Causes and Countermeasures for the "High" Alarm from the Simple Radiation Monitor in the Unloading Wharf Drainage Channel at the Fukushima Daiichi Nuclear Power Station, which was deemed to conform to Article 18.10 of Fukushima Daiichi regulations

【Overview】

- On March 2, 2021, the simple radiation monitor (plastic scintillation fibers (PSF) monitor) in the unloading wharf drainage channel issued a “High" alarm. When the cause of the “High" alarm was investigated it was found that there was soil (deposit) that contained a gel-like substance with a high dose equivalent rate (Beta + Gamma) of 70μm on the surface of the ground in temporary storage area W2, which is upstream from the aforementioned drainage channel. The substance was subsequently collected.
- When the inside of a container showing partial but considerable corrosion (one container) that was transported from the W2 area to the solid waste storage warehouse was inspected, a plastic bag filled with absorbent material that contained water was found, and it could be seen that water had accumulated at the bottom of the container. (Already announced by April 12)
- In order to investigate the correlation between the deposit found on the surface of the W2 area and the water that had accumulated at the bottom of the container, an analysis of the deposit and the water from the bottom of the container was conducted. For the following reasons <u>it was determined that the deposit had been formed due to leakage of the water that had accumulated at the bottom of the aforementioned container</u>. (Refer to slides 7 and 8)
  - ✓ Radiation measurements of both the deposits and the water found that compared to cesium-137, the amount of radiation from strontium-90 was significantly higher.
  - ✓ An analysis of the chemical properties found that the chemical properties of the deposit and the water were similar (both the deposit and the water contained total organic carbon and sodium)
  - ✓ A molecular composition analysis found that both the deposit (extracted water from the deposit) and the water were similar to the molecular properties of polymeric adsorbents (material used for comparison).
- Since there have been no significant increases in gross beta radiation concentration in the unloading wharf drainage channel since the deposit was removed and the ground surface in the W2 area covered, we have determined that <u>the "high" alarm from the PSF monitor on March 2 was caused when rain washed water that had leaked from the aforementioned container (water that accumulated at the bottom of said container) into the drainage channel</u>. Therefore, at 1:15 PM today (May 20) <u>we determined that this event conforms to Article 18.10 “A leak of nuclear fuel material outside of controlled areas” of the Regulations on the Security of TEPCO Fukushima Daiichi Nuclear Power Station Facilities and the Protection of Specified Nuclear Fuel Material.</u>

Environmental impact assessment

- Given the assessment of the amount of radioactivity that leaked into the port(*1), drainage channels flow, PSF monitor readings and sampling measurements were used to assess average concentration in the drainage channel for three months (*2) (January 1~March 31, 2021). The assessment found that even when compared to drainage water concentration limits (three month average concentration) stipulated by law, the concentration of strontium-90 was 25Bq/liter (legally required concentration (*3): 30Bq/liter).
- Furthermore, the radioactivity concentration of seawater in the port is within the range of normal fluctuation (*4).
- We have therefore determined that there is no impact on the environment.
- No significant increase in gross beta radiation concentration in the unloading wharf drainage channel has been seen since the deposit found in the W2 area was removed and the surface of the ground covered.

*1: It was conservatively estimated that 1.6 billion Bq of strontium-90 leaked into the port (January 1~March 31, 2021). A fallout assessment has shown that 2.3 billion Bq of gross beta radiation leaked from the unloading wharf drainage channel between January 1 and December 31, 2020 (including cesium fallout).

*2: Assessment period stipulated by ministerial ordinances that stipulate Requirements for the safety of the TEPCO Fukushima Daiichi Nuclear Power Station facilities and the protection of specified nuclear fuel material.

*3: Ministerial ordinances that stipulate Requirements for the safety of the TEPCO Fukushima Daiichi Nuclear Power Station facilities and the protection of specified nuclear fuel material.

*4: Measurements taken from in front of the unloading wharf (sampling point closest to the unloading wharf drainage channel outlet), the north side of the inside of the port, and each monitoring point at the mouth of the port.

Countermeasures ①

① The spots in the W2 area where the leak from the container occurred have been decontaminated (completed)

- The deposits were identified and in areas with a high dose equivalent rate of 70μm the asphalt was stripped and the spot was repaved
- The repaved areas were also painted in order to prevent the dispersion and leak of radioactive substances

Photo 1. Deposits removed/decontaminating agents applied (March 24)

Photo 2. Area covered after deposit removal (March 24)

Photo 3. Asphalt stripped (April 15) (locations of high dose equivalent rate of 70μm)

Photo 4. Asphalt repaving (April 15)/painting (April 16, 19th) (photo taken on April 20)

Countermeasures ②, ③

② Enhanced radiation monitoring of the unloading wharf drainage channel (ongoing)

- PSF monitors with separate valves for beta and gamma measurements will be installed in the unloading wharf drainage channel in order to enhance detection of leaks of contaminated water (primary nuclide: strontium-90 (beta nuclide) (the monitors will be put into operation on May 21 and trends will continue to be monitored)

Conventional PSF monitors do not enable radiation from beta nuclides to be differentiated from radiation from gamma nuclides so it was impossible to differentiate leaks of contaminated water (containing primarily beta nuclides) from fallout flow (beta + gamma nuclides, such as cesium-137).

