Measure of reduction of groundwater inflow into buildings of Units 1 to 4 using Land-side Impermeable Wall (“Ice Wall”)

July 3, 2014
Tokyo Electric Power Company

東京電力 TEPCO 鹿島

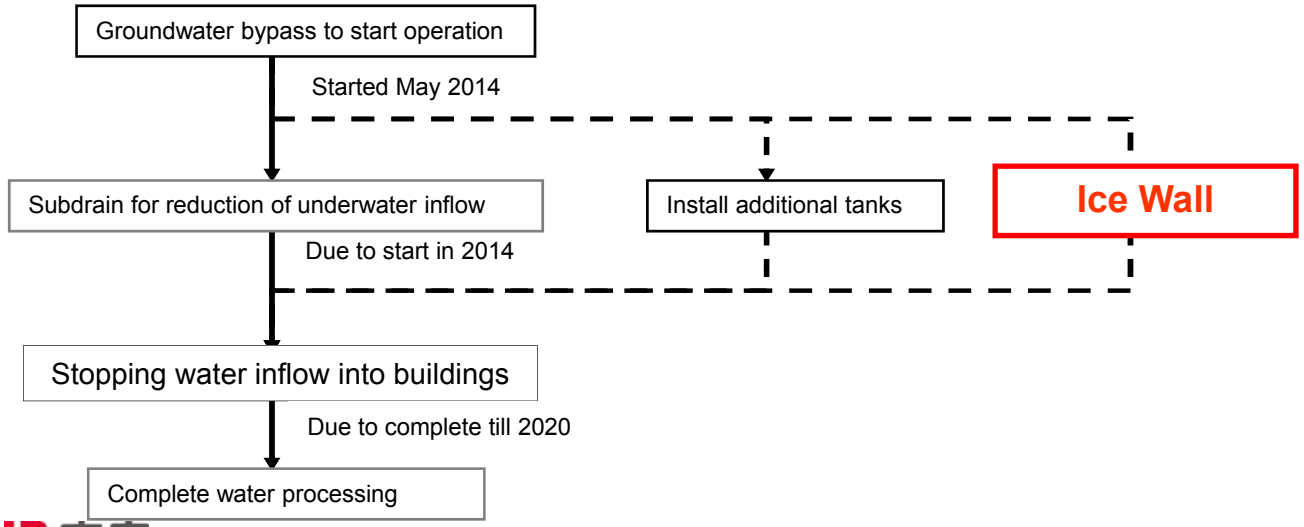
Selecting “Ice Wall” to address water issues

As one of the measures to reduce underground water flowing into buildings, TEPCO has been conducting various measures such as the groundwater bypass system (started May 21, 2014), or the the recovery of the subdrain facilities.

In the Committee on Countermeasures for Contaminated Water Treatment, the land-side water-barrier wall surrounding whole plant buildings were proposed as a fundamental measure to prepare for risks that previous measures should not work sufficiently. “Frozen Ground method” was selected as the most appropriate way to construct the wall.

The large-scale “Ice Wall” project, building a frozen wall around the buildings of Units 1 to 4, is a joint proposal of Kajima Corporation and TEPCO selected and supported by the government.

The construction of the “Ice Wall” started preparatory works in November, 2013, followed by main construction starting in June, 2014.



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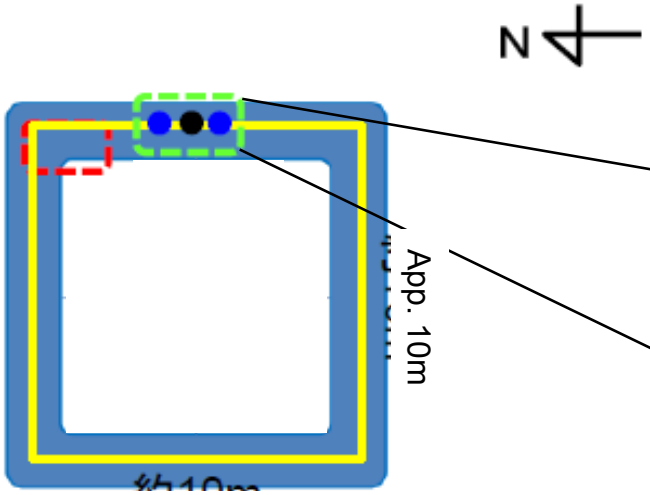
Results of onsite experiment (Demonstration Experiment 1)



App. 10m

Figure. Small-scale ice wall

*frozen pipes set at app. 1m intervals on the yellow line

Frozen Soil (red rectangular area in above figure)

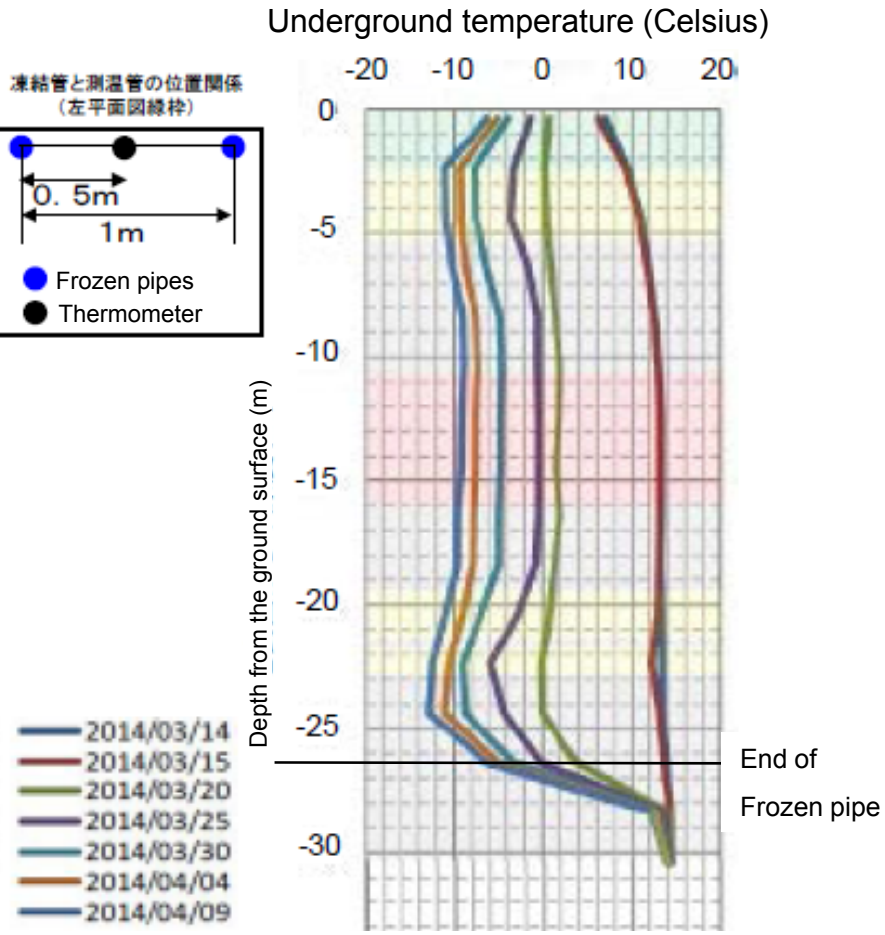
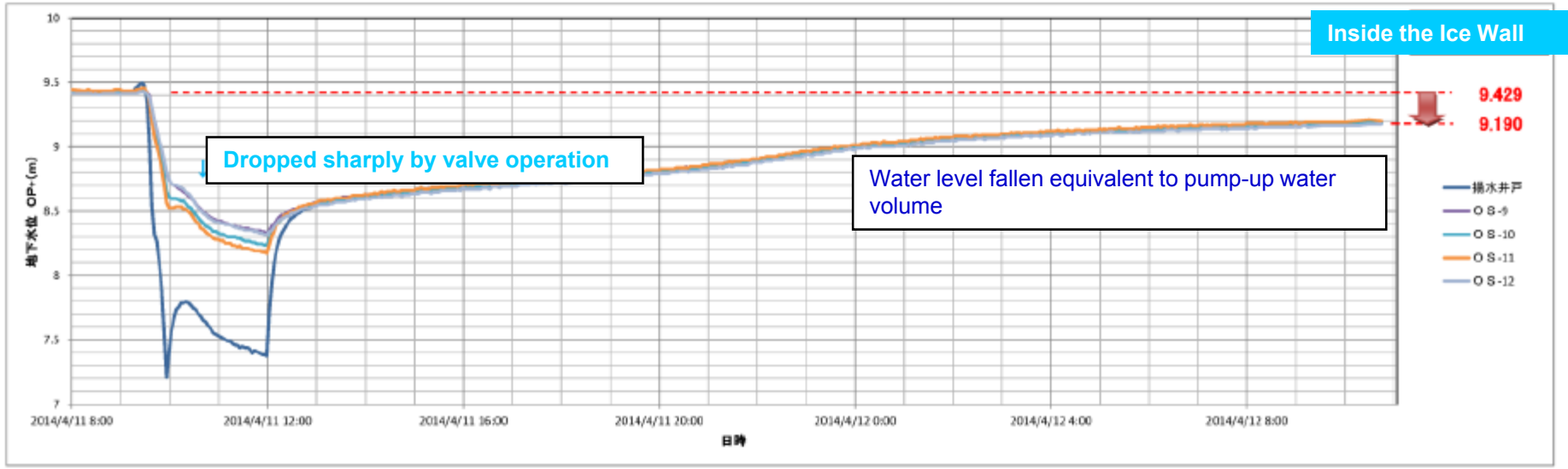


