Updated Status of Fukushima Daiichi Nuclear Power Station

～Regulation, Overview, Actions～

Hiroshi YAMAGATA

Director, Nuclear Regulation Division for BWR
Nuclear Regulation Authority (NRA), Japan

September 2013

Contents

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.

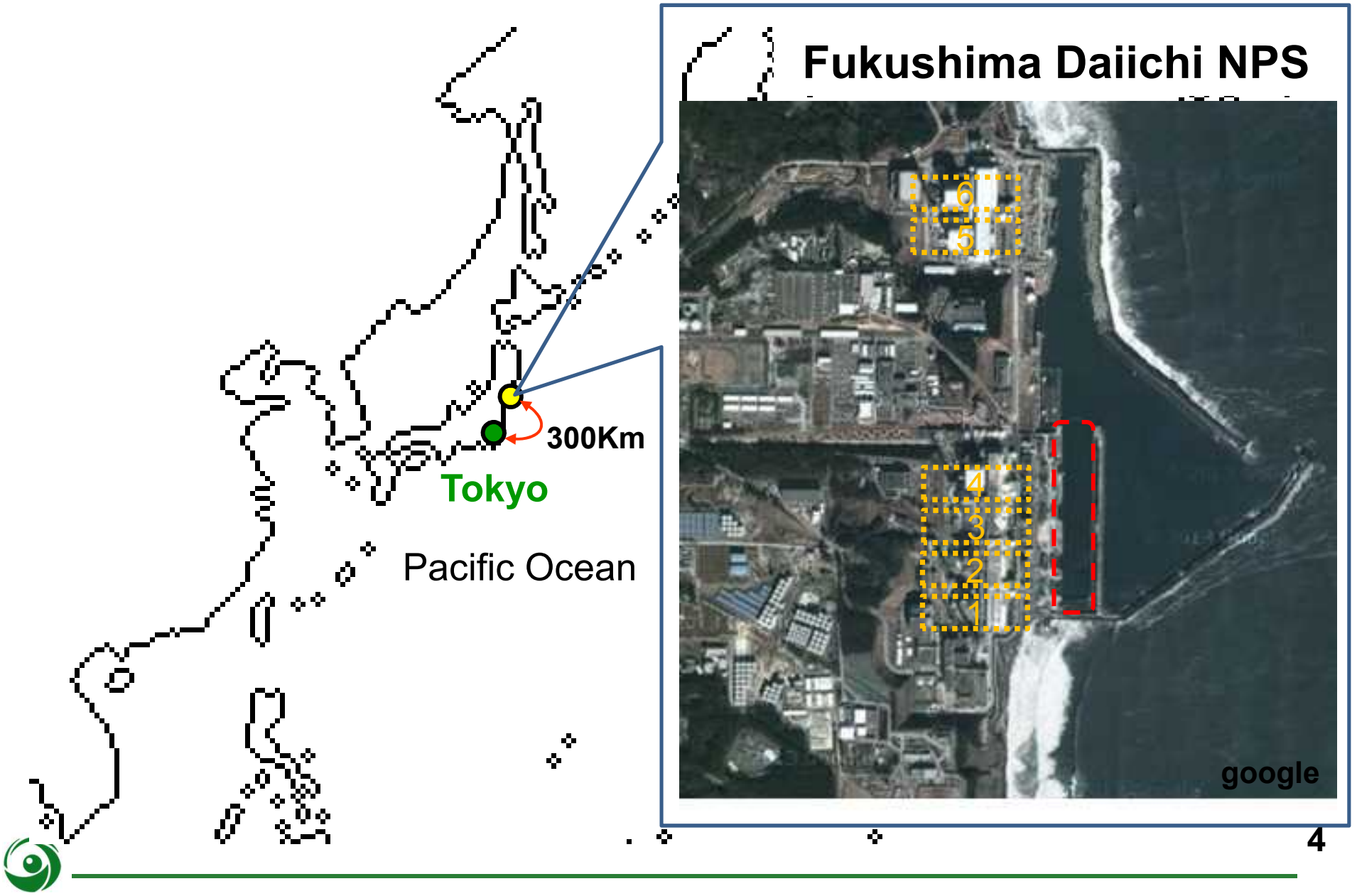
2012. 9.19 NRA was established.

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.

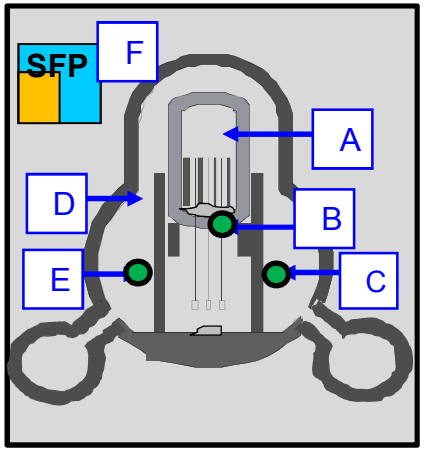
Overview of Fukushima Daiichi NPS

Location of Fukushima Daiichi NPS



Molten Cores and Spent Fuels

✓ Molten cores in RPV and PCV, and spent fuels in SFP have been cooled.
✓ H_2 concentration in PCV have been much lower than flammability limit.



		 Unit 1	 Unit 2	 Unit 3	 Unit 4
A	Water Injection to RPV [m^3/d]	102	126	130	No Fuel in RPV
B	RPV Bottom Temperature[℃]	33	43	43	
C	PCV Temperature[℃]	33	44	41	
D	N_2 Injection to PCV [Nm^3/h]	28	15	16	
E	H_2 Concentration in PCV[Vol%]	0.02	0.06	0.1	
F	Spent Fuel Pool Temperature[℃]	27	27	26	36

Unit 5 & 6 are cold shutdown.

As of September 13, 2013

Spent Fuel Pools (Unit 3 &4)

- ✓ Fuel Rack and Assembly of SFP of Unit4 had little damage.
- ✓ Removal of Spent Fuel in Unit4 will be started from November, 2013.
- ✓ Debris over SFP of Unit3 are being removed.

Unit 4

Unit 3

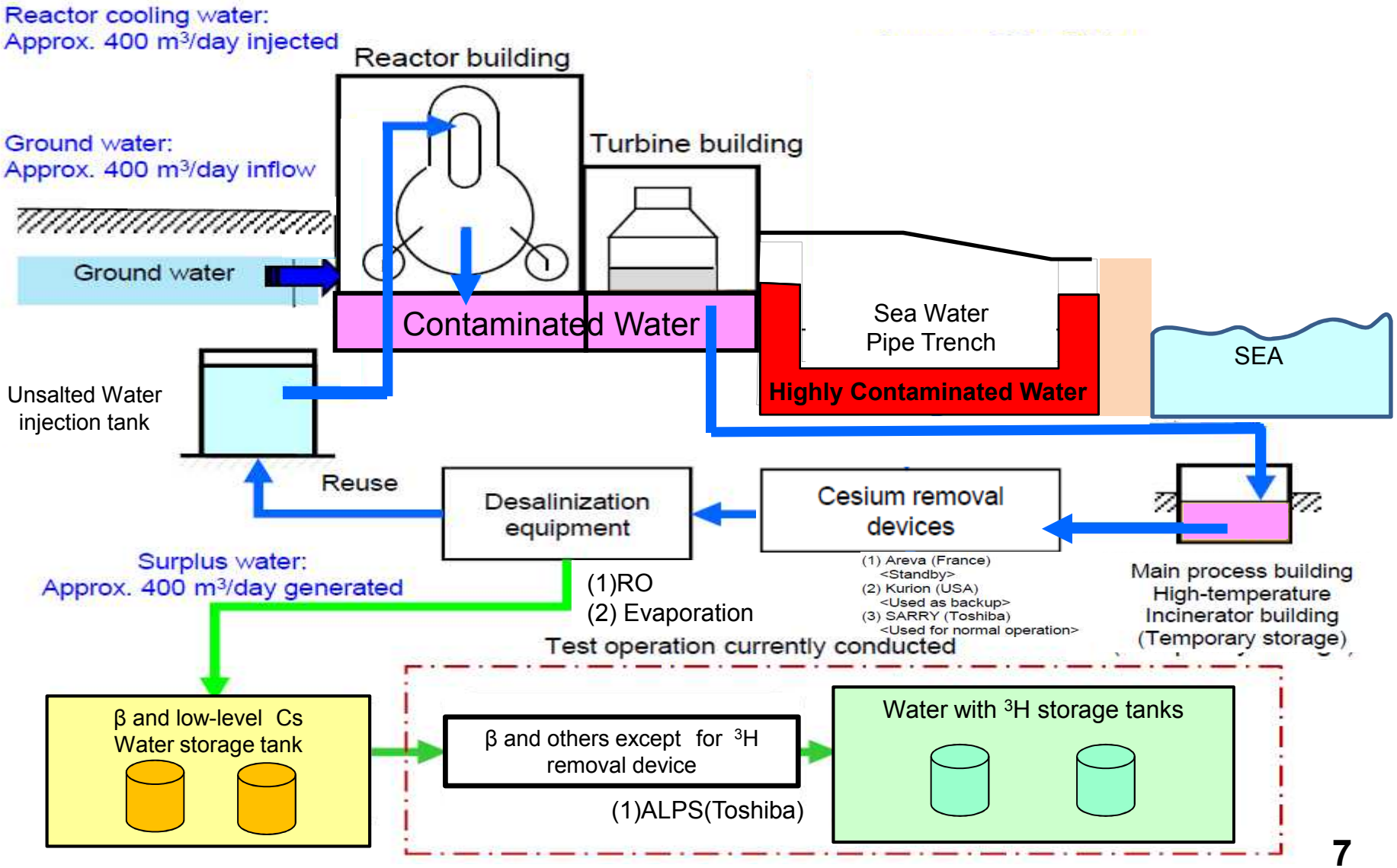
Fuel Rack

Fuel Assembly

Photo by TEPCO

Treatment System of Contaminated Water

✓ Contaminated Water in Turbine buildings is treated and injected to RPVs.
✓ 400m³/d of groundwater inflowing buildings forces capacity of tanks increase.



Radioactivity Levels of Contaminated Water

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

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

Storage Tanks

✓340,000 m^3 of various levels of contaminated water is stored in the storage tanks.
✓280,000 m^3 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

Square- shaped storage tanks

Horizontal-installation-type storage tanks

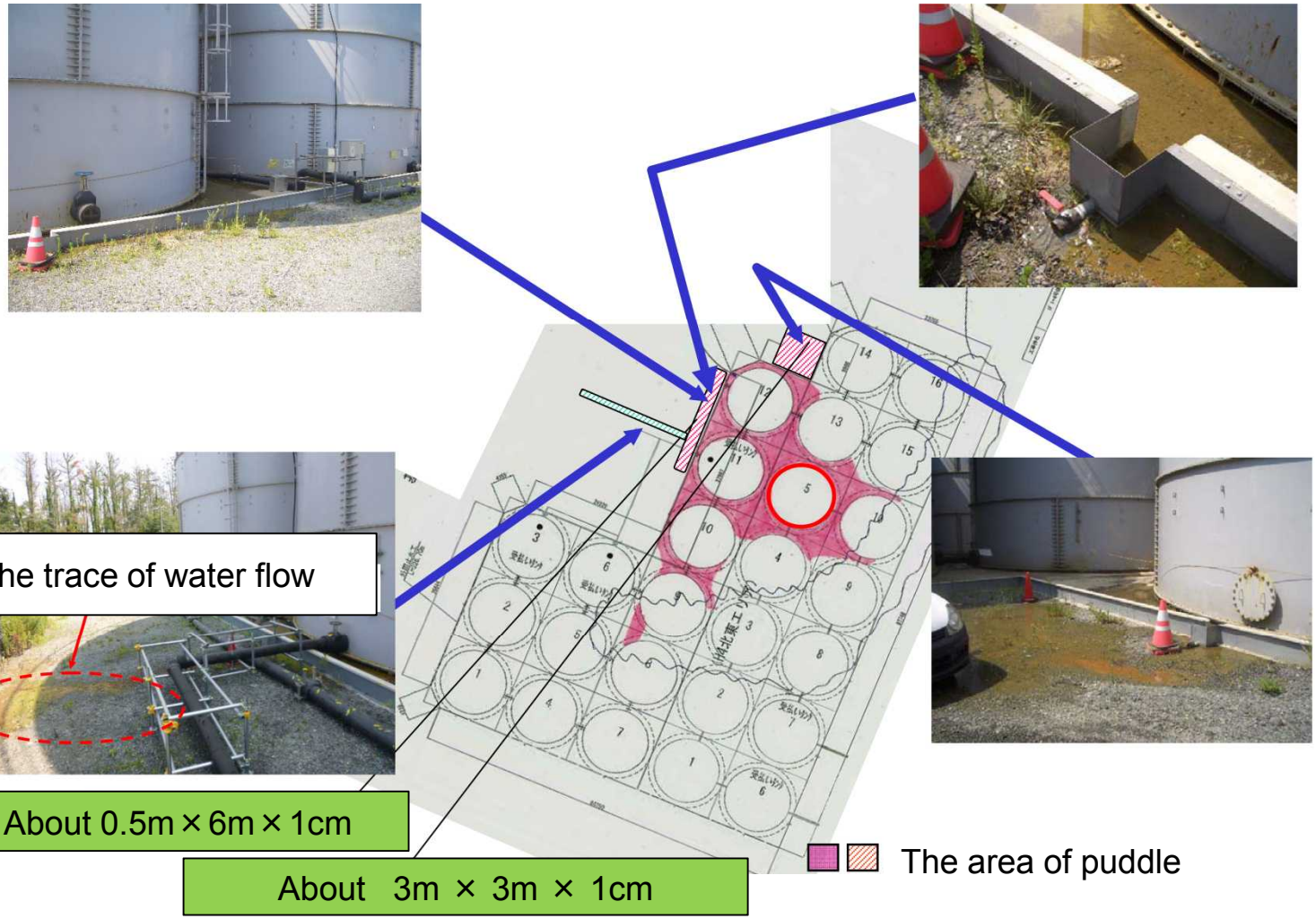
Shape	Junction Method	Measures against Corrosion	Contents	The number of tanks
Cylindrical	Flange	Exterior : Painting Interior : tar-epoxy resin	β and low-level Cs Water after RO Unsalted Water after RO Water with ^3H after ALPS	305
	Welding	Exterior : Painting Interior : tar-epoxy resin	Water with ^3H after ALPS β and low-level Cs Water after RO	64
Square- shaped	Welding	Exterior : Painting Interior : tar-epoxy resin	β and low-level Cs Water after RO Unsalted Water after RO	217
Horizontal-installation-type	Welding	Exterior : Painting Interior : FRP	β and low-level Cs Water after RO or evaporation	342

As of August 20, 2013

Recent Issues

Leakage of β and low-level Cs Water from Cylindrical Tank(1)

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

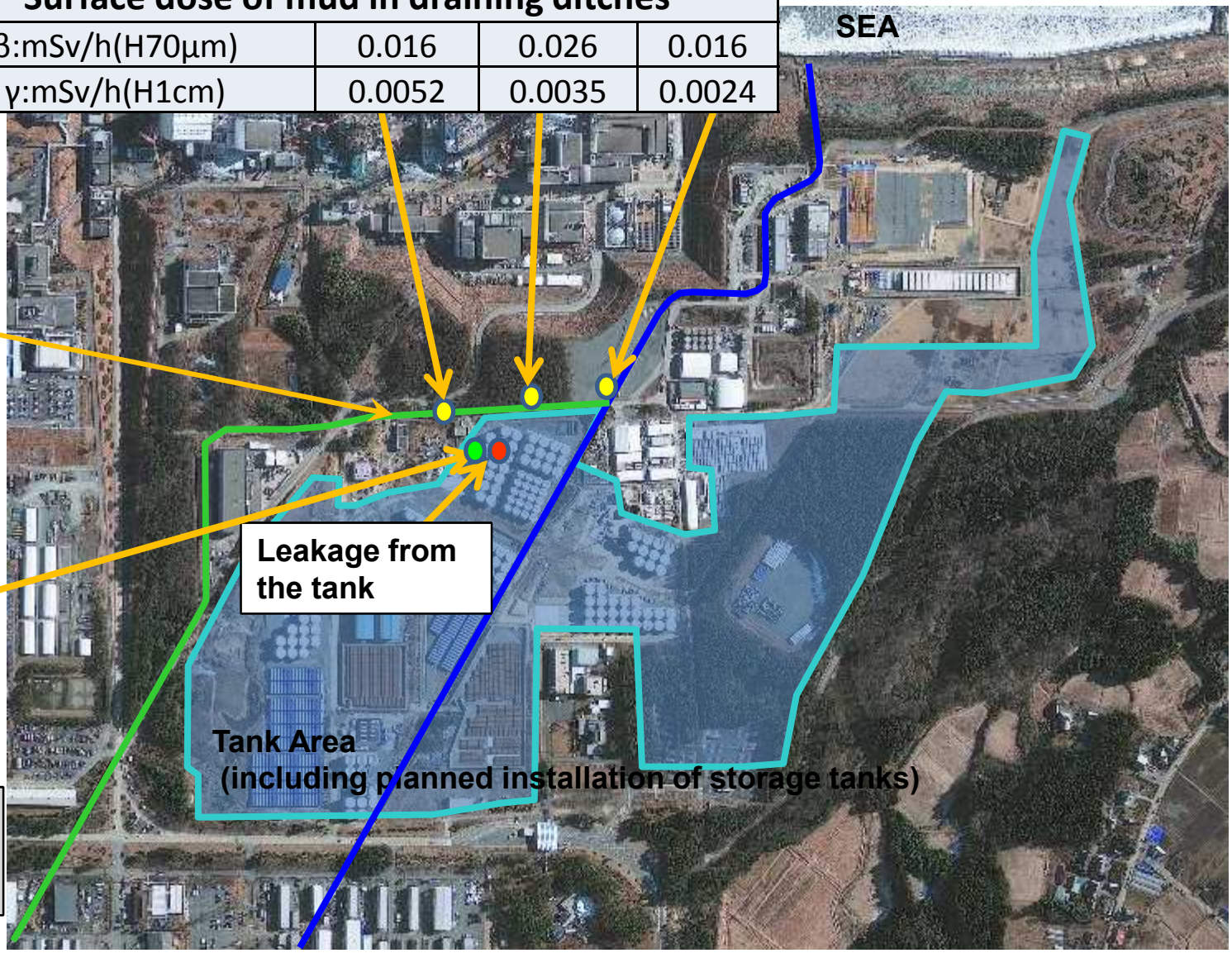


Source:TEPCO

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

Surface dose of mud in draining ditches			
β:mSv/h(H70μm)	0.016	0.026	0.016
γ:mSv/h(H1cm)	0.0052	0.0035	0.0024

Draining Ditches

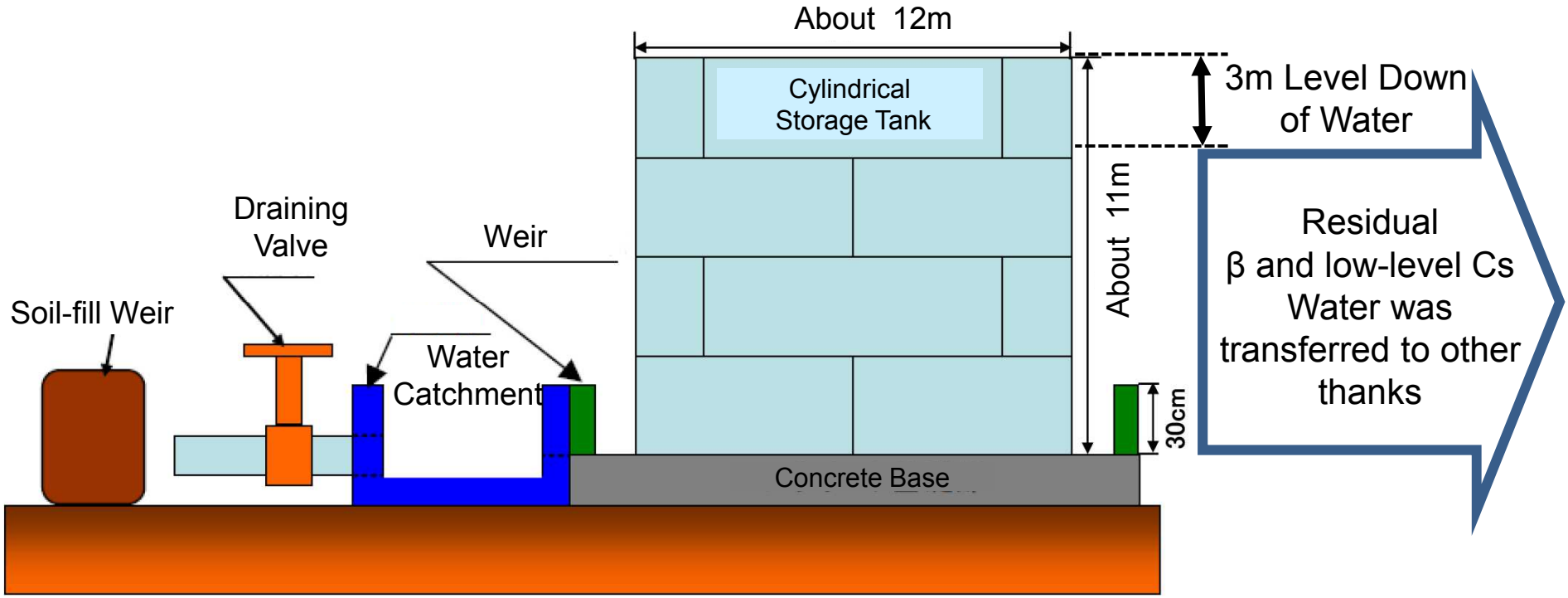


Sampling Well
- **15m from the Leakage point**
- **7m of depth**

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

These value are not guaranteed by the NRA.
Modified by the NRA, Original illustrated by TEPCO

Leakage of β 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 β and low-level Cs Water

[Provisional]

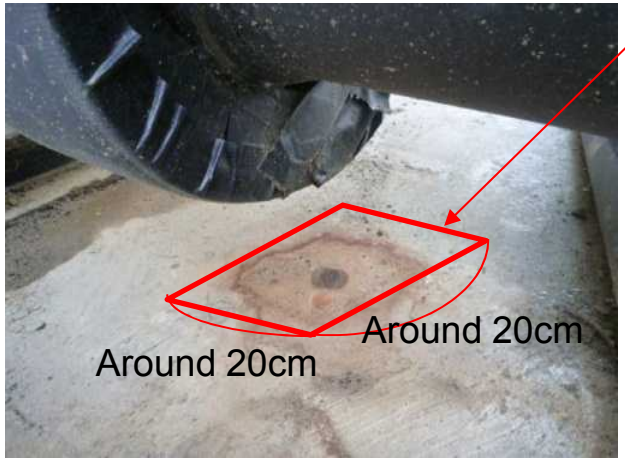
^{137}**Cs 1.0 × 10^{2} Bq/cm^{3}**
^{134}**Cs 4.6 × 10^{1} Bq/cm^{3}** **× 300m^{3} > A few thousand TBq ^{99}Mo**
Total β 8.0 × 10^{4} Bq/cm^{3}

✓ No remaining safety layer

Hot Spots on the Tanks

H5 Area

Place of color change



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

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

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

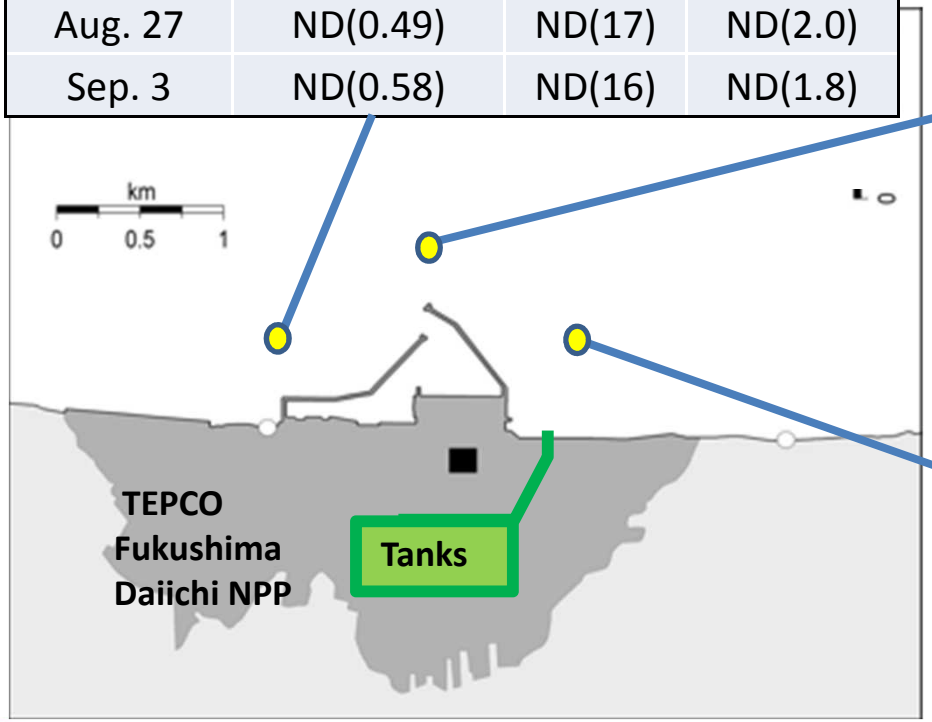
③At the point 5cm from the flange, 1800 mSv/h * of β rays was detected by TEPCO on 31 August.
No water leakage was found around here.

* 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.

Sampling Date	Radioacitivity of sea water (Bq/L)		
	Cs-137	total β	H-3
Aug. 14	ND(1.4)	ND(18)	4.7
Aug. 27	ND(0.49)	ND(17)	ND(2.0)
Sep. 3	ND(0.58)	ND(16)	ND(1.8)



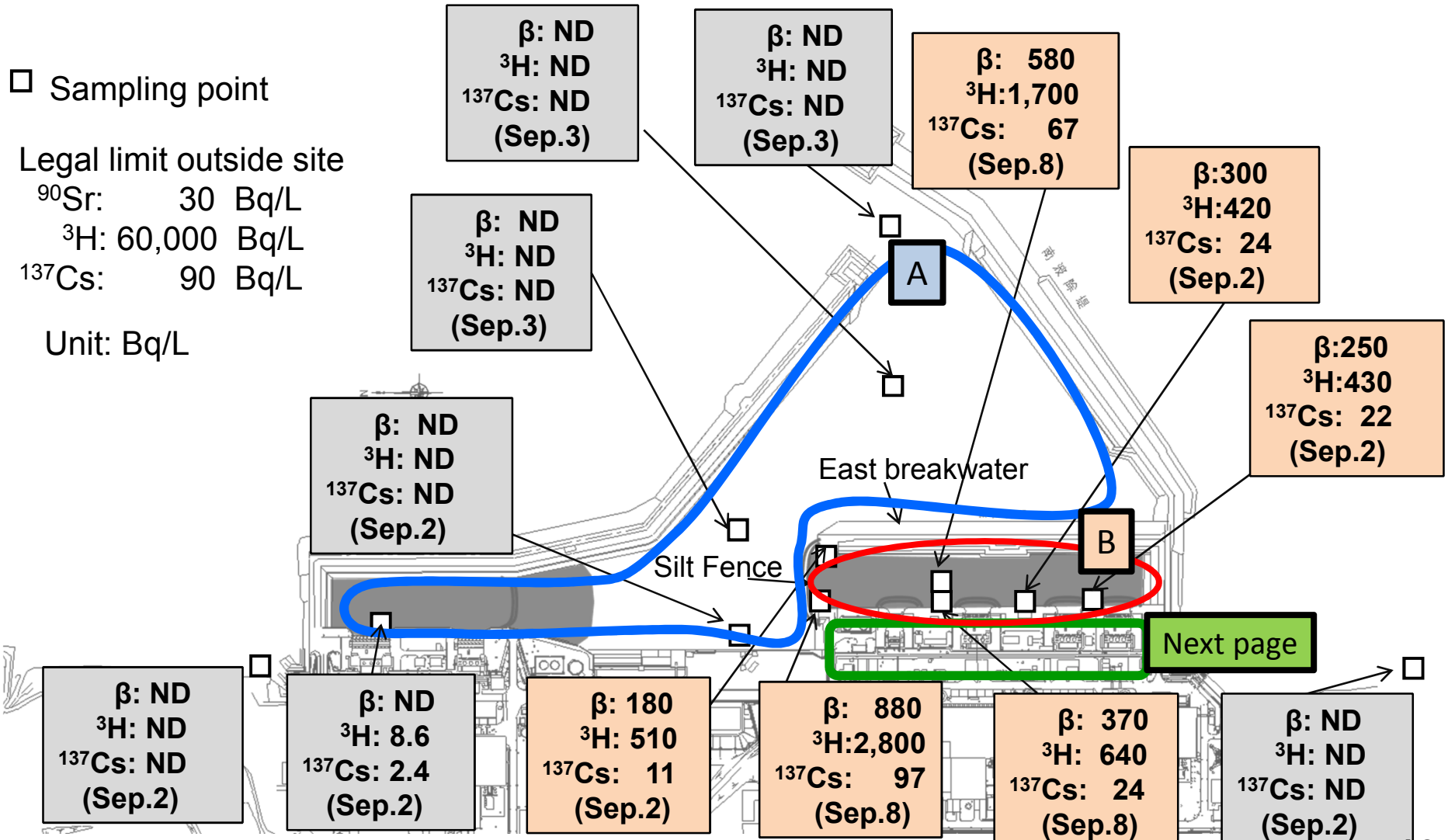
Sampling Date	Radioacitivity of sea water (Bq/L)		
	Cs-137	total β	H-3
Aug. 14	ND(1.1)	ND(18)	ND(2.9)
Aug. 27	ND(0.69)	ND(17)	ND(2.0)
Sep. 3	ND(0.69)	ND(16)	ND(1.8)

Sampling Date	Radioacitivity of sea water (Bq/L)		
	Cs-137	total β	H-3
Aug. 14	ND(1.1)	ND(18)	ND(2.9)
Aug. 27	ND(0.68)	ND(17)	ND(2.0)
Sep. 3	ND(0.66)	ND(16)	ND(1.8)

ND: under detection limit
( ): DetectionLimit

Radioactivity Concentration in Harbor

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

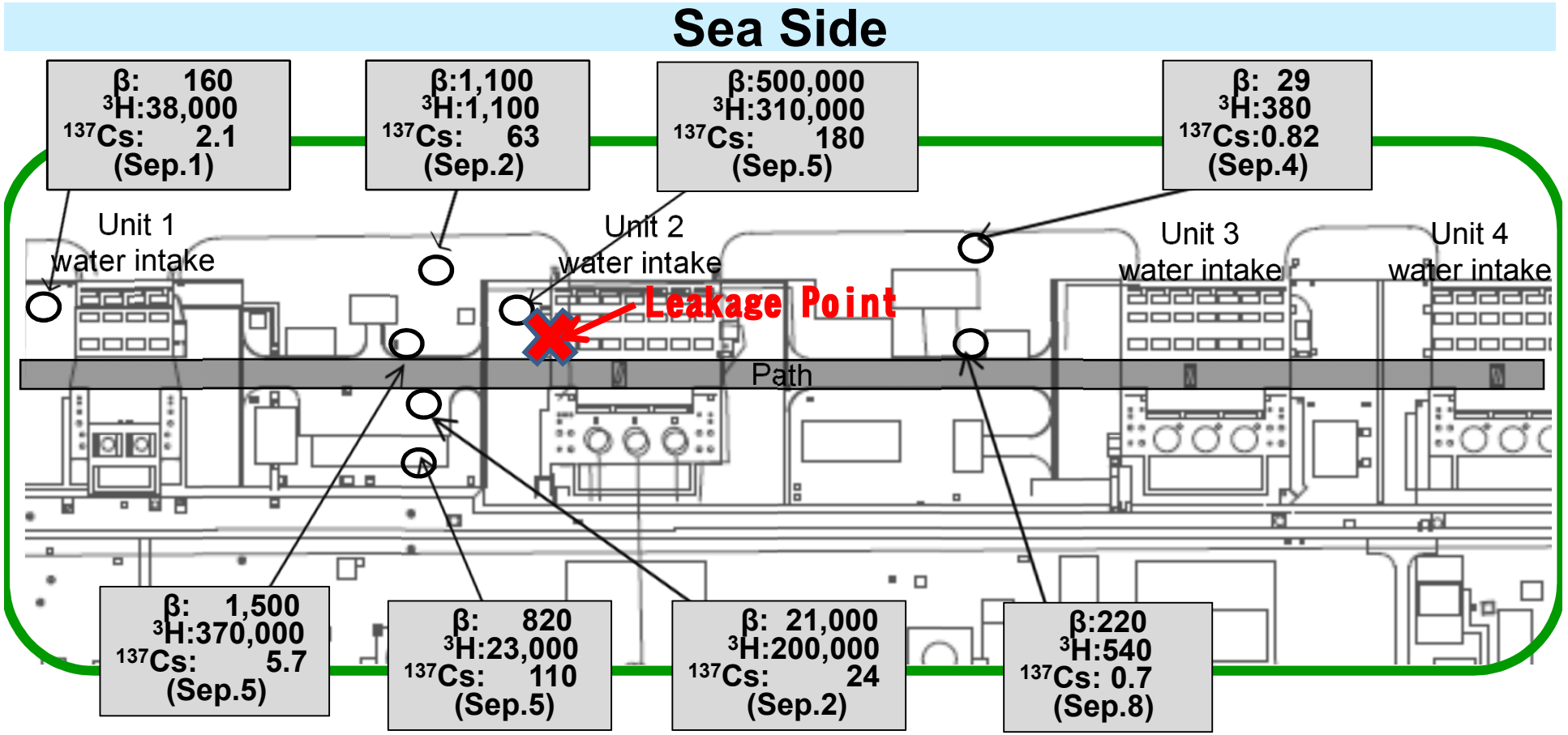


This value is not guaranteed by the NRA.
Modified by the NRA, Original illustrated by TEPCO

Contamination in Groundwater

✓High Contamination in Groundwater was found near the Leakage Point on April 2, 2011.

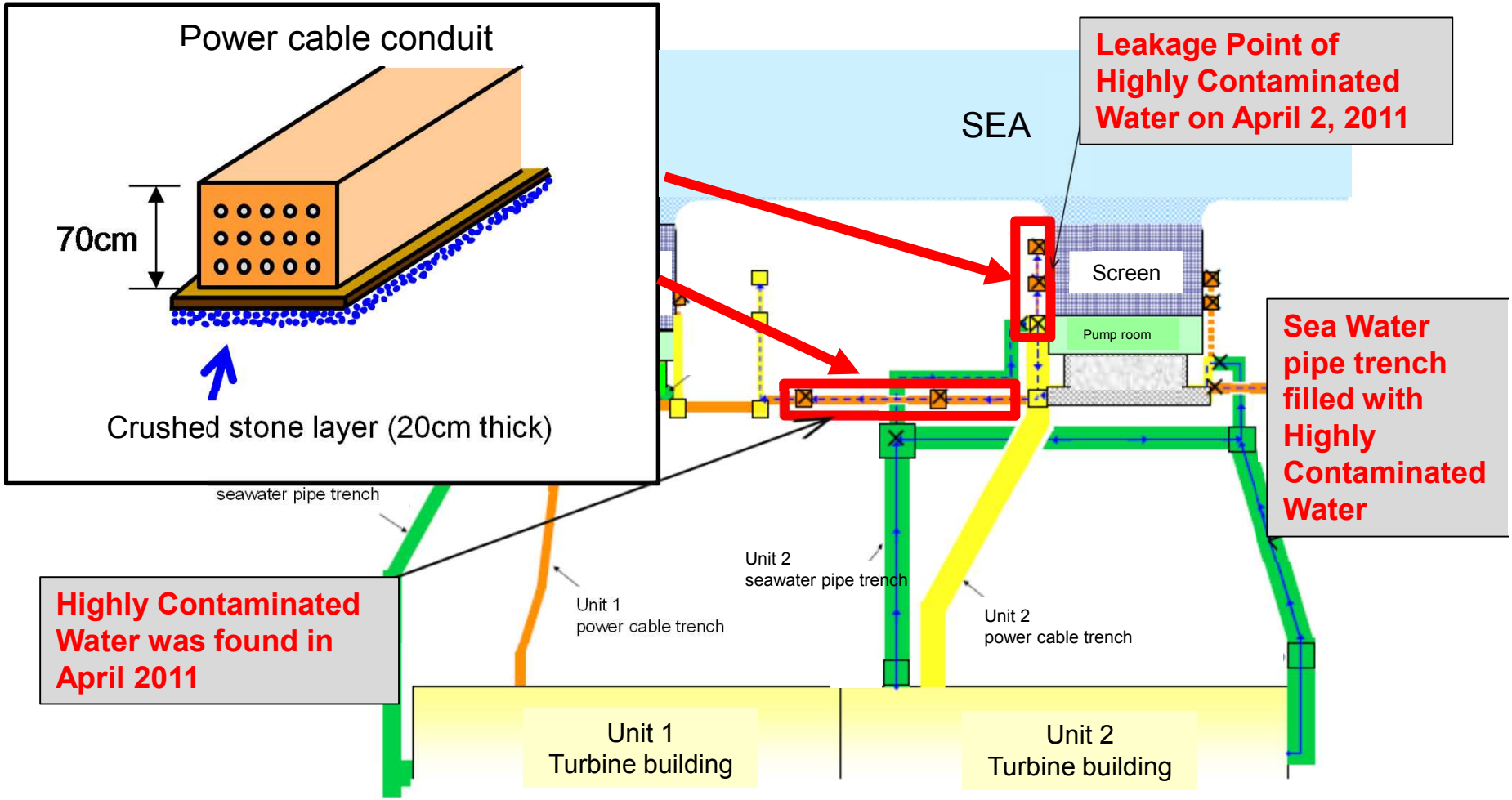
✓Groundwater with ^{3}H were also found.



This value is not guaranteed by the NRA.
Modified by the NRA, Original illustrated by TEPCO

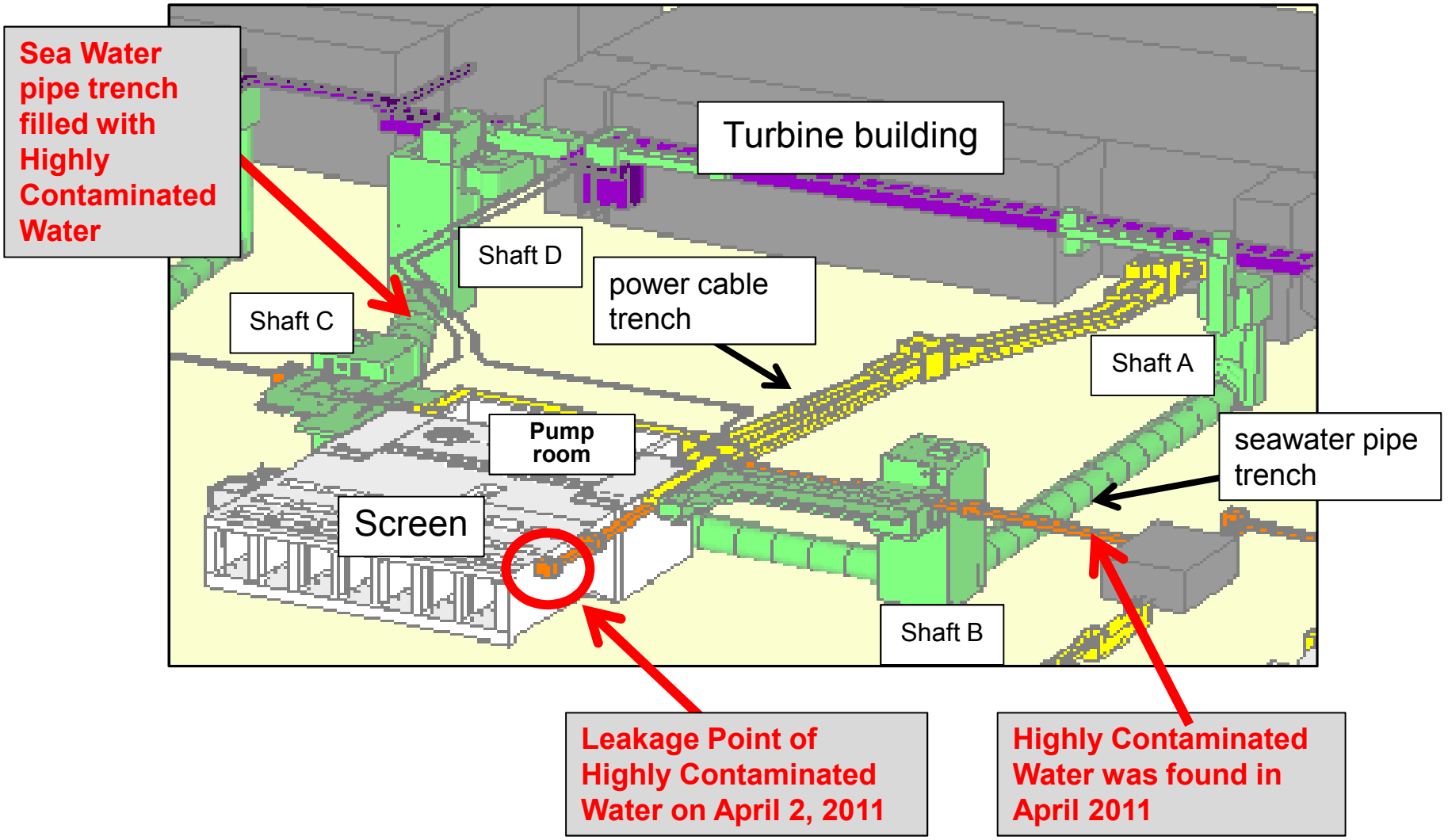
Highly Contaminated Water in Underground Trenches and Conduits(1)

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



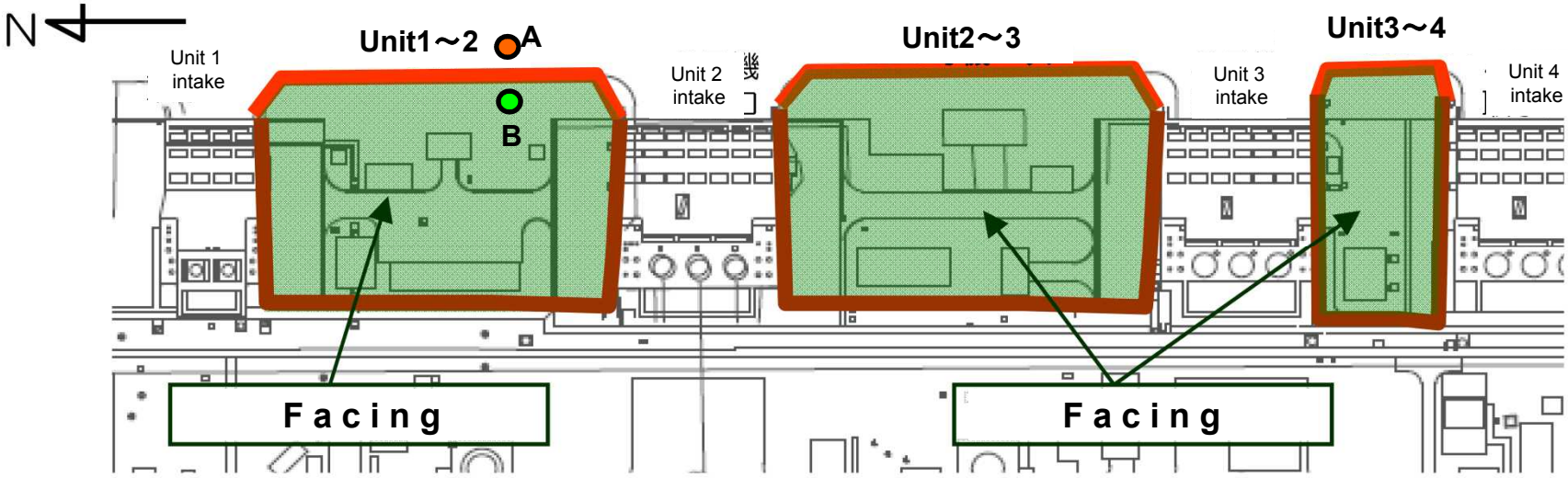
Source:TEPCO

Highly Contaminated Water in Underground Trenches and Conduits(2)

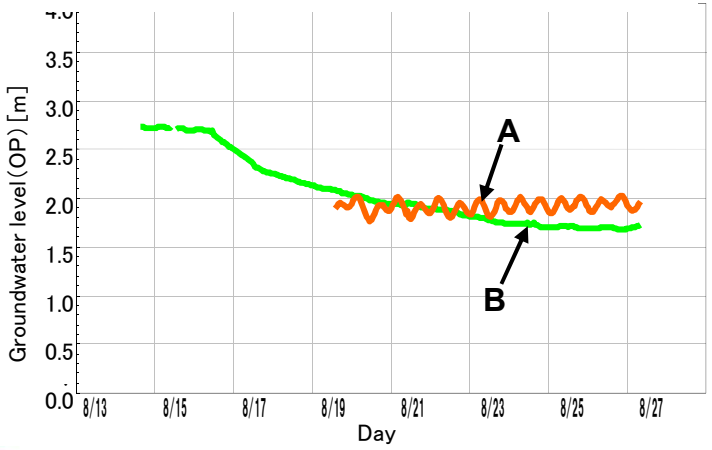


Sealing Wall embracing Contamination

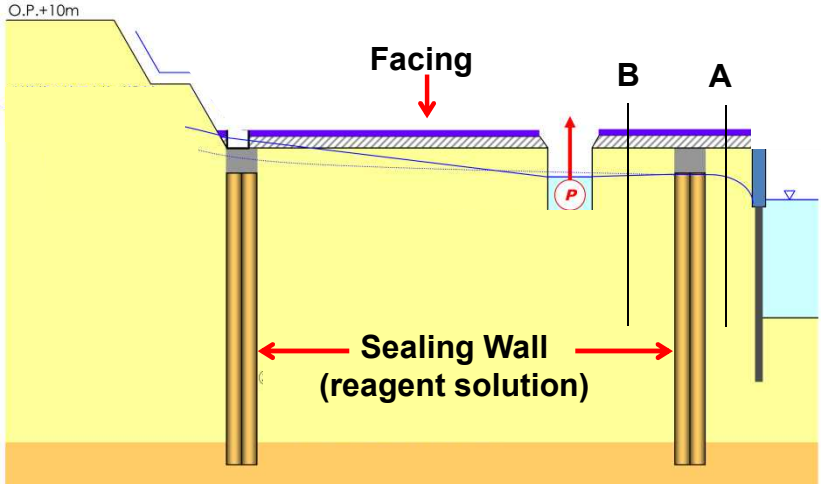
✓Sealing Wall and Facing embracing contaminated water is under construction.



Groundwater Level inside the wall is lover than outside.



Facing and the measure against groundwater (side view)



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.

NRA Actions(2)

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