Since PSF monitors with different valves for beta and gamma radiation can differentiate between radiation from beta nuclides and that from gamma nuclides, they are more accurate and can detect contaminated water leaks

③ Strengthening inspections that look for a radioactive substance leaks from containers (new/ongoing)

- Implementation of visual inspections of containers (5,338) that must* have boundary functions (vessels/tarp covering) (April 15 through June 2021)
- Inspection of the contents of containers for which of the contents are unknown (4,011 containers) (July through October 2021)
- When applying for permission to temporarily store containers, photos of the contents will now be required to be submitted along with the application (new policy) in order to confirm that the contents does not contain water.
- The monitoring of temporary storage areas used to store containers and must* have boundary functions (vessels/tarp program) shall be enhanced

＜ Enhanced monitoring of containers subject to visual inspections (new) ＞

In order to confirm the radioactive substances are not leaking from containers, dose equivalent rate (70μm, 1cm) measurements will be taken at ditches that serve as the drainage channels for temporary storage areas and nearby cesspools once a day (excluding Sundays) to confirm that there are no significant fluctuations.

＜Temporary storage area monitoring (ongoing) ＞

Area patrols and air dose rate measurements: Once a week; Measurements of the concentration of radioactive substances in the air: Once every three months

＜ Monitoring during rainfall (ongoing) ＞

Jinbazawa River into which rain water from the temporary storage area flows (once a month); Unloading wharf drainage channel (continual) monitoring

*Applies to rubble, etc. with a surface dose rate (Gamma) of 0.1 mSv/hour or higher, and rubble, etc. with a surface dose rate (Beta) of 0.01 mSv/hour or higher

【Reference】 Locations of temporary storage area W2 and the unloading wharf drainage channel

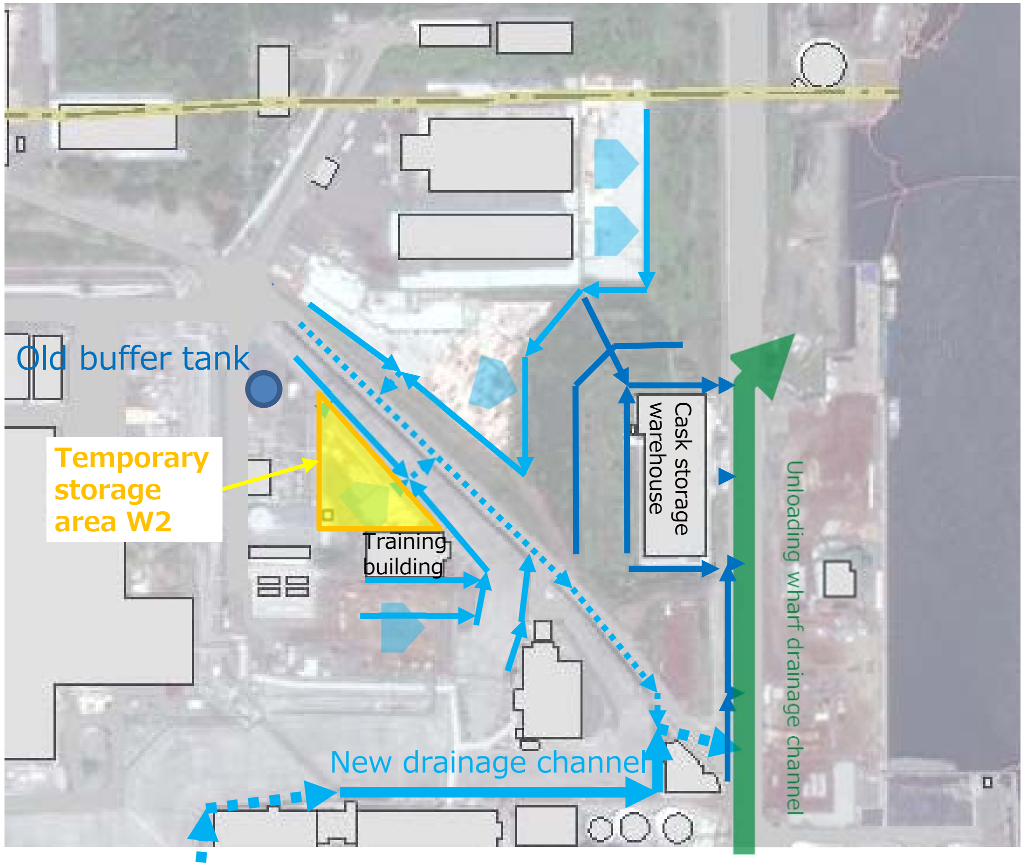


Figure 1. Locations of temporary storage area W2 and the unloading wharf drainage channel

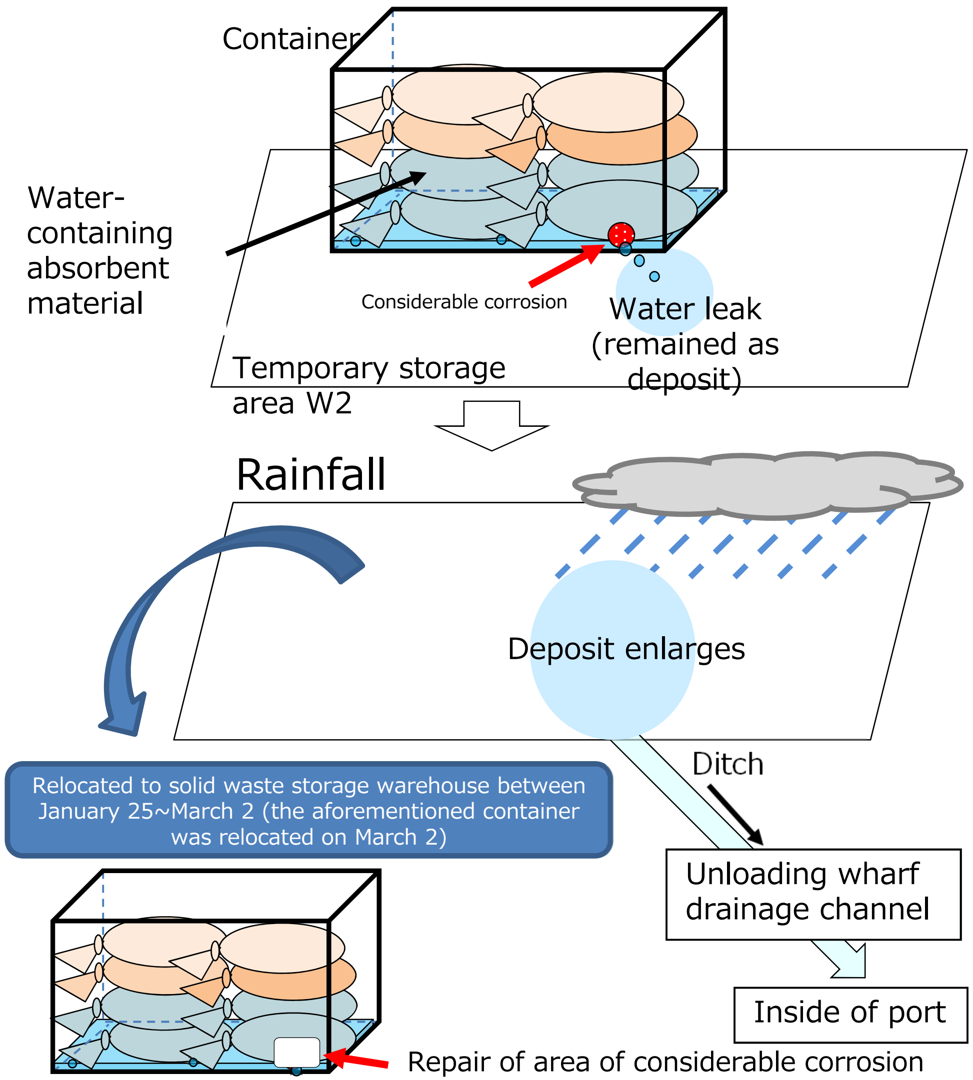
Photo 1. Inside of the container prior to removing the plastic bags

Photo 2. Inside of the container and repaired area

Rubble, etc. from the disaster in temporary storage area W2 will be put into containers or covered with tarps. The area will be patrolled and air dose rate measurements (once a week) and measurements of the concentration of radioactive substances in the air (once every three months), taken.

Repair material applied from the outside of the container could be seen inside the container

【Reference】 Causes of the “High" alarm from the PSF monitor



- 273 containers were relocated to the solid waste storage warehouse in conjunction with construction to widen Shiomizaka Road
- Visual inspections performed when the containers were relocated
- Corrosion on the aforementioned container (one container) was repaired after the container was relocated
- No holes or evidence of leaks were found on any of the other containers

Plastic bags filled with water-containing absorbent material were piled on one another. The pressure from the weight of the bags on top forced the ties on the bags at the bottom to become loose thereby allowing water to leak out into the container.

⇩

The bottom of the container corroded as a result of the water that had leaked out into the container

⇩

Water containing radioactive substances leaked out of the container from areas at the bottom of the container showing considerable corrosion

⇩

When the containers were relocated to the solid waste storage warehouse, the water that had leaked out remained in the area as a deposit

⇩

During times of rain, the radioactive substances contained in the deposit were dispersed throughout the area and washed into the ditch

⇩

The radioactive substances were washed into the unloading wharf drainage channel via the ditch

⇩ "High" radiation alarm indicated by the PSF monitor

Leakage into the port

Gate closed

【Reference】 Analysis of deposit and water accumulated at the bottom of the container (radiation measurement, chemical property analysis)

- ✓ Radiation measurements found significantly high concentrations of Sr-90 compared to Cs-137 in both the deposit and the water accumulated at the bottom of the container.
- ✓ A chemical property analysis found that both the deposit and the water accumulated at the bottom of the container contained Na and TOC.
- ✓ Radiation measurements and chemical property analysis of the deposit and the water that accumulated at the bottom of the container found them both to be similar.

	Cs-134 (Bq/kg) ※	Cs-137 (Bq/kg) ※	全β (Bq/kg) ※	Sr-90 (Bq/kg)	Na (mg/kg)	SiO_2 (mg/kg)	TOC (mg/kg)
Deposit ①	2.9E+4	9.0E+5	2.3E+8	2.1E+7	9,400	210	29,000
Deposit ②	2.1E+4	4.9E+5	2.4E+7	4.4E+6	1,900	240	5,800
Deposit ③	2.7E+4	5.8E+5	6.4E+6	3.8E+6	590	57	3,000
Deposit ④	8.2E+4	1.9E+6	4.7E+7	2.1E+7	1,400	170	4,900

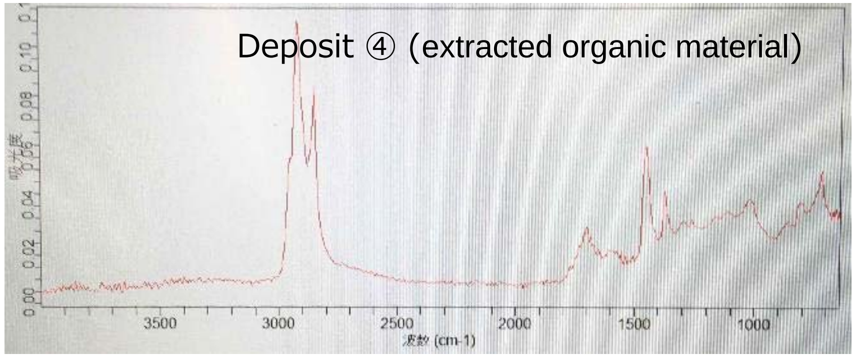
Kg used as unit of denominators throughout unit
*Announced on March 29, 2021

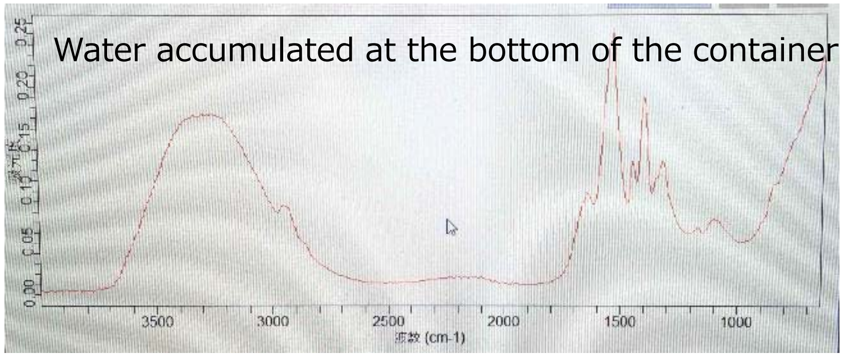
	Cs-134 (Bq/L)	Cs-137 (Bq/L)	全β (Bq/L)	Sr-90 (Bq/L)	Na (mg/L)	SiO_2 (mg/L)	TOC (mg/L)
Water accumulated at the bottom of the container	3.1E+3	8.9E+4	2.6E+7	1.4E+7	7,500	11	13,000

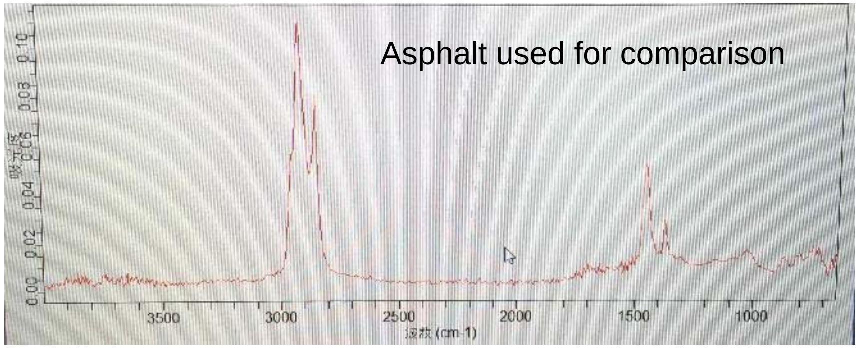
L used as unit of denominators throughout unit

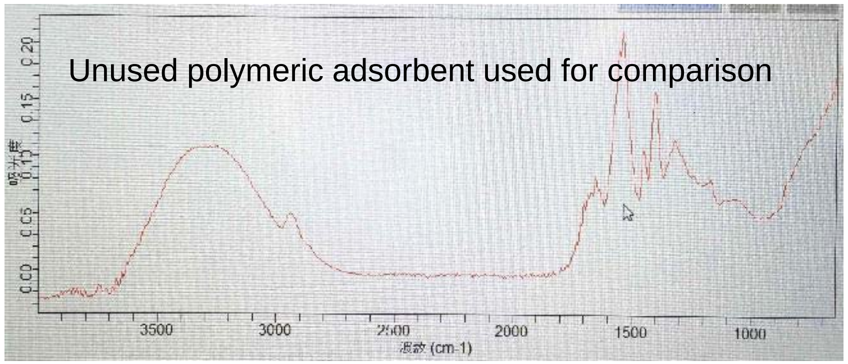
【Reference】 Analysis of deposit and water accumulated at the bottom of the container (Molecular composition analysis)

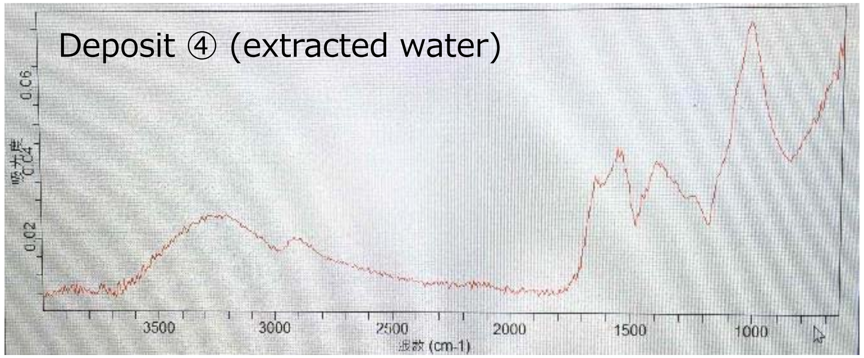
- ✓ Spectral analysis found that the water accumulated at the bottom of the container closely matched the unused polymeric adsorbent used for comparison.
- ✓ Deposit ④ (extracted organic material) closely matched the spectrum of the asphalt used for comparison.
- ✓ Deposit ④ (extracted water) was similar to the spectrum of the water accumulated at the bottom of the container.
- ✓ From the above it was determined that the water accumulated at the bottom of the container is a polymeric adsorbent, and that the deposit contains elements of asphalt, and is a polymeric adsorbent that has absorbed water.
- ✓ The results of radiation measurements, chemical property analysis and molecular composition analysis found that **<u>the deposit was formed by water that had accumulated at the bottom of the container and leak onto the surface of the storage area.</u>**





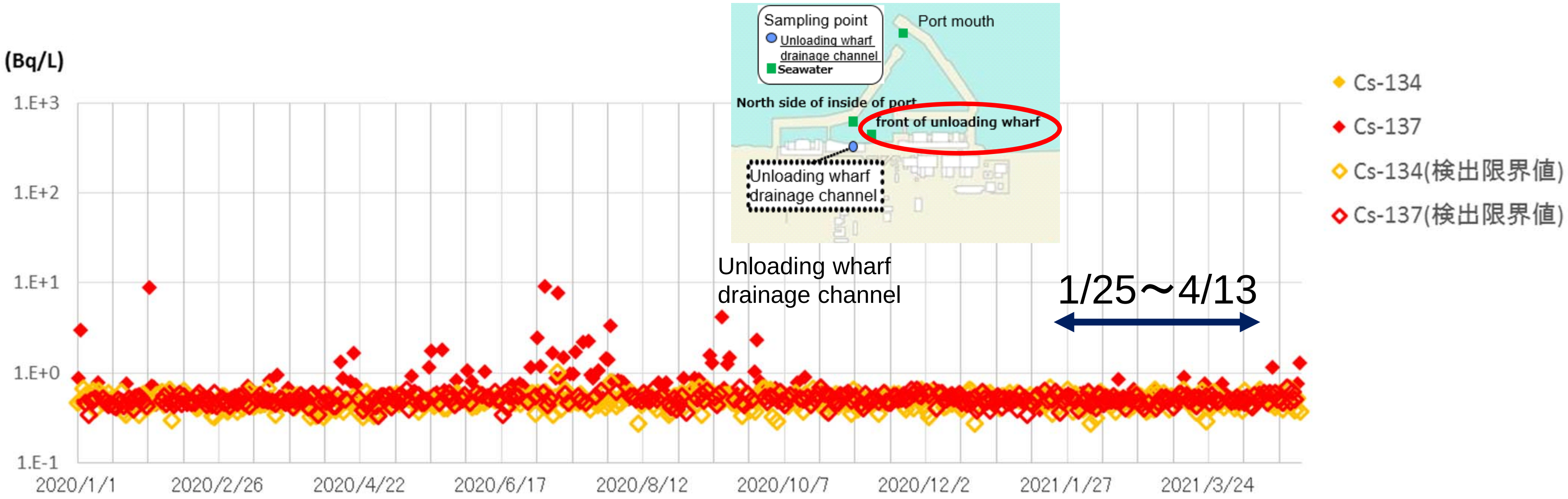


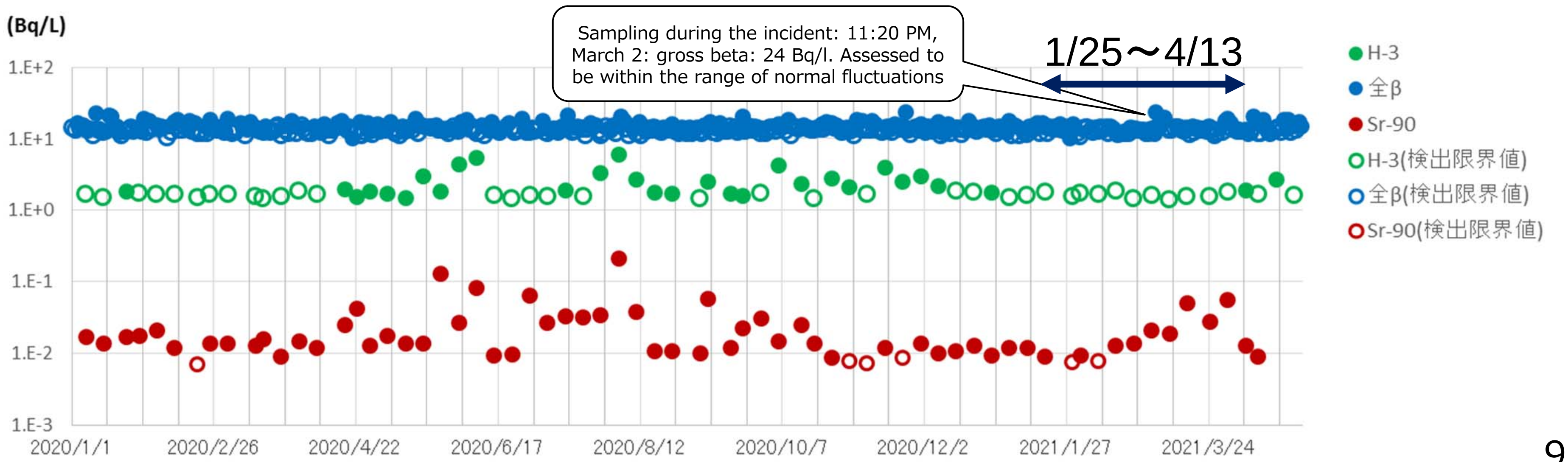




【Reference】 Seawater monitoring (from in front of unloading wharf)

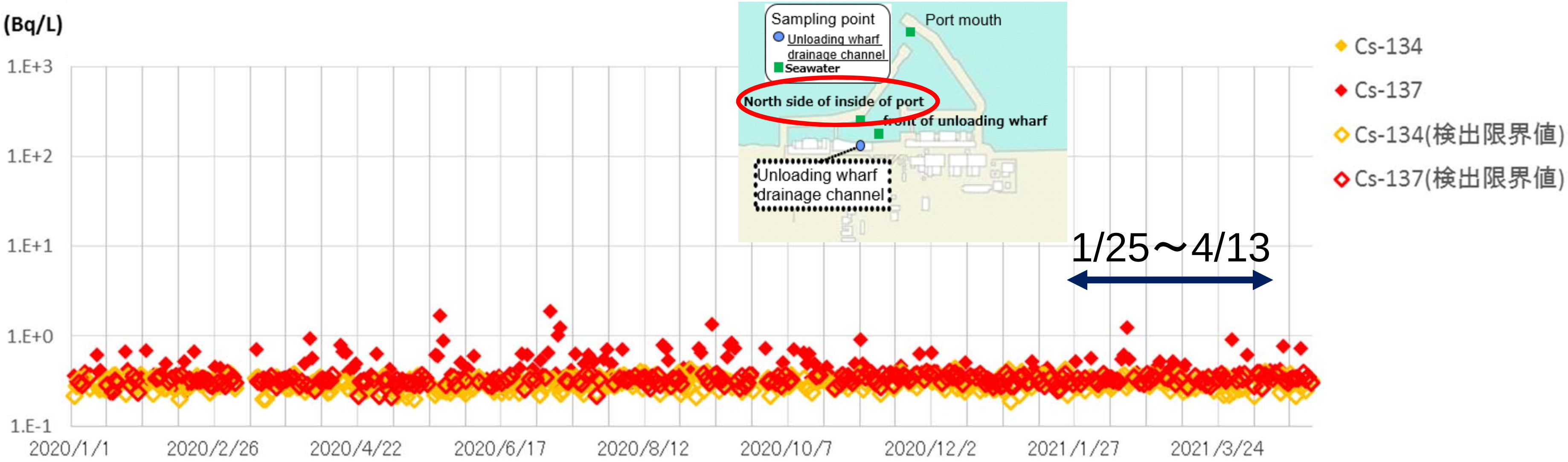
✓ **No significant fluctuations have been seen in the concentration of radiation in the seawater at the measuring point in front of the unloading wharf**, which is the closest measurement point to the outlet of the unloading wharf drainage channel

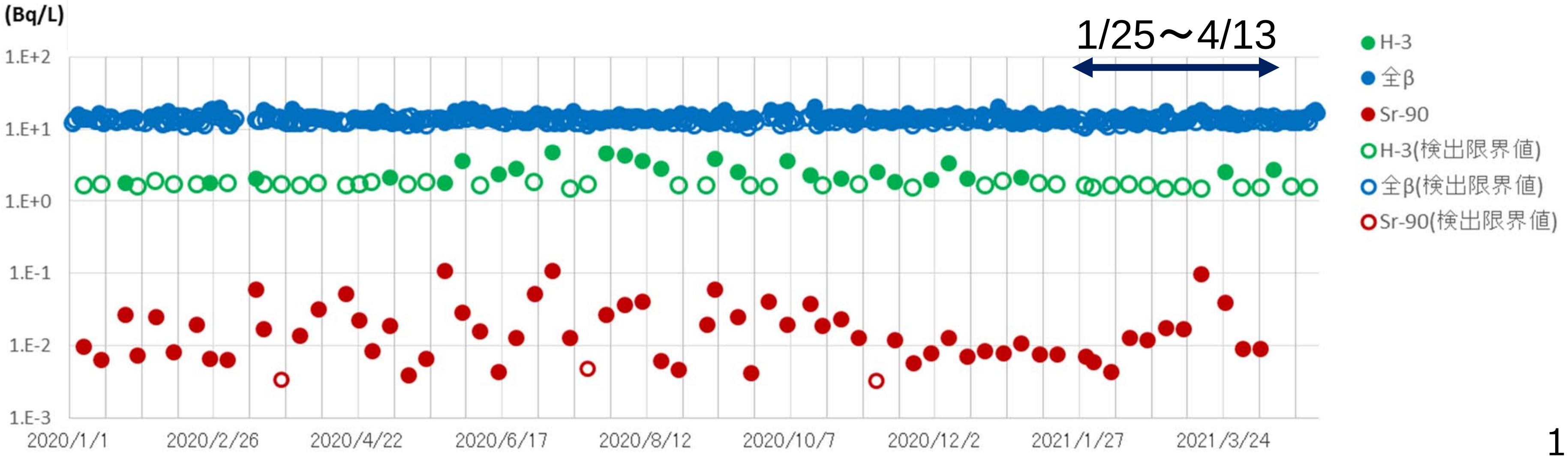




【Reference】 Seawater monitoring (North side of inside of port)

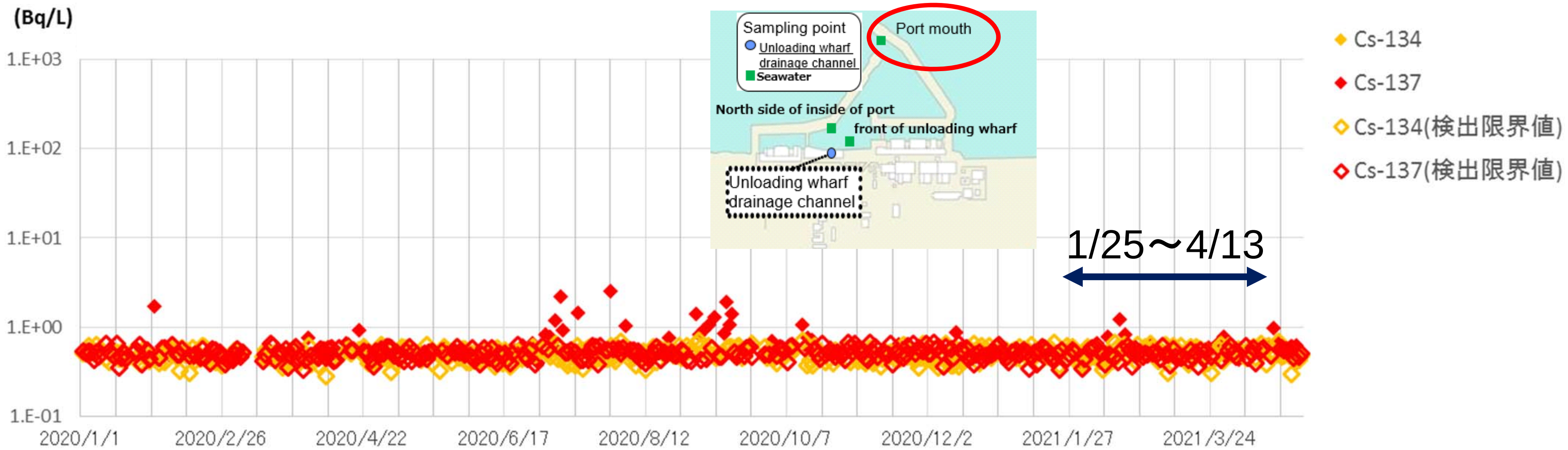
✓ **No significant fluctuations in the concentration of radiation in seawater has been found at the measuring point on the north side of the inside of the port**

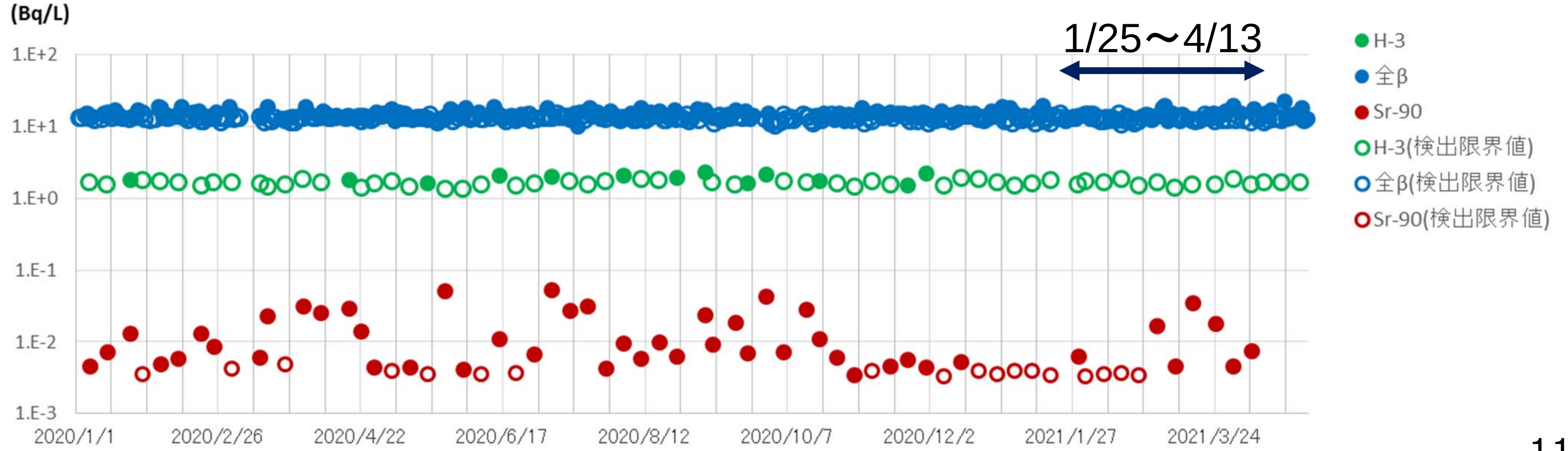




【Reference】 Seawater monitoring (Port mouth)

✓ **<u>No significant fluctuations in the concentration of radiation in seawater has been found at the measuring point at the port mouth</u>**





【Reference】Seawater radiation monitor trends

✓ **No significant fluctuations have been seen with seawater radiation monitors**