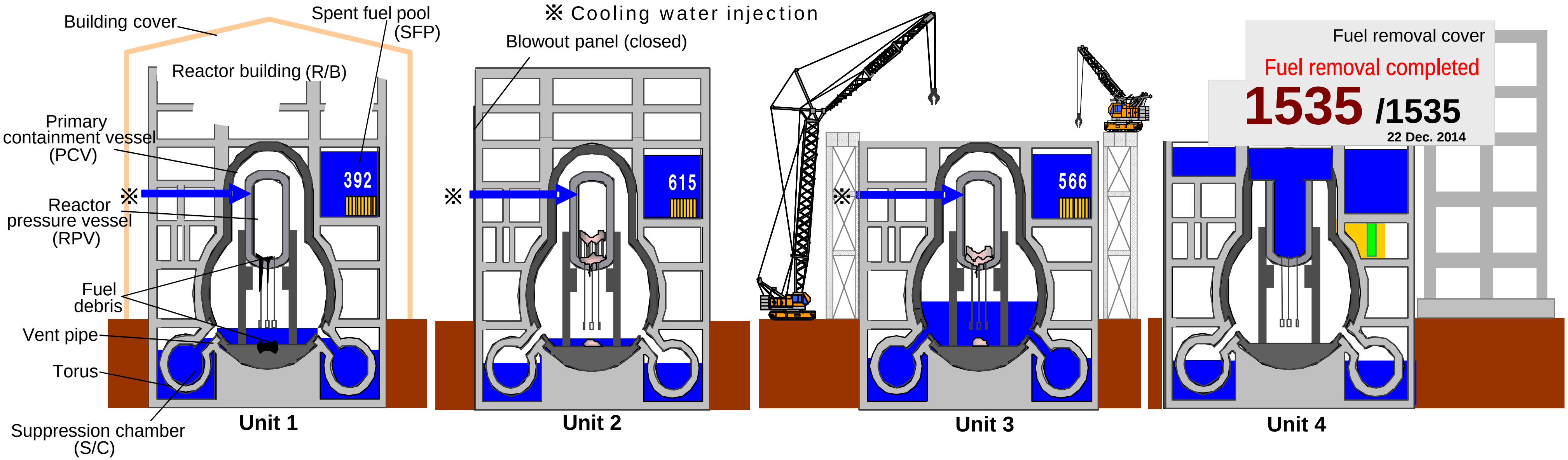
Present State & Future Response to TEPCO's Fukushima Daiichi Nuclear Power Station

August 2015
Tokyo Electric Power Company

(1) State of Units 1–4

All Units continue to be in cold shutdown



Values as of 5:00 on 30 July 2015

	RPV bottom temp.	PCV internal temp.	Fuel pool temp.	Water injection to the reactor
Unit 1	~27℃	~27℃	~31℃	4.3 m³/h
Unit 2	~34℃	~35℃	~33℃	4.5 m³/h
Unit 3	~31℃	~30℃	~28℃	4.2 m³/h
Unit 4	No fuel, so monitoring not required	No fuel, so monitoring not required	~27℃	–

Plant parameters, including RPV and PCV temperatures, are monitored continuously 24 hours a day.

Normal cooling systems

Reactor coolant pump
Condensate storage tank
2 per unit

Cooling water injected into reactors

＜Cooling multiplexed＞

Various auxiliary means have been readied to inject cooling water into the core to maintain Units 1–3 in cold shutdown

Even if power sources fail, cooling water injection can be restarted using fire engines within three hours.

Also, multiplexing is achieved with multiple tanks ready to serve as sources for cooling water injection pumps.

(2) Current Status and Tasks for Units 1–4

■ Common task among all the units: selecting the fuel/ fuel debris removal plan from the perspective of seismic safety and workability

Unit 1

Current status

Building cover installed (October 2011)

Removal of the building cover toward removal of fuel from spent fuel pool

Tasks

Identification of the status of debris on the operating floor and inside the pools

Countermeasures for the dispersion of radioactive materials during the removal of the building cover

Immediately after the earthquake

Unit 2

Current status

Closed the blowout panel

Very high radiation level in the building

Tasks

Radiation dose reduction measures

Immediately after the earthquake

Unit 3

Current status

Debris removal from the top of the reactor building completed (October 2013)

Installation of fuel removal cover and fuel handling facility planned

Tasks

Due to high radiation levels, radiation dose reduction measures must be carried out safely and steadily with remote-controlled heavy machinery

Immediately after the earthquake

Unit 4

Current status

Fuel removal from spent fuel pool completed

(commenced on 18 November 2013,

completed on 22 December 2014)

Immediately after the earthquake

(3) Illustration of Roadmap Toward Decommissioning

Roadmap targets (formulated Dec. 2011, revised June 2013 and June 2015)

Stabilization efforts	Phase 1	Phase 2	Phase 3
	Dec. 2011	Dec. 2013	30-40 years later
<Cold shutdown achieved> ・Cold shutdown ・Significantly reduce radiation release	Period up to the commencement of the removal of the fuel from the spent fuel pool (within 2 years)	Period up to the commencement of the removal of the fuel debris (within 10 years)	Period up to the completion of decommissioning measures (30–40 years in the future)

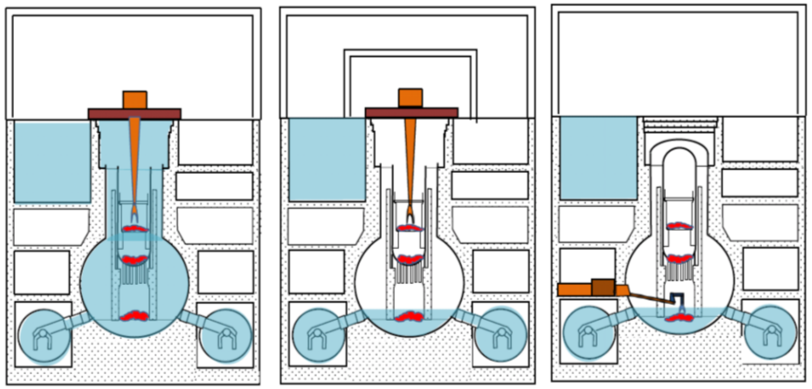
Started at Unit 4 on 18 Nov. 2013.

※Fuel debris
(Fuel, cladding, and other material that melted and hardened again)

Fuel debris removal (Units 1, 2 and 3)

In terms of reducing radiation exposure during work process, the most reliable method of fuel debris removal is to remove the fuel debris while submerged. But depending on the results of future investigations, we may adopt a substitute method such as taking fuel debris without filling the primary containment vessel with water.

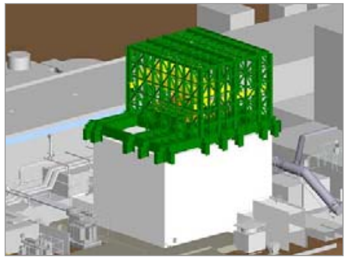
Construction method for fuel debris removal (image)



Fuel Debris	In the water	In the air	
Removal Channel	Upside		Side
Challenge	Water proof and earthquake proof	Shielding radiation and radioactive dust	

Spent fuel removal plan (Units 1, 2 and 3)

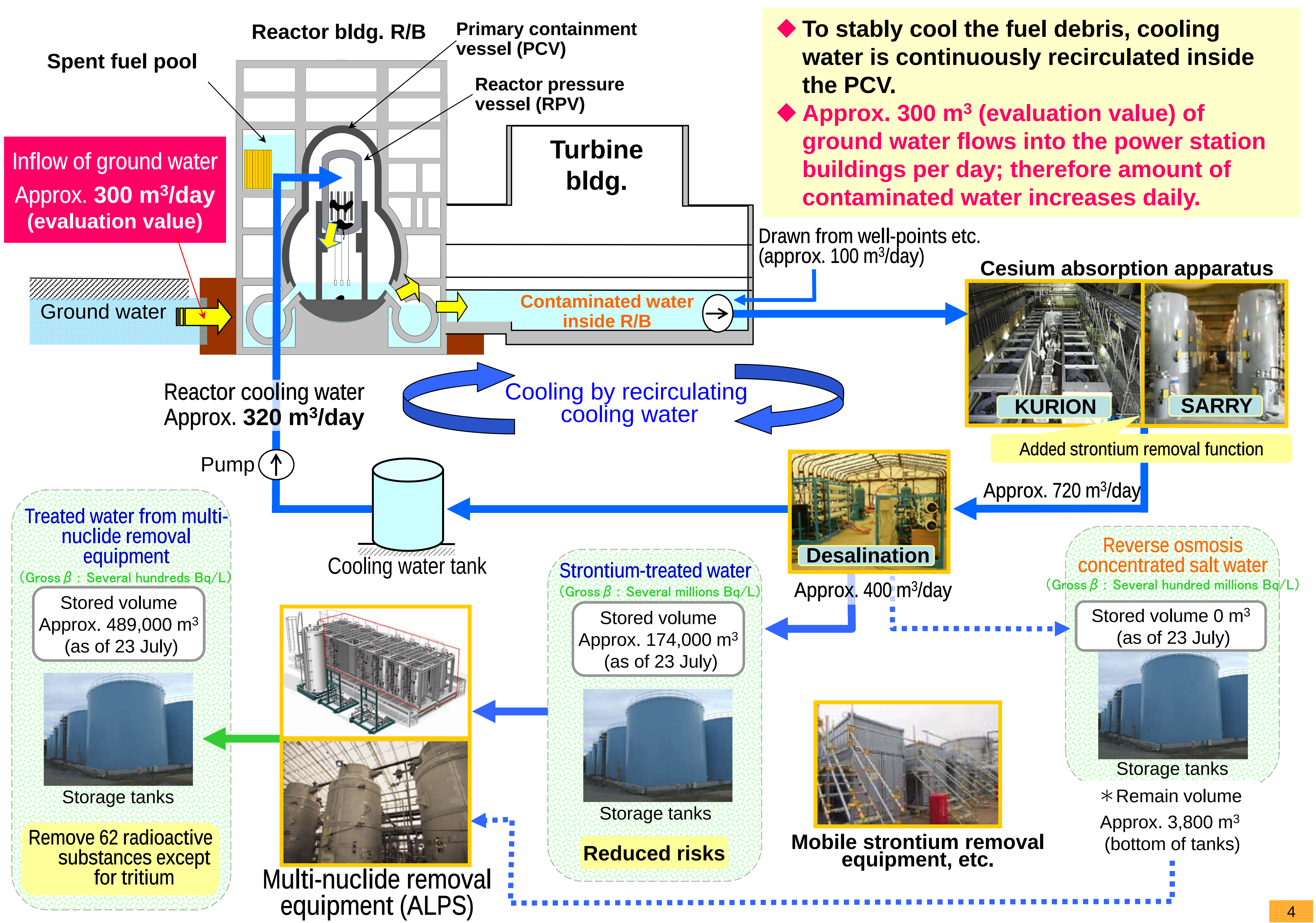
FY	2015	2016	2017	2018	2019	2020	2021	2022
Unit 1	Demolition of building covers		Removal of rubble		Construction of covers		Spent fuel removal	
Unit 2	Preparation	Demolition of upper buildings			Plan ① Construction of containers / Plan ② Construction of covers		Spent fuel removal	
Unit 3	Removal of rubble	Demolition of building covers	Spent fuel removal					



Frame for Unit 1 pool

Cover for Unit 3 pool

(4) Conceptual Diagram of Reactor Circulation Cooling and Continuously Increasing Contaminated Water



- Water used to cool molten fuel during the accident and groundwater have mixed, generating approximately 300 tons of contaminated water per day. Countermeasures are being implemented based on the following three basic polices.

Policy 1. Removing source of contamination

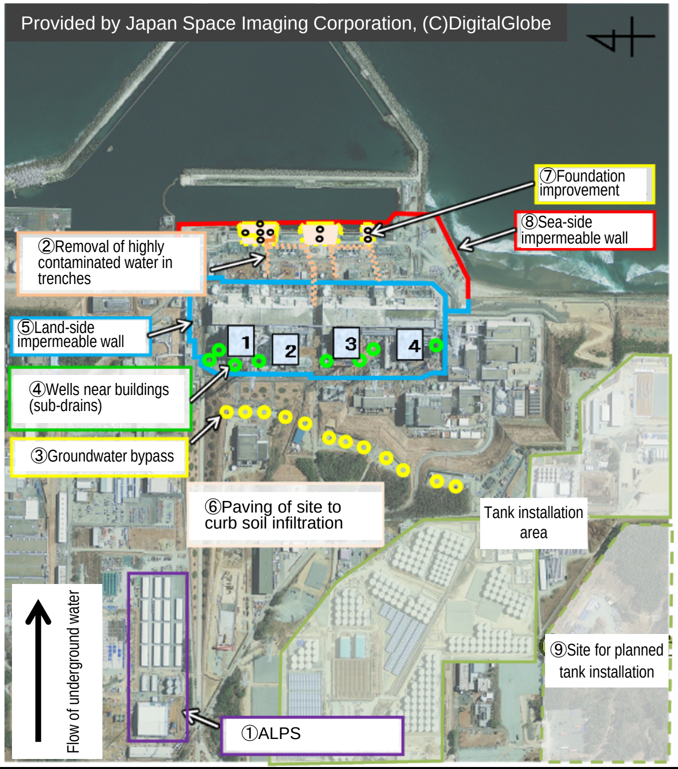
① Clean up contaminated water with multi-nuclide removal equipment (ALPS)
② Remove contaminated water in trenches (underground tunnel with piping)

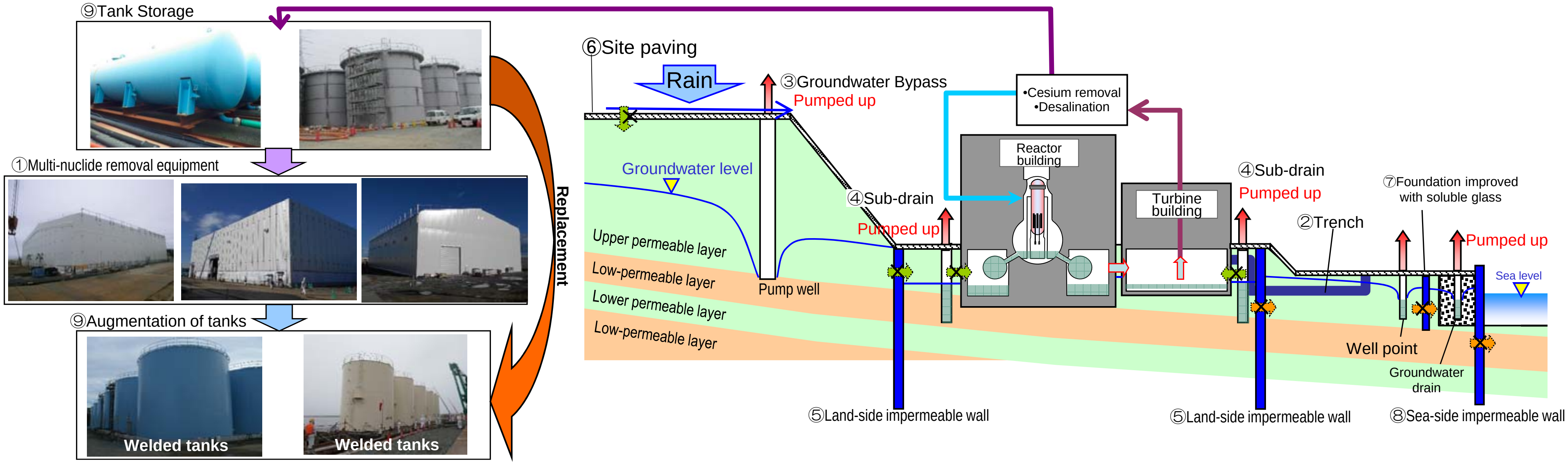
Policy 2. Isolating groundwater from contamination sources

③ Pumping up groundwater through groundwater bypasses
④ Pumping up groundwater through wells near buildings
⑤ Installation of frozen-soil impermeable wall on the land side
⑥ Paving of site to curb permeation of rainwater into soil

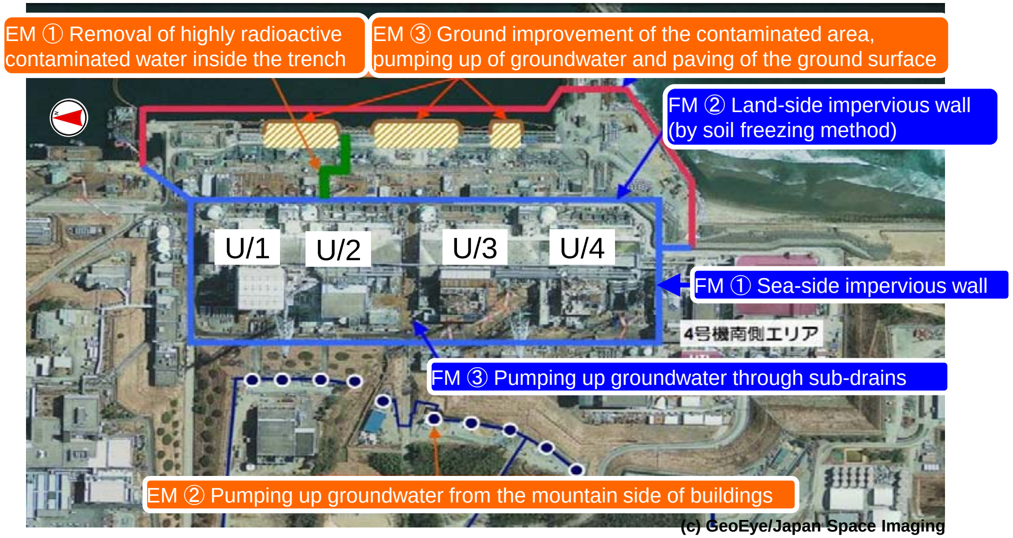
Policy 3. Preventing leakage of contaminated water

⑦ Ground improved with water glass
⑧ Installation of impermeable walls on the sea side
⑨ Augmentation of tanks (replacement with welded tanks, etc.)



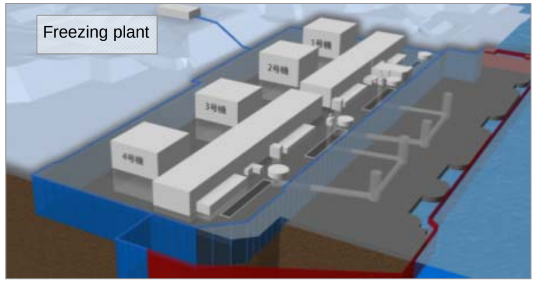


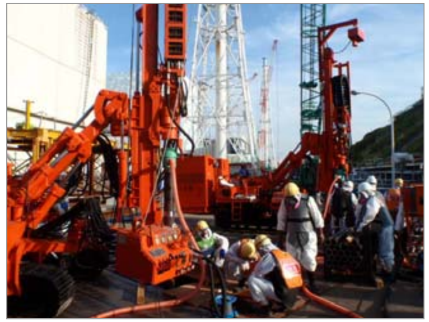
(6) Contaminated Water Countermeasures: Fundamental Measures

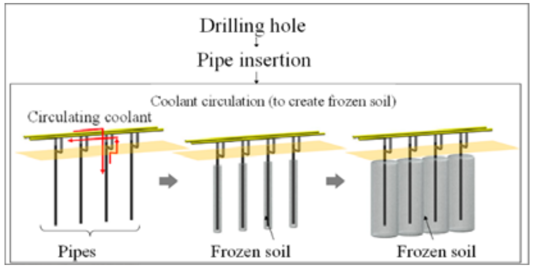


Fundamental Measure②
Install land-side (frozen soil) impermeable wall

To control increase in contaminated water and prevent its flow into port



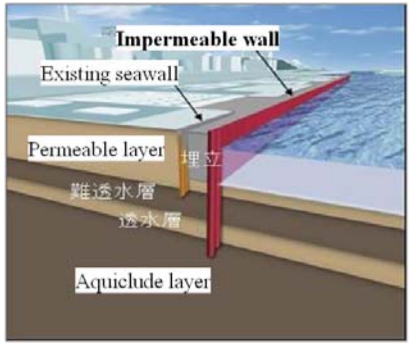


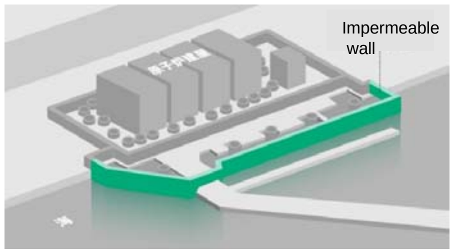


- Buildings will be enclosed by ice wall to curb inflow of groundwater into buildings
- Since August 2013, field tests have been conducted and full-scale construction began in June 2014
- To start freezing (mountain side) planned from May 2015

Fundamental Measure ①
Construct sea-side impermeable wall

To prevent flow out into sea

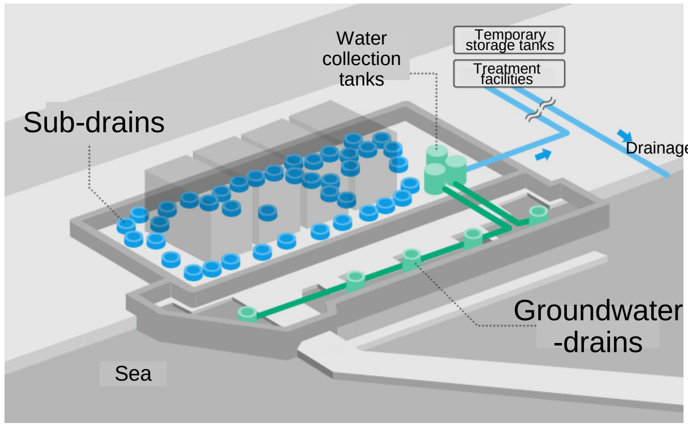




- Impermeable wall will be constructed along the sea side of Units 1-4 to prevent outflow of contaminated groundwater into sea
- Construction of steel sheet-piles comprising impermeable wall is complete except for some sections (98% completed)

Fundamental Measure ③
To pump up groundwater from sub-drains

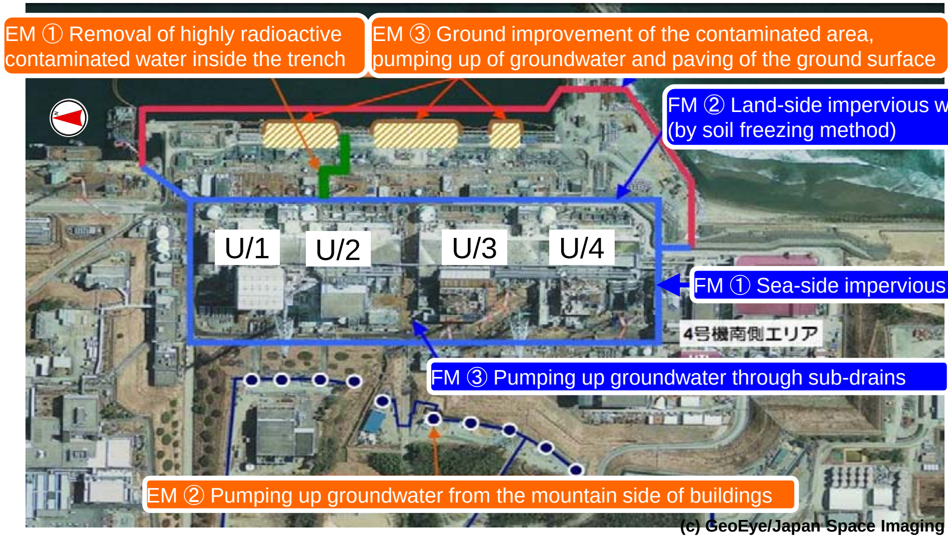
Curb inflow of groundwater into R/B, etc.



New sub-drain pit

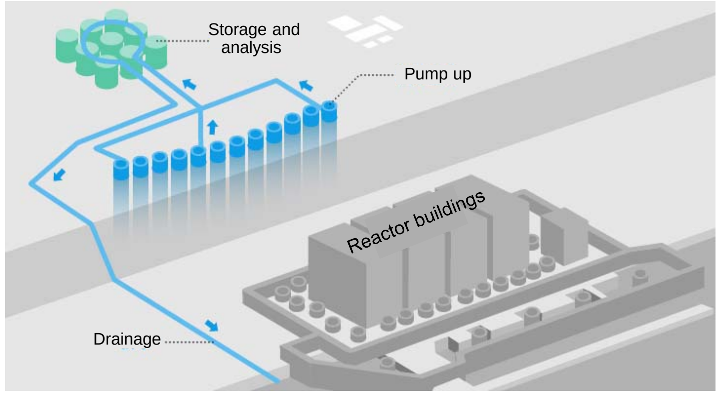
- Wells (sub-drains) installed near buildings will be rehabilitated and groundwater around buildings will be pumped up to control inflow into the buildings

(7) Contaminated Water Countermeasures: Emergency Measures



Emergency Measure② To pump up groundwater on mountain side of buildings (groundwater bypass)

To control increase in contaminated water



Temporary storage tank analysis results (collected on 24 Feb.)

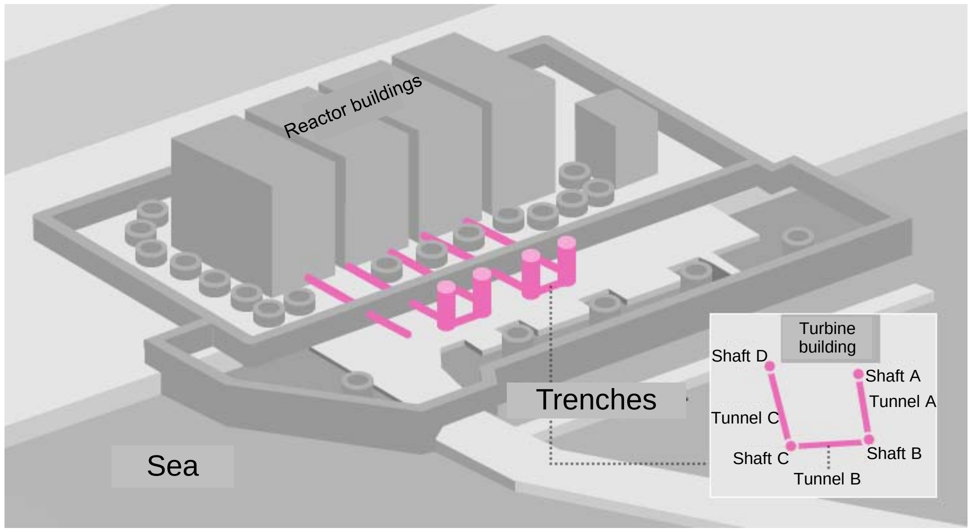
	Cesium 134	Cesium 137	Total Beta radiation	Tritium
TEPCO	ND (0.66)	ND (0.60)	ND (0.92)	180
Third-party agency	ND (0.59)	ND (0.55)	ND (0.53)	170
TEPCO's limit	1	1	5	1,500
Legally notifiable limit	60	90	-	60,000
WHO drinking water quality guideline	10	10	-	10,000

•TEPCO; Tokyo Electric Power Company
•ND indicates 'not detectable' (below the limit of detection, which is stated in parentheses)

- Groundwater inflow into the buildings is reduced by pumping up and bypassing groundwater, flowing from the land side, on the upstream side of the buildings.
- Start of water drainage on 21 May 2014.

Emergency Measure ①
To remove highly contaminated water in trenches

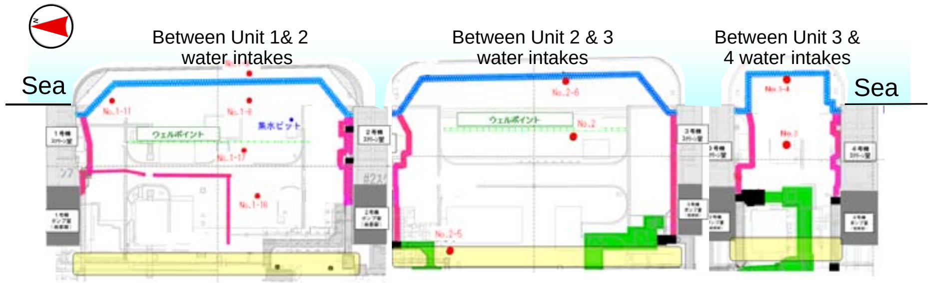
To remