Increases in the Concentration of Radioactive Materials in Seawater and Groundwater on the Ocean Side of the Site: Current Situation and Countermeasures

1. Analysis of Current Situation
   (1) Measurement History
   - The concentrations of radioactive material in the seawater in the port have clearly been decreasing since immediately after the accident. However, recently, although levels are still lower when compared to levels immediately after the accident, the concentrations have been fluctuating up and down. (Reference A)
   - In order to ascertain the cause of these fluctuations, groundwater was sampled at the groundwater observation hole on the ocean side of the site, which was subsequently analyzed.

   (2) Results of Groundwater Analysis from between Unit 1 and Unit 2 Water Intakes
   - 400,000 to 500,000Bq/L of tritium and 1,600Bq/L of all beta radiation were detected from the No.1 groundwater observation hole between Unit 1 and 2. (Reference B)
   - Thereafter, additional observation holes No. 1-1 to 1-4 were added in the vicinity of No. 1 and the groundwater was analyzed. At observation hole No. 1-2, which is the closest to the leak discovered two years ago, 380,000Bq/L of tritium (as of July 11), 890,000Bq/L of all beta radiation (as of July 15), 12,000Bq/L of cesium 137 and 5,900Bq/L of cesium 134 (as of July 15) were detected. (Reference C)
   - The No. 1-2 hole is prominent in the boring core analysis as well, but this is assessed to be the result of past leaks, since high concentrations of cesium were found in terms of height within areas near to the past leak points. (Reference D) (Reference E)
   - The high levels of all beta radiation and the complex underground structure of the trench in the No. 1-3 hole area suggests that a cause other than past leaks, such as a leak from the trench, may be possible. Therefore, an area survey and detailed risk mitigation countermeasures will be deliberated. (Reference E)
(3) Groundwater Analysis Results from between the Unit 2/3 Intake and the Unit 3/4 Intakes
• Since one thousand and several hundred Bq/L of all beta radiation and several thousand Bq/L of tritium were detected from the No. 2 observation hole between Unit 2 and 3, and from the No. 3 observation hole between Unit 3 and 4 respectively, monitoring has been enhanced and additional observation holes are being established in the vicinity. Preparations are being made to implement the countermeasures that were implemented in the vicinity of No. 1 without delay in accordance with analysis results. (Reference E)

(4) Fluctuations in the Water Level of Groundwater
• Since fluctuations in the water level of ground area in the concerned areas seem to be affected by changes in the tides and rainfall, it is assumed that these fluctuations come and go with seawater inside the open culvert. As a result it is assumed that groundwater that contains the contamination detected in the No. 1 observation hole after May this year is coming and going, so countermeasures are being implemented (countermeasures will be mentioned later). Furthermore, based on water level data from newly established observation holes, a detailed analysis and assessment will be completed by the end of October. (Reference F) (Reference G)

(5) Analysis Results of Seawater in the Open Culvert for the Unit 1-4 Intake
• Fluctuations in radioactive material concentration caused by rainfall can also be seen on the inner side of the silt fence. In particular, these trends are remarkable on the inner side of the Unit 3 silt fence. Therefore, a survey of the area around the Unit 3 intake will be progressed. (Reference H)
• The concentration of tritium in the seawater in the port has risen to 2,300Bq/L on the north side of the Unit 1-4 intake channel. There are possibilities of fallout leakage, such as from rain from the seawall, or leaking of groundwater. Also, the concerned observation points are in an area that has already been installed with impermeable walls on the ocean side, and it is possible that these impermeable walls have been hindering flow. However, since concentrations in the seawater do not just rise, but also fall, it is assumed that dispersion into seawater is limited. Furthermore, analysis results from a newly established observation hole on the outer side of the impermeable wall on the ocean side (north side of east breakwater) are approximately the same as observation results taken on the north side of the Unit 1-4 intake. (Reference I)
In order to confirm the impact from groundwater leaking into the port, additional holes will be bored on the north side of the Unit 1 intake and a survey will be conducted.

(6) Analysis Results of Seawater from inside the Port (outside the Unit 1-4 Intake Open Culvert) and at the Border of the Port

- Concentrations of tritium and all beta radiation inside the port on the outer side of the Unit 1-4 intake open culvert are almost below detectable limits (ND) (several tens Bq/L at most), and this appears to have no impact on the concentration fluctuations on the inner side of the Unit 1-4 intake open culvert. (Reference J)
- In the vicinity of the border of the port (port entrance, north intake, near the south intake) the concentration of tritium is almost below detectable limits (ND) (several tens Bq/L at most), and all types of all beta radiation are below detectable limits (ND) according to the most recent observation results, thereby showing concentrations to be the same or lower than those inside the port.

(7) Analysis Results of Seawater Offshore

- The results of seawater analysis taken 3 km offshore of the power station outside the port do not show any significant fluctuations. (Reference K)

Based on the above, the fluctuations in radiation concentrations are limited to inside the Unit 1-4 open culvert and have no impact offshore or inside the port. These results will be subject to a quantitative assessment through analysis of the behavior of concentrations within the port, and external third-party experts will be asked to make an assessment.

2. Countermeasures (Refer to reference materials)

(1) Ground Improvement through the injection of Chemicals

- Injection of chemicals into the ground between the Unit 1-2 intakes began on July 8, and as of July 20, 75 out of 231 chemical injections had been completed. The first round of improvements should be completed by around July 25, and the second round is to be completed by around August 10. (Reference L)
- Preparations have begun to confirm the scope of contamination between the Unit 1-2 intakes and implement countermeasures that encompass the confirmed scope of contamination. (Reference M)
- As an interim countermeasure until construction of an impermeable wall on the
ocean side, preparations have begun to implement ground improvements through chemical injection behind the seawall, between the Unit 2-3 intakes and the Unit 3-4 intakes. *(Reference M)*

(2) Draining of Contaminated Water from around the Vicinity of the Unit 2 Intakes and Sealing of the Branching Trench (Power Cable Trench)

- Extremely high concentrations of radioactivity have been detected at the No. 1-2 observation hole, which is closest to the area in which a leak of contaminated water from the Unit 2 screening room was discovered two years ago (April 2, 2011). High possibilities of either residual highly concentrated contaminated water from the countermeasures implemented two years ago slowly seeping around and leaking out, or the leak stopping countermeasures from two years ago degrading with time, were assessed.

Therefore, a survey of the contaminated water inside the branching trench (power cable trench), which may be residual highly concentrated contaminated water from countermeasures implemented two years ago, is underway and the contaminated water will be drained and the concerned trench sealed by the end of October. *(Reference N)*

(3) Cleansing of Contamination in the Main Trench (Seawater Piping Trench)

- Due to the difference in height between the main trench (seawater piping trench) and the turbine buildings of each unit, the conditions between each plant differ, but it is certain that a large volume of highly concentrated contaminated water is accumulating inside the main trench at Unit 2/3 (seawater piping trench). There is no hard proof that this water is directly causing the increases in concentrations, but in order to alleviate risk, a mobile cleansing unit will be used to clean the water inside the trench as early as possible (cleaning planned to commence in September).

In addition, the installation of pipes to transport contaminated water to existing water treatment equipment, such as secondary cesium adsorption device (SARRY) and the cesium adsorption device, etc., will be accelerated (plan to be completed in September). *(Reference O)*

(4) Draining the Water from within the Main Trench (Seawater Piping Trench) and Sealing It

- Draining water from the main trench (seawater piping trench) requires shutting it off from the turbine building, so in order to remove accumulated water from the
main trench, freezing tests must first be implemented as quickly as possible in order to solve certain technical issues, such as methods for freezing water that has high saline content and mitigating the effect on the structure from the increase in volume caused by the expansion of frozen water, etc., after which it will be determined whether this method can be applied or not. If possible, the plan is to remove water from the seawater piping trench after it is cut off by freezing, and sealing the trench closed. *(Reference P)*

(5) Impermeable Wall on the Ocean Side

- Advanced boring began in June 2012 and steel pipe sheet-piles began being inserted in April 2013. The ocean side impermeable wall on the ocean side of the seawall will be completed in September 2014, thereby providing even better water shielding performance.

As mentioned above, the power station is working together with the head office and coordinating with related departments to handle everything from sampling, analysis, and assessment, to countermeasure proposal and implementation and public relations in order to handle the situation quickly and with certainty.

A flexible approach to handling the situation, such as appropriately reflecting changes in plans as a result of insight acquired from future survey results and contaminated water countermeasure committees, will be taken.

3. Reference Materials

   Status of Implementation of Contaminated Water Countermeasures on the Ocean Side and Future Plans

End of Document
Trends in Radioactive Material Concentration in Seawater in the Port

Unit 1 Intake (outside silt fence)
- Silt fence erection: 4/11~4/14
- Construction to prevent permeation through south seawall: 8/18~9/28
- Seabed covering work: 3/14~5/11

Unit 2 Intake (outside silt fence)
- Silt fence erection: 4/11~4/14
- Construction to prevent permeation through south seawall: 8/18~9/28
- Seabed covering work: 3/14~5/11

Unit 3 Intake (outside silt fence)
- Silt fence erection: 4/11~4/14
- Construction to prevent permeation through south seawall: 8/18~9/28
- Seabed covering work: 3/14~5/11

Unit 4 Intake (outside silt fence)
- Silt fence erection: 4/11~4/14
- Construction to prevent permeation through south seawall: 8/18~9/28
- Seabed covering work: 3/14~5/11

Unit 1~4 Water Intake Canal (North)
- Silt fence erection: 4/11~4/14
- Construction to prevent permeation through south seawall: 8/18~9/28
- Seabed covering work: 3/14~5/11

Unit 1~4 Water Intake Canal (South)
- Silt fence erection: 4/11~4/14
- Construction to prevent permeation through south seawall: 8/18~9/28
- Seabed covering work: 3/14~5/11

(Reference) Density Limits specified by the Reactor Regulation (The density limits in the water outside the surrounding monitored areas)
- Cs-134: 60,000 Bq/L
- Cs-137: 90,000 Bq/L

Key:
- : Sampling point (daily)
- : Silt fence
- : Area in which the seabed has been covered
(Reference) Notification Concentrations (concentration limits in water outside of surrounding area monitoring zones)
- Cs-134: 60Bq/L
- Cs-137: 90Bq/L

Key
- Sampling point (daily)
- Silt fence
- Area in which the sea floor has already been covered

North side of Unit 5, 6 Discharge Channel

Port Entrance

Shallow Draft Quay

Near Fukushima Daiichi South Discharge Channel
Trends in Groundwater Tritium Concentrations

Reference B

地下水中のトリチウム濃度の推移

Bq/L

10,000,000
1,000,000
100,000
10,000
1,000
100

12/12/1 12/12/31 13/1/30 13/3/1 13/3/31 13/4/30 13/5/30 13/6/29

告示濃度 60000Bq/L

Groundwater No. 1
Groundwater No. 2
Groundwater No. 3
Groundwater No. 1-1
Groundwater No. 1-2
Groundwater No. 1-3
Groundwater No. 1-4
Trends in All Beta and Strontium concentrations in Groundwater

Bq/L

10,000,000

1,000,000

100,000

10,000

1,000

100

10

1

12/12/1 12/12/31 13/1/30 13/3/1 13/3/31 13/4/30 13/5/30 13/6/29 13/7/29

Groundwater No. 1
All Beta

Groundwater No. 1-2
All Beta

Groundwater No. 1-3
All Beta

Groundwater No. 1-4
All Beta

Groundwater No. 2
All Beta

Groundwater No. 3
All Beta

Groundwater No. 1-1
Sr-90

Groundwater No. 1-2
Sr-90

Groundwater No. 1-3
Sr-90

Groundwater No. 1-4
Sr-90

Sr-90
Density Limit
30Bq/L
Groundwater Measurements from East Side of Turbine Building

Ground improvement through the injection of chemicals in order to prevent the dispersion of contamination into the ocean.

Sheet piles inserted at impermeable wall on ocean side (As of the middle of July)

Groundwater observation hole (No.1)
(400,000~500,000 Bq/L of highly concentrated tritium detected)

Recent measurement results (Bq/L)

- **No.1-1**
  - All Beta: 67
  - Tritium: 98,000
  - (Samples from 7/15)

- **No.1-2**
  - All Beta: 4,400
  - Tritium: 630,000
  - (Samples from 7/8)

- **No.1-3**
  - All Beta: 67
  - Tritium: 98,000
  - (Samples from 7/15)

- **No.1-4**
  - All Beta: 4,400
  - Tritium: 630,000
  - (Samples from 7/8)

- **No.2**
  - All Beta: 49
  - Tritium: 410
  - (Samples from 7/11)

- **No.3**
  - All Beta: 1,400
  - Tritium: 1,700
  - (Samples from 7/11)

- **No.4**
  - All Beta: 100,000
  - Tritium: 290,000
  - (Samples from 7/15)

- **Cesium 134**: ND
- **Cesium 137**: ND
  - (Samples from 7/15)

- **No.1**
  - All Beta: 1,500
  - Tritium: 390,000
  - (Samples from 7/11)

- **East sea wall**

- **April 2, 2011 leak location**

- **Reference C**
  - April 2, 2011 leak location
  - East sea wall
  - All Beta: 890,000
  - Tritium: 380,000
  - Cesium 134: 5,900
  - Cesium 137: 12,000
  - (Samples from 7/15)
Condition of trenches in area 4m above sea level (Unit 1/2)

- The pits are basically sealed

Source: Plan for Preventing External Leakage of Water that includes Highly Concentrated Radioactive Substances at the Fukushima Daiichi Nuclear Power Station (Submitted to NISA on June 1, 2011) (partially revised and added to)
Condition of trenches in area 4m above sea level (Unit 3/4)

- The pits are basically sealed

Source: Plan for Preventing External Leakage of Water that includes Highly Concentrated Radioactive Substances at the Fukushima Daiichi Nuclear Power Station (Submitted to NISA on June 1, 2011) (partially revised and added to)
Leak locations/Estimated leak paths (Unit 2 ocean side trench location diagram)

Source: TEPCO Fukushima Nuclear Accident Analysis Report (June 20, 2012) (partially revised and added to)
Dose Rate Distribution for Boring Cores from Ocean Side
Groundwater Observation Hole No. 1-2

Dose rate (mSv/h)

Elevation O.P. (m)

※ B.G level measurements are all 0
Groundwater Radioactive Material Concentration Measurements

H-3 notified concentration

Cs-137 notified concentration

Bq/liter

Reference E
Groundwater levels in ocean-side boring holes No. 1~No. 3 and Onahama tide levels

*Onahama tide levels were taken from Japan Meteorological Agency website.*
Groundwater levels in ocean-side boring holes No. 1~No. 3 and Onahama tide levels

(Enlarged Version)

*Onahama tide levels were taken from Japan Meteorological Agency website.
Groundwater levels in ocean-side boring holes No. 1~No. 3 and Rainfall levels at Hirono
<table>
<thead>
<tr>
<th>Time</th>
<th>No. 1-1</th>
<th>No. 1-2</th>
<th>No. 1-3</th>
<th>No. 1-4</th>
</tr>
</thead>
<tbody>
<tr>
<td>10:00 AM July 9</td>
<td>1.80</td>
<td>1.82</td>
<td>—</td>
<td>1.83</td>
</tr>
<tr>
<td>10:00 AM July 11</td>
<td>1.91 (Note 2)</td>
<td>1.91</td>
<td>1.96</td>
<td>1.94</td>
</tr>
<tr>
<td>10:00 AM July 16</td>
<td>1.94 (Note 2)</td>
<td>2.22</td>
<td>2.22</td>
<td>2.25</td>
</tr>
</tbody>
</table>

Note 1: Values for water levels inside holes are provisional since the standard elevation of observation holes is being confirmed.

Note 2: Measurements taken after July 11 used for reference since No. 1-1 is within the area subjected to chemical injections.
A correlation can be seen between the increase in the concentration inside the Unit 3 silt fence and rainfall.
Trends in tritium concentration in seawater

Reference I
Trends in all beta, strontium concentrations in seawater

Bq/L


1F1-4 intake north side
All beta

1F1-4 intake north side
Sr-90

East sea wall north side
All beta

Sr-90
Density Limit 30Bq/L

告示濃度 30Bq/L

取水口北側全β

東波除堤北側全β

東波除堤北側Sr-90
Seawater Measurements from inside and outside the Port

**Inside of silt fence (Unit 1~4)**
- **All beta**: 320, 250, 1000, 300 (Samples from July 15)
- **Tritium**: 1300, 440, ND, 180 (Samples from July 15)

**Reference J**

**Most recent measurements (Bq/L)**

- **All beta**: ND (samples from July 9)
  - Tritium: 4.7 (samples from July 9)

- **All beta**: ND (samples from July 15)
  - Tritium: ND (samples from July 15)

- **All beta**: ND (samples from July 15)
  - Tritium: 5.5 (samples from July 15)

- **All beta**: ND (samples from July 15)
  - Tritium: ND (samples from July 15)

- **All beta**: ND (samples from July 15)
  - Tritium: ND (samples from July 15)

- **All beta**: ND (samples from July 15)
  - Tritium: 4.2 (samples from July 15)

- **All beta**: ND (samples from July 15)
  - Tritium: ND (samples from July 15)

- **All beta**: ND (samples from July 15)
  - Tritium: 5.5 (samples from July 15)

- **All beta**: ND (samples from July 15)
  - Tritium: ND (samples from July 15)

- **All beta**: 310 (Samples from July 16, surface layer)
  - Tritium: 800 (Samples from July 16, surface layer)

- **All beta**: 250 (samples from July 15)
  - Tritium: 460 (samples from July 15)

- **All beta**: 35 (samples from July 15)
  - Tritium: ND (samples from July 15)

- **All beta**: ND (samples from July 9)
  - Tritium: ND (samples from July 9)

- **All beta**: 260 (samples from July 15)
  - Tritium: 430 (samples from July 15)

- **All beta**: 500 (samples from July 16)
  - Tritium: 2300 (samples from July 16)
Radioactive Material Concentration Measurements for Seawater

- Inside Unit 1-4 intake open culvert
- Inside harbor
- At harbor boundaries
- Offshore

**Bq/Liter**

- 1: Inside of Unit 4 silt fence
- 2: Between Unit 3-4 intakes
- 3: Inside of Unit 3 silt fence
- 4: Between Unit 2-3 intakes
- 5: Inside of Unit 2 silt fence
- 6: Between Unit 1-2 intakes (surface layer)
- 7: Between Unit 1-2 intakes (bottom layer)
- 8: Inside of Unit 1 silt fence
- 9: North side of Unit 1-4 intake
- 10: North side of east sea wall
- 11: Shallow Draft Quay
- 12: West inner side of port
- 13: East inner side of port
- 14: In front of Unit 6 intake
- 15: Port entrance
- 16: North side of Unit 5, 6 intake
- 17: Near south discharge
- 18: 3km offshore

- Cs-137 (triangles)
- H-3 (circles)
- All Beta (squares)

White circles indicate detectable limits.
福島第一原子力発電所周辺海域の海水中放射性セシウム濃度の経時変化

資料K

Neither tritium nor all beta were detected

福島第一
福島第二

⑨ ⑩ ⑪ ⑫

海水 30点
海底土 43点
魚類等 11点

海水1回/日・海底土1回/月(2点)
海水1回/週・海底土1回/月(8点)
海水1回/月・海底土1回/2ヶ月(9点)及び
魚類等1回/月
海底土1回/月(13点)

Cs-134 Density Limit:60Bq/L
Cs-137 Density Limit:90Bq/L
H-3 Density Limit:60000Bq/L

3km offshore of Ukedogawa (T-D1) Top layer seawater radiation concentration (Bq/L)

3km offshore of Fukushima Daiichi site (T-D5) Top layer seawater radiation concentration (Bq/L)

3km offshore of Fukushima Daiichi site (T-D9) Top layer seawater radiation concentration (Bq/L)

15km offshore of Fukushima Daiichi site (T-5) Top layer seawater radiation concentration (Bq/L)
Progress Status of Ground Improvements behind Bank Protection
Progress Status of Ground Improvements behind Bank Protection

- Ground improvements commenced on July 8. (Work times: 7 PM to 7 AM)
- As of the morning of July 21, 75 injections have been completed (first round: 117, second round: 114 for a total of 231 injections)
- First row should be completed around July 25. Second row should be completed around August 10.
Additional Countermeasures behind the Bank Protection
(1) Additional countermeasures between unit 1-2 intakes

- Ground improvements commenced on July 8
- After completion of current chemical injections the range of chemical injections will be expanded behind the seawall to surround the mountainside and effort to suppress the dispersion of radioactive materials.
- The location of chemical injections needs to be considered due to obstacles on the mountainside, such as buildings and pipes, etc., but surrounding of the mountainside should be completed by the end of October (details to be deliberated)
- Preparations are being made to apply facing consisting of an aggregate layer and asphalt to the surface of the ground after the mountainside is surrounded by ground improvements in order to prevent the infiltration of rainfall.

※ The area to be surrounded will be determined based on future survey results
※ The area to be faced will be determined based on future survey results
(2) Additional Countermeasures for between the Unit 2-3 intakes/Unit 3-4 Intakes

- Preparation and deliberation of ground improvements through chemical injections such as those being implemented between the Unit 1-2 intakes are underway.

(Key)
- Ground improvements through chemical injection (behind seawall between Units 2-3 and 3-4)
Branch Trench (Power Cable Duct) Sealing Plan
Sealing the Branching Trench (Power Cable Duct)

Current State

- Main Trench (seawater piping trench)
- Contaminated water
- Branching Trench (power cable duct)
- Aggregate
- Highly fluid mortar
- Underwater anti-washout concrete
- Shaft B

← To T/B
Countermeasure (Step 1)

- **Contaminated water transfer**

**Work**
- The water will be transferred so as to prevent the leakage of contaminated water when the sealant is injected.
- Water transfer will commence in September.

**Amount to be transferred**
- Minimum transfer amount Trench 150-160m³
- Shaft B portion

**Details**
- Main Trench (seawater piping trench)
- Underwater anti-washout concrete
- Highly fluid mortar
- OP+4
- To T/B
Countermeasure (Step 2)

Shaft B

Contaminated water transfer

Repeated filling

Branching Trench (power cable duct)

OP+10

OP+4

Filler material

1st filling

2nd filling

3rd filling

Highly fluid mortar

Underwater anti-washout concrete

Main Trench (seawater piping trench)

Aggregate

To T/B

Work

• Sealant will be filled in while balancing the injection with water transfer

* Sealant selection and filling method to be determined
Countermeasure (Step 3)

- OP+10
- Shaft B
- Final filling
- Repeated filling
- Branching Trench (power cable duct)
- 3rd filling
- 2nd filling
- 1st filling
- Filler material
- OP+4

- Highly fluid mortar
- Underwater anti-washout concrete
- Main Trench (seawater piping trench)
- Aggregate
- To T/B
Countermeasure (Step 4)

After sealing the trench, soluble glass will be filled into the aggregate layer at the bottom of the duct (October-November).
Concentration Reduction Measures for Contaminated Water inside the Main Piping Trench (Seawater Piping Trench)
Concentration Reduction Measures for Contaminated Water inside the Main Piping Trench (Seawater Piping Trench) (1)

<Concentration Reduction Measures>

Since the turbine building has not been waterproofed concentration reduction measures will be implemented in the form of transferring contaminated water into the turbine building from inside the trench and treating the contaminated water inside the trench.

- Transfer to the turbine building
  
  If the concentration of contaminated water inside the trench is higher than that of the turbine building it is possible to reduce the concentration of contaminated water by transferring it to the turbine building
  
  (Reducing concentration by transferring contaminated water from the trench into the turbine building)

- Transferred to water treatment facilities (existing facilities) and treating contaminated water
  
  Along with transferring contaminated water to the turbine building it is possible to reduce high concentrations inside the trench. This requires some adjustments since the current flow contaminated water is going a different way.

- Installation of treatment equipment and treating contaminated water
  
  A closed system where contaminated water is removed from the shaft treated with treating equipment (additional) and then returned to the shaft will be created.
Concentration Reduction Measures for Contaminated Water inside the Main Piping Trench (Seawater Piping Trench) (2)

**Transferred to turbine building**

Water inside the trenches circulated and cleansed using new water treatment equipment

- Concentrations reduced to approximately the same as water inside the T/B building

**Transferred to water treatment facilities (concentrated RW building)**

- Water transfer to concentrated RW building
- Concentrations reduced to approximately the same as water inside the T/B building

Additional installation of equipment for treating water inside the trench

It is possible to purify the water to concentrations lower than that in the T/B building by restricting the amount of water leaking from the T/B building.
## Concentration Reduction Measures for Contaminated Water inside the Main Piping Trench (Seawater Piping Trench) (3)

<table>
<thead>
<tr>
<th>Method</th>
<th>Characteristics</th>
<th>Concentration reduction limits</th>
<th>Assessment</th>
</tr>
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<tbody>
<tr>
<td>T/B transfer</td>
<td>Increase in contamination concentrations in the turbine building (worsening of work environment)</td>
<td>Trench concentrations can be reduced by half or one third even if they are high and based on dose measurements it is highly probable that the concentrations in Unit 3 are high</td>
<td>×</td>
</tr>
<tr>
<td></td>
<td>Increase exposure during piping work conducted in the high dose areas in ocean side yard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transfer to water</td>
<td>Transfer route in the case of connection to the Unit 4 valve unit needs to be considered, and may have impacts such as increases in doses in the concentrated RW building</td>
<td>Concentrations can be reduced to the same level as contaminated water currently inside the turbine building</td>
<td>○</td>
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<tr>
<td>treatment facilities</td>
<td></td>
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<tr>
<td></td>
<td>Heavy load on current water treatment equipment if the concentrations of the water being treated increase</td>
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<td></td>
<td>Increase exposure during piping work conducted in the high dose areas in ocean side yard</td>
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<td></td>
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<tr>
<td>Treatment equipment</td>
<td>Sr purification possible with right media</td>
<td>Possible to purify the water to concentrations lower than that in the turbine building (depends on restricting the flow from the building)</td>
<td>©</td>
</tr>
<tr>
<td>installation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Installation space these to be secured</td>
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</tr>
<tr>
<td></td>
<td>Increase exposure during piping work conducted in the high dose areas in ocean side yard</td>
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</tbody>
</table>
### Concentration Reduction Measures for Contaminated Water inside the Main Piping Trench (Seawater Piping Trench) (4)

<table>
<thead>
<tr>
<th>&lt;Trench Purification Equipment&gt;</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Survey of 7M loading dock</td>
<td></td>
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<tr>
<td>*Make opening</td>
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<tr>
<td>*Sampling (Unit 2, 3)</td>
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<tr>
<td>2. Purification equipment</td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>installation commences</td>
<td></td>
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<tr>
<td>3. Water transfer equipment</td>
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<tr>
<td>installed</td>
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<tr>
<td>4. Adsorption tower manufacturing</td>
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<tr>
<td>5. Purification equipment</td>
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<tr>
<td>installed</td>
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<tr>
<td>6. Purification commences at one plant</td>
<td></td>
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<tr>
<td>7. Newly ordered purification equipment manufactured</td>
<td></td>
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<td>8. New equipment installed</td>
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<tr>
<td>9. Purification commences at second plant</td>
<td></td>
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</tbody>
</table>

### <Transfer to water treatment equipment>

<table>
<thead>
<tr>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Transfer pipes ordered</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Pipes, pumps installed</td>
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</tbody>
</table>

- Water sampled from shaft next to Unit 3 turbine (7/10)
- PE pipe laying, valves, shielding installation, power
- Purification commences
- Purification commences
Measures for Early Draining of Contaminated Water from Main Piping (Seawater Piping Trench)
Measures for Early Draining of Contaminated Water from Main Piping (Seawater Piping Trench)

Unit 2 work proposal

1. **Waterproofing the connection to the building through freezing**
   - Freezing water in gaps in the earth is accepted practice, but since this water has never been directly frozen...

2. **Contaminated water in the trench will be transferred**

3. **The trench and the shaft will be filled**

4. **The connection with the building will be thawed and then filled**

**Proving method through freezing tests**

- Areas to be filled:
  - Level of accumulated water: O.P. Approx. +3m
  - O.P. +10m
  - O.P. +7.4m

**Areas to be filled**

**Level of accumulated water**

**O.P. Approx. +3m**

**References:**
- Turbine building
- Cable tray
- Pipe
- Shaft
- Tunnel
## Schedule for draining the main piping trench (see water pipe trench) the water (proposal)

<table>
<thead>
<tr>
<th>Activity</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>January</th>
<th>February</th>
<th>March</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Transfer piping ordered</td>
<td></td>
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<td></td>
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<td></td>
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<tr>
<td>2. Piping, pumps installed</td>
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<tr>
<td>&lt;T/B Waterproof/filled&gt;</td>
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<tr>
<td>1. Design/deliberation</td>
<td></td>
<td></td>
<td>Water proofing (method, efficacy confirmation method, piping/concrete impact assessment, etc.), filling (method, efficacy confirmation method, etc.)</td>
<td></td>
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<tr>
<td>2. Testing</td>
<td></td>
<td></td>
<td>Preparations</td>
<td>Freezing commenced</td>
<td>Hold Point (adequacy of waterproofing by freezing)</td>
<td></td>
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<tr>
<td>3. Work on actual facilities</td>
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</tbody>
</table>

- Water draining commences
Issues Surrounding the Early Drainage of Contaminated Water from the Main Piping Trench (Seawater Piping Trench)

The following issues must be addressed with before draining the contaminated water from the trench. Beginning in 2013 methods for waterproofing, draining, and filling the trench will be examined and the adequacy of those methods confirmed.

- **Waterproofing the connections with buildings through freezing**
  - Stopping gap water in the earth by freezing is an accepted practice but we have never directly frozen water → Whether or not this is a viable means of waterproofing needs to be confirmed
  - Impact on the trench and piping during freezing
  - Method for confirming waterproofing after waterproofing freezing (because there will no longer be access to the inside of the trench)

- **Methods for draining and filling the trench**
  - Hindrances to installation of pumps in shafts (pipes, supports, etc.)
  - Groundwater flow after drainage and until filling of the trench
  - Methods for filling trenches that have obstacles such as pipes
  - Method of confirmation after filling is complete (because there’ll no longer be access to the inside of the trench)
Freezing tests on contaminated water in the main piping trench (seawater piping trench)

• Freezing test objective: To confirm the validity of waterproofing connections through freezing

Things to be confirmed to the test (issues)

• Whether or not waterproofing is possible by direct freezing of water and waterproofing performance
• The impact of equipment (the pipes/cable trays) on waterproofing performance
• The impact of water inside pipes on waterproofing performance
• The impact of cooling from outside the trench on waterproofing performance
• The impact of the number of rows of frozen pipes on waterproof performance

Execution Schedule

• Test plan, preparation: from July 2013
• Freezing tests, assessment: from September through December 2013

※ Freezing will commence in September in consideration of outside air temperature
## Countermeasures on the Ocean Side and Future Plans

<table>
<thead>
<tr>
<th>Location</th>
<th>Countermeasures Objectives</th>
<th>Countermeasure Method</th>
<th>Unit 1 Intake</th>
<th>Unit 2 Intake</th>
<th>Unit 3 Intake</th>
<th>Unit 4 Intake</th>
</tr>
</thead>
<tbody>
<tr>
<td>Near the sea wall</td>
<td>Prevent leaks of contaminated water into the ocean</td>
<td>Prevent the migration of seawater from the intake canal to the port by the silt fence</td>
<td>Countermeasures implemented</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Screen Pump Room</td>
<td>Prevent the migration of seawater into the Screen Pump Room from the silt fence</td>
<td>Countmeasures implemented</td>
<td></td>
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</tr>
<tr>
<td>Back of bank protection between each unit</td>
<td>Improve the ground behind the bank protection sheet-piles and prevent contaminated water from dispersing into the ocean</td>
<td>Countmeasures being prepared or deliberated</td>
<td></td>
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</tr>
<tr>
<td>Seawall on ocean side</td>
<td>Prevent contaminated water from flowing into the ocean by installing steel sheet-piles in front of the bank protection.</td>
<td>Countmeasures being prepared or deliberated</td>
<td></td>
<td></td>
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<tr>
<td>Location of leak present between March-June, 2011 right after the disaster</td>
<td>Seal the leak by filling the leak with soluble glass</td>
<td>No leaks</td>
<td></td>
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<tr>
<td>Main manhole pit of the branching trench (power cable trench)</td>
<td>Seal the main manhole pit of the branching trench (power cable trench) with concrete</td>
<td>Main manhole pit filled in June 2011</td>
<td></td>
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<tr>
<td>Branching trench (power cable trench) waterproofing and filling the bottom of the trench with aggregate</td>
<td>Implementation of internal survey in order to implement countermeasures</td>
<td>Countmeasures not implemented</td>
<td></td>
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</tr>
<tr>
<td>Drainage (of contaminated water) and sealing the branching trench (power cable trench)</td>
<td>There is little chance of contaminated water accumulating due to the relationship between height of the connection between the T/B and the trench (seawater piping trench)</td>
<td>Internal survey results show contaminated water (July 2012)</td>
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<tr>
<td>Inside main trench (seawater piping trench)</td>
<td>Water treated in order to reduce concentrations inside main trench (seawater piping trench)</td>
<td>Internal contaminated water concentrations being measured and concentration reduction countermeasures are being implemented, such as circulating contaminated water with the T/B</td>
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</tr>
<tr>
<td>Near T/B building</td>
<td>Seal off from T/B, draining water and fill</td>
<td>The connection between the T/B and the trench (seawater piping trench) will be sealed by freezing after which water will be drained and the inside of the trench filled. (Being deliberated)</td>
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</tbody>
</table>

### Key
- Countermeasures implemented
- Countermeasures being prepared or deliberated
- Implementation and preparations underway
- Unlikely
- Being deliberated