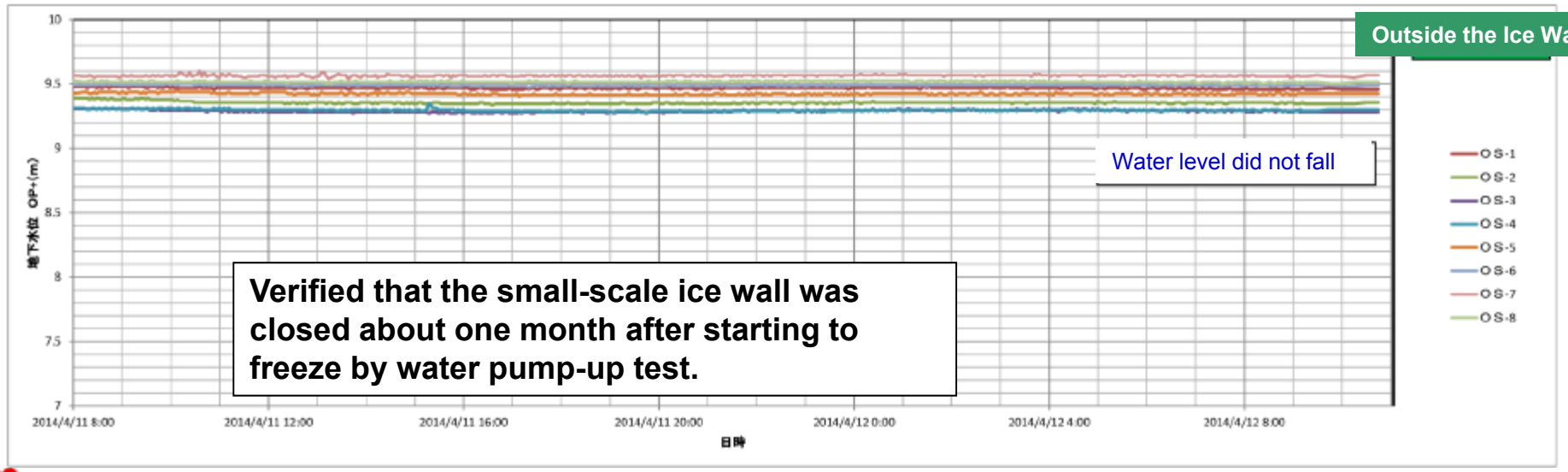
Figure: Temperature distribution between frozen pipes (app. 1m interval)

Verified by ground temperature that the ground got frozen about one month after starting to freeze.

Results of onsite experiment (Demonstration Experiment 1)

- Shallow-layer (middle-sized sandstone layer)





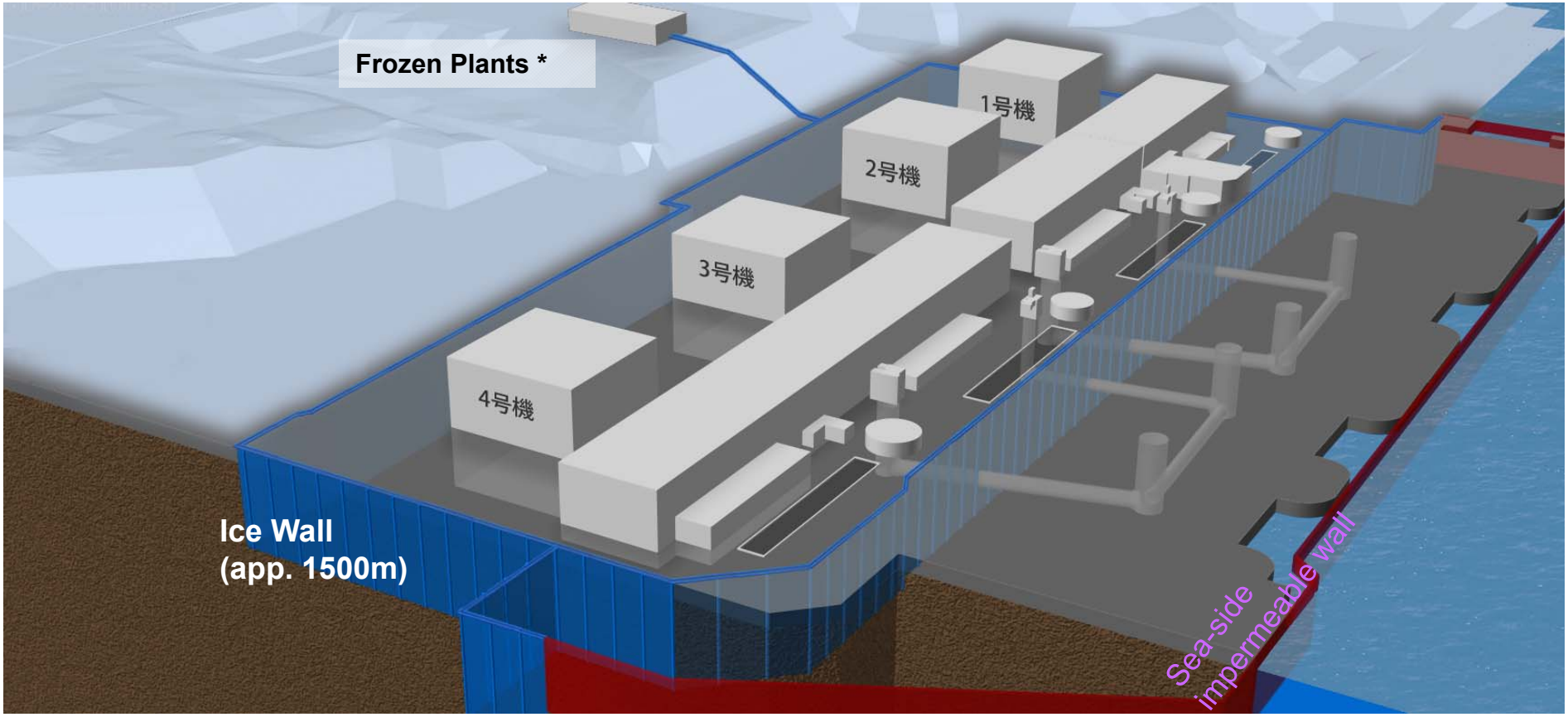
Verified that the small-scale ice wall was closed about one month after starting to freeze by water pump-up test.

Purpose of the “Ice Wall”

As one of the measures to prevent water from getting close to contaminated source, measures were reviewed to reduce the volume of underground water flowing into the basements of Reactor Buildings, Turbine Buildings and Radioactive Waste Treatment Facilities of Unit 1 to 4, which mixes with the highly radioactive water coming from the reactors.

- Term of the project will last 7 years (when treatment preventing underwater from into buildings completed)
- During the term, it is required that maintenance and replacement of the facilities such as frozen pipes and refrigerator are easily implemented.
- It is also required that facilities will work properly by maintenance and replacement as needed even after the term.
- After stopping underground water inflow into the buildings, the ice wall will be promptly unfreezed.

Sketch of the “Ice Wall”



* Frozen Plant

-brine (under -30 Celsius) ; solution of calcium chloride
- refrigerator: capacity: 261kW (per unit), refrigerant: R404A; totally 30 units
- cooling tower; heat exchange: 600 kW (per unit); 30 units
- circulating pump for cooling tower
- brine pump
- brine tank

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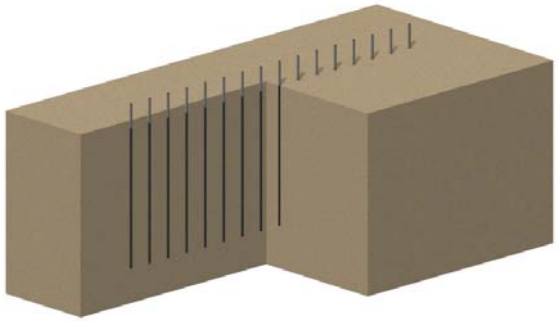
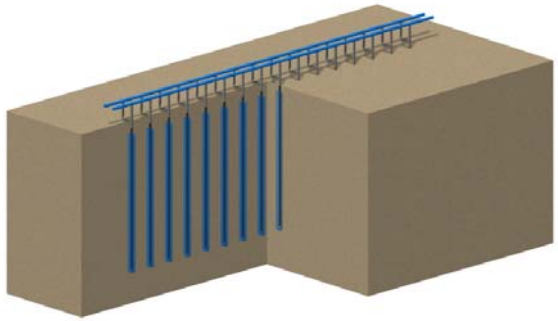
Construction process of the “Ice Wall”

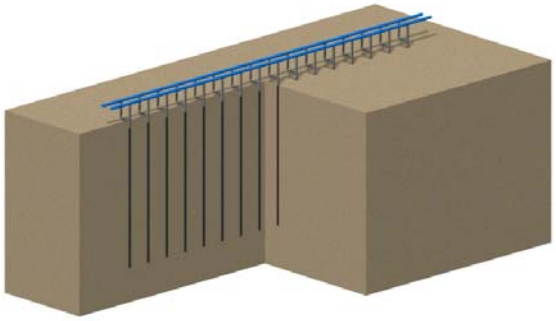
Process



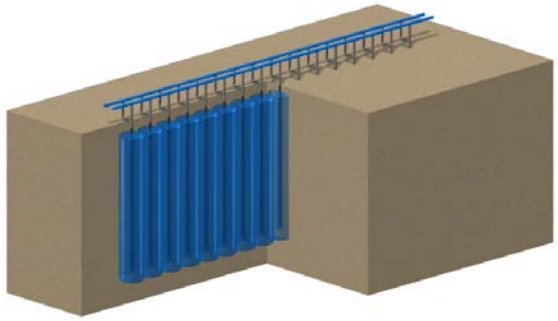
(1)Boring and standing frozen pipes



(3)Frozen Wall construction starts



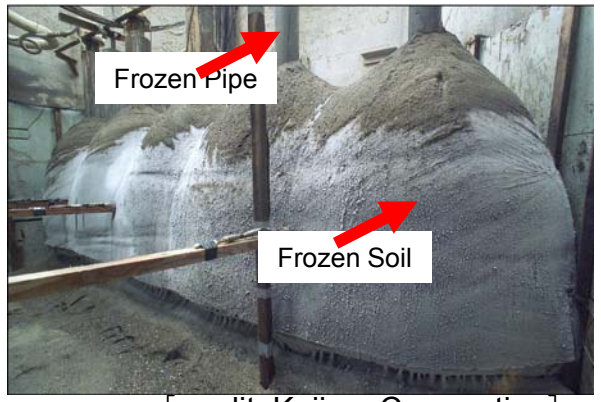
(2)Connect freezing pipes



(4)Frozen Wall completed

Construction site

Drilling with rotary boring machine used in well boring and pile driving (versatile)

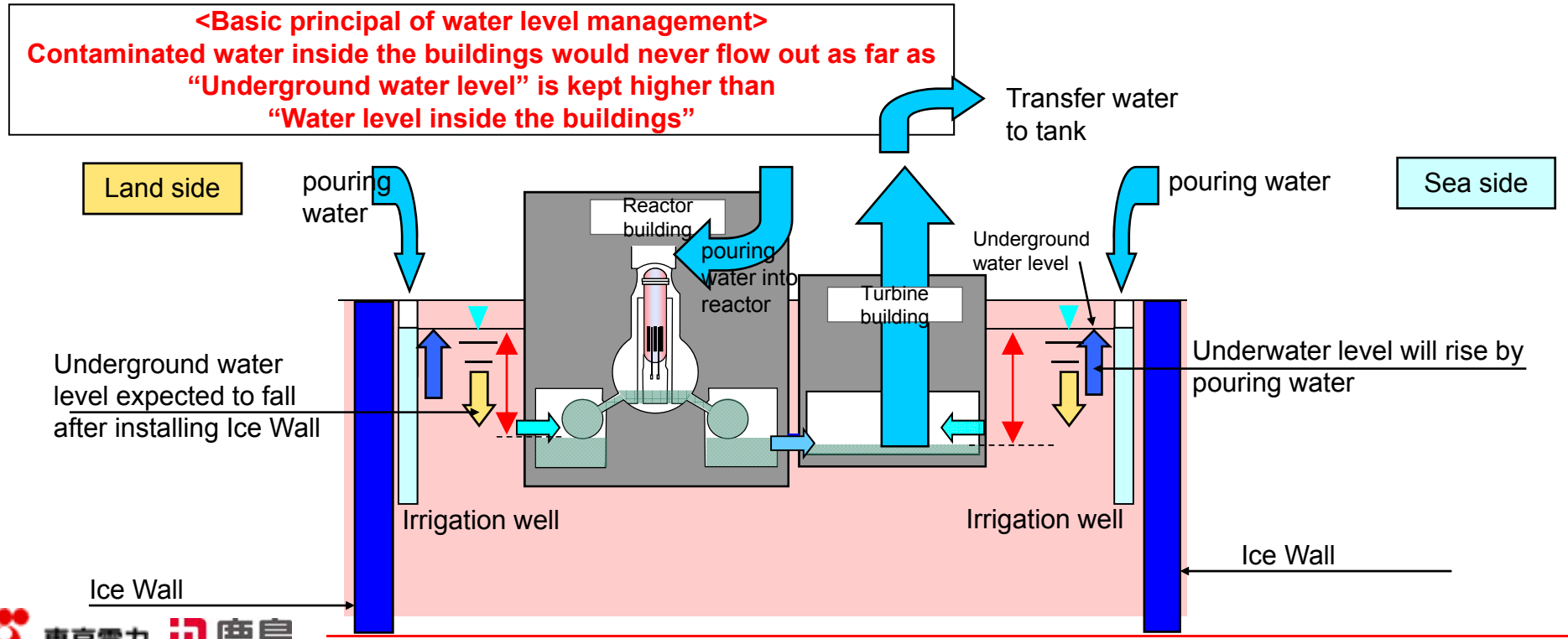


[credit: Kajima Corporation]

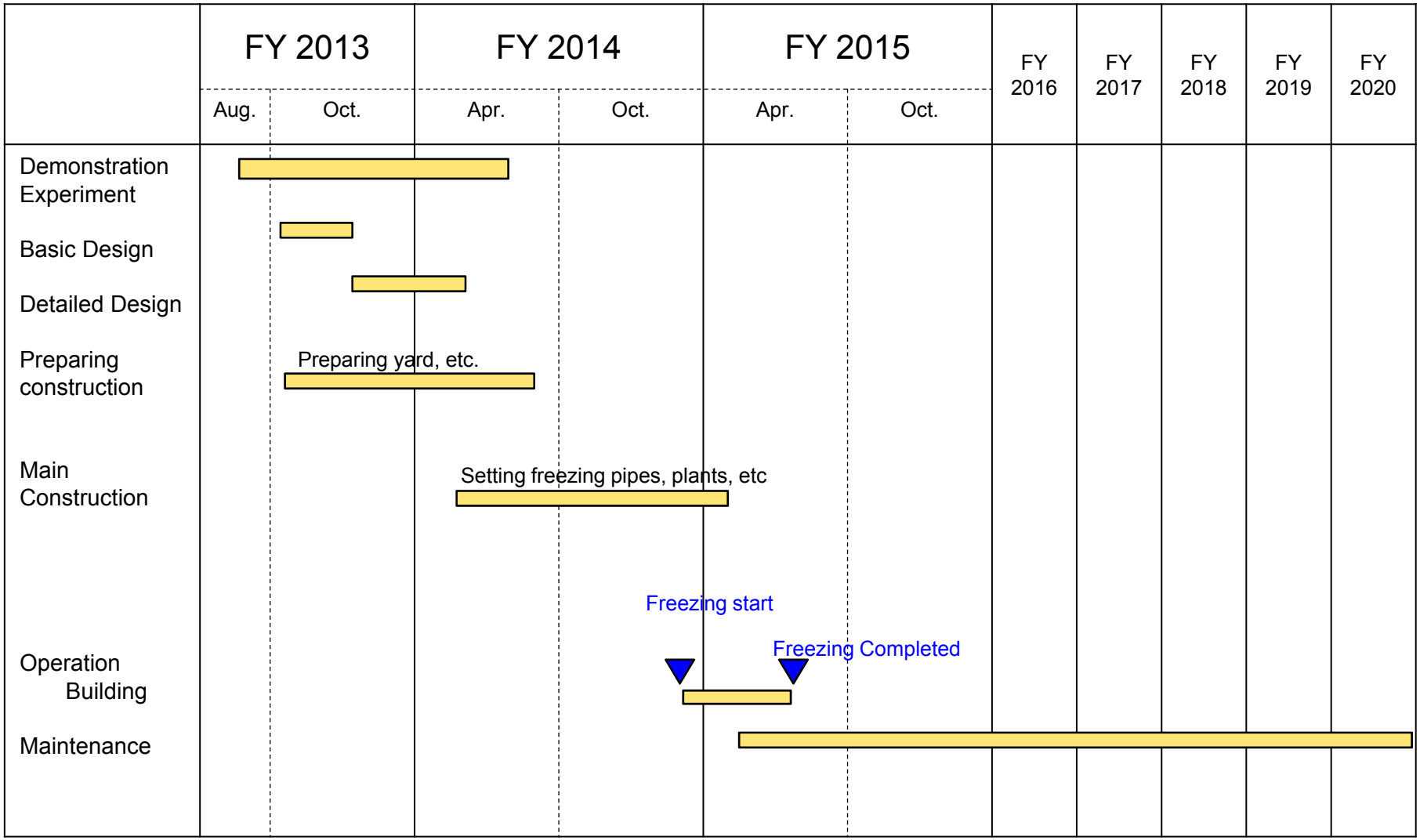
Management of water level after the “Ice Wall” installation

- After the “Ice wall” has been installed, underground water flow to the inside the wall will be stopped.
- On the other hand, as underground water inside wall will flow into the buildings, the groundwater level will drop gradually. The water level difference of the underground water and that of accumulated water inside the building will reduce so that the volume of water flowing into Unit 1 to 4 buildings (current: app. 320m3 per day) will decline gradually, until it reaches 30m3 per day, based on the analysis.
- We will manage the accumulated water level inside Units 1 to 4 buildings lower than that of the surrounding groundwater level to prevent contaminated water from flowing out of the buildings. To say specific, as follows:

- Corresponding to the lowering of underground water level around the buildings, water level inside the buildings will be kept lower by transferring the accumulated water outside the buildings, therefore producing constant water level difference.
- In case of long-term stop of water processing facilities or heavy rain, if the water level inside the buildings rise sharply, the water will be transferred and preserved to highly-concentrated radioactive water tank, etc.
- During the term when water level inside the buildings are constant, when the underground water level is approaching that of water inside the buildings, underground water level will be kept high enough by pouring water from the irrigation well systematically (note: underground water level management using this method will not be used in emergency cases).

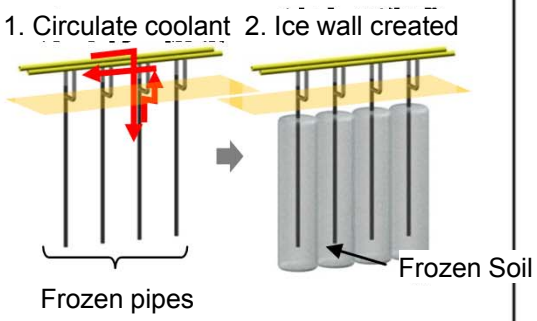
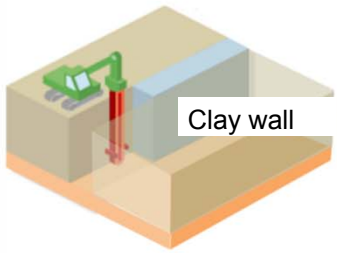
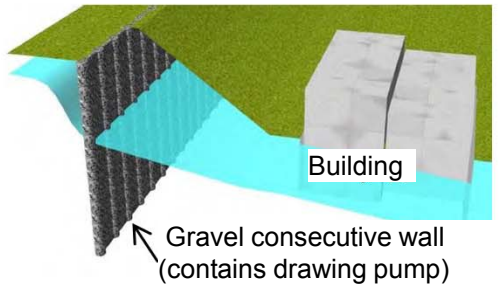


Schedule of the “Ice Wall” Project



<Reference>Types of construction method for land-side water barrier

From reference of the 19th Specific atomic energy facilities monitoring evaluation, study meeting

		1) Frozen Soil (Ice Wall)	2) Clay wall	3) Gravel consecutive wall
Building system				
Permeability coefficient		0m／s	10^{-8}～10^{-9}m／s	— *1
Workability	Heavy machinery spec *2	Small Specific heavy machinery for Ice Wall (2m*2m)	Large General heavy machinery (15m*15m)	Large General heavy machinery (15m*15m)
	Construction area	Not restricted	Restricted	Restricted
	Amount of excavated soil	Little	Quite an amount of contaminated soil	Quite an amount of contaminated soil
Construction outline		Arrange pipes in specific intervals, circulating coolant minus tens Celsius freezing the soil and creating the “Ice Wall”	Excavating the ground filling clay creating the “Clay Wall”	Excavating the ground filling gravel, installing pump inside the created wall and manage groundwater by pumping up upstream groundwater
Term of construction		App. 18 – 24 months	App. 24 - 30 months	App. 24 months
Construction area		App. 1,400m long	App. 1,500m long	App. 2,000m long

*1 Since Gravel consecutive wall is permeable design, it is not suitable comparing by permeability coefficient.

*2 If heavy equipment is small, it is (1)convenient to construct near the building (2) easy to set barrier and prevent workers from being exposed to radiation.

<Other benefits for Frozen Soil (“Ice Wall”)>

- Buried object would not be an obstacle. Arranging thin pipes, a consecutive wall could be built.
- With the situation where underground water exists within the soil, construction is comparatively easy by freezing soil itself.