it takes a lot of time to measure those radionuclides other than Cs (ref. Ministry of Health, Labour and Welfare HP).
- The effective dose from radionuclides other than Cs is assumed to be about 12% of the total effective dose from food (i.e., 0.9 mSv/year).

<table>
<thead>
<tr>
<th>Drinking water</th>
<th>Food</th>
<th>1 mSv (the same value of annual effective dose for food and drink set by Codex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ca. 0.1 mSv</td>
<td>ca. 0.9 mSv</td>
<td>88% of 0.9 mSv from radioactive Cs, 12% of 0.9 mSv from Radionuclides other than Cs</td>
</tr>
</tbody>
</table>

### Strontium-90 in fishery products

- In order to ensure the safety, the effective dose from these radionuclides other than Cs in fishery product is assumed to be the same as that from radioactive cesium. This assumption is applied when radioactive Cs standard limit (100 Bq/kg-wet) for food was established.
- According to the data from the monitoring of fishery products, the effective doses from strontium-90 were from about 1/500 to 1/50 of that from radioactive cesium. This result shows the above assumption was conservative enough.
Strontium-90 (half-life: 28.8 years)

- Conversion factor (Bq to Sv) of effective dose for strontium-90 is about 2.2 times higher than that of cesium-137 (by the factor for adult in ICRP Publication 72).
- However, the concentration factors (the ratio of the concentration in organism to that in water) for strontium-90 in marine aquatic organisms were lower than those for cesium. That indicates that most of strontium-90 taken in organism is rarely absorbed and is excreted out.

Tritium (half-life: 12.3 years)

- The standard limits do not consider effect from tritium because the influence of tritium in food to human health is considered to be sufficiently small (ref. Ministry of Health, Labour and Welfare HP).
- Conversion factor of effective dose for tritium is about 1/700 of that of cesium-137 (by the factor for adult in ICRP Publication 72).
- Tritium mainly exists as water in nature. Therefore, tritium taken in organism is rarely kept in the body and is excreted out promptly. Consequently, the concentration factors for marine organisms are about 1.

Concentration factor (ref. IAEA TRS 422; Bio-concentration, Edit. N. Yamagata)

<table>
<thead>
<tr>
<th></th>
<th>Fish</th>
<th>Mollusks</th>
<th>Macroalgae</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cesium</td>
<td>5 ~ 100</td>
<td>10 ~ 60</td>
<td>10 ~ 50</td>
</tr>
<tr>
<td>Strontium</td>
<td>1 ~ 3</td>
<td>1 ~ 10</td>
<td>10</td>
</tr>
<tr>
<td>Tritium</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Framework for Radioactive Cesium Monitoring for Fishery Products

- Target species: Major commercial species and species that has record of detection with more than 50 Bq/kg in the previous year. Due consideration is given to, inter alia: ① living layers of species (surface, mid water and bottom), ② fishing season, ③ results of neighboring prefectures’ monitoring.

- Monitoring is strengthened when detected level of contamination is a smaller, but approximate to the standard limit (100 Bq/kg), or detected levels of contamination exceed the limit in the neighboring prefectures.

- In case of exceeding the limit, a relevant local government requires distribution restriction of the species and/or the Nuclear Emergency Response Headquarters directs distribution suspension order to the species.

**Monitoring plan developed mainly by local governments**

- **Monitoring Area**
  - Local government divides its area into several areas
  - Inspection at the main landing ports in each area

- **Target species**
  - Major species
  - Species that has record of detection with more than 50 Bq/kg

- **Frequency**
  - Once a week
  - Before fishing season (skipjack, saury .etc.)

- **Results of neighboring monitoring**
  - Approximate to standard limit
  - Distribution for consumption (when the monitoring result is close to the limit, a prefecture may require distribution restriction.)

- **Monitoring**

  - >100 Bq/kg
    - Distribution restriction in case the excess of the limit is found only in one area
    - Distribution suspension order in case more than one area show the excess.

  - ≤100 Bq/kg
    - Strengthen monitoring

For the effective implementation, landing of the species subject to the restriction and/or suspension is prohibited (except samples for monitoring). In addition, market people confirm that the species are not sold at ports.
In Fukushima, Apr.–Jun., 2011, excess ratio (No. of samples more than 100 Bq/kg/Total No. of samples) was 57.7% but was reduced by half in 1st quarter 2012. After 2nd quarter of 2012, monitoring has been focusing on species that have records more than 50 Bq/kg. The excess ratio still shows constant decrease, and it was 1.6% in Jan.-Feb., 2014.

Coastal fishing and trawl fishing off Fukushima have been suspended except trial fishing.

Monitoring Results for Marine Fishery Products in Fukushima

- Total: 16,357 samples
  - No. of samples more than 100Bq/kg: 2,036
  - No. of samples less than 100Bq/kg: 14,321
In prefecture other than Fukushima, excess ratio (No. of samples more than 100 Bq/kg/Total No. of samples) has been gradually decreasing to under 1% in 3rd quarter of 2012. No sample exceeded the standard limit in Jan.-Feb., 2014.

Distribution suspension order directed by the Chief of the Nuclear Emergency Response Headquarters (Prime minister) and/or distribution restriction directed by local governments have been imposed on the fishery products if their monitoring results exceeded the Standard Limit in order to prevent those products from being marketed.

**Monitoring Results for Marine Fishery Products in Other Prefectures**

- **Total No. of samples:** 23,000
- **No. of samples more than 100Bq/kg:** 174
- **No. of samples less than 100Bq/kg:** 22,826

**Excess Ratio**

- 2011 3-6: 22, 4.7%
- 2011 7-9: 11, 1.9%
- 2011 10-12: 1,509, 2.2%
- 2012 1-3: 1,727, 2.5%
- 2012 4-6: 2,539, 1.1%
- 2012 7-9: 2,260, 0.5%
- 2012 10-12: 2,885, 0.3%
- 2013 1-3: 2,189, 0.1%
- 2013 4-6: 2,671, 0.2%
- 2013 7-9: 2,280, 0.1%
- 2013 10-11: 2,345, 0.1%
- 2014 1-2: 1,395, 0.0%
As a result of radioactive cesium monitoring, almost all main fishery products are confirmed to be under the Standard Limit in whole Japan including Fukushima prefecture.

### Monitoring Results for Fishery Products

Main fishery products  have confirmed to be under the Standard limit in all prefectures since 1 April 2012

<table>
<thead>
<tr>
<th>Species</th>
<th>Panther Puffer</th>
<th>Olive flounder</th>
<th>Stone flounder</th>
<th>Ocellate spot alate, Rockfish, Nibe croaker, Pacific Cod</th>
<th>Japanese black porgy</th>
<th>Seabass</th>
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</thead>
<tbody>
<tr>
<td>Pelagic fish</td>
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<tr>
<td>Sardines</td>
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<td>Saury</td>
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<td>Japanese Amberjack</td>
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<td>Skipjack, Tunas, Coho Salmon, Chum Salmon</td>
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<td>Mackerel</td>
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<td>Swordfish</td>
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<td>Mid-water pelagic fish</td>
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<td>Blackthroat Seaperch</td>
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<td>Horse Mackerel</td>
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<td>Chlorophthalmus albatross, Striped Beakfish, Threadfin Hakeling, Black Scraper</td>
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<tr>
<td>Red Bream (Beryx splendens)</td>
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<td></td>
<td>Tiger Puffer, Herring, Yellowfin Goby, Purple Puffer</td>
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<td>Broadbanded Thornyhead (Sebastolobus macrochir)</td>
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<td>Demersal fish</td>
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<td>Marine mammal</td>
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<tr>
<td>Whales</td>
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#### Notice
a) × : Species and Area subject to distribution suspension order by the Chief for the Nuclear Emergency Response Headquarters (Prime Minister)
b) South of the latitude of the boundary between Iwate Prefecture and Miyagi Prefecture
c) Off Fukushima Prefecture, 40 marine species including above 9 species are subject to distribution suspension order by the Chief for the Nuclear Emergency Response Headquarters (Prime Minister).
d) Area of north of the latitude 36° 38’ North
e) Japanese black porgy in northern Ibaraki is under distribution restriction
After the Great East Japan Earthquake, Fukushima Prefectural Federation of Fisheries Co-operative Association has decided to stop fishing activities of all the coastal and trawl fisheries off Fukushima Prefecture.

Fukushima prefectural government conducts particularly intensive monitoring. It carries out monitoring for 150 samples of major marine species in every week.

Fish species and sea area covered by the trial fishing operation must be determined after confirming that: 1) the species is not under distribution suspension order by the Chief of the Nuclear Emergency Response Headquarters, and 2) the levels of radioactive cesium remain lower than the Standard for a certain time period.
Responses to the recent Water Leakage

- In response to recent leakage of contaminated water from F1NPS, the trial fishing operation for actual human consumption was not resumed on 1 September 2013 even after the opening of fishery season (please see the next page for more information).
- During the suspension period, Fukushima prefectural government monitored water samples of coastal sea off Fukushima prefecture, and confirmed that the level of radioactive cesium and total beta ray in water samples were the same level before the accident. Fukushima prefectural government also confirmed that concentration of radioactive Cs in fishery products were still in trend of decrease.
- After the confirmation by Fukushima prefectural government, the trial fishing operation for actual human consumption was resumed in offshore bottom trawling fishery on 25 September 2013.

Future of trial fishing operation

- Fukushima Prefectural Federation of Fisheries Co-operative Association intends to expand both species and areas of the trial fishing operation for actual human consumption subject to confirmation of food safety through monitoring.
The target species of trial fishing operation: 31 species, as of 1 Mar. 2014

(by offshore bottom trawlers: 30 species)

*A screening survey conducted on 27 February 2014 revealed that the radioactive contaminant level of Hilgendorf saucord was 110 Bq/kg. Accordingly, marketing of Hilgendorf saucord caught by the Trial Fishing Operation is suspended.

(by coastal pelagic trawlers: 2 species)
Kounago (Juvenile of Japanese sandlance) and Whitebait

(by coastal gillnet fishery: 1 species)
Salangichthys isikawae

The area of trial fishing operation as of 1 March 2014

The area of offshore bottom trawlers: ①～⑥
The area of octopus pot fishery: ①～④
The area of coastal pelagic trawlers: A～C
The area of coastal gillnet fishery: A,C
Inspection of radioactive materials and the distribution management of the fish products are conducted under the initiative of the Fukushima Prefectural Federation of Fishery Cooperative Association.

○ Since June 2012 to February 2014, 1,200 products (fresh or boiled) are inspected for radioactive cesium after being landed.

○ These results are publicized on the home page of Fukushima Prefectural Federation of Fisheries Co-operative Association. (Japanese only) http://www.jf-net.ne.jp/fsgyoren/siso/sisotop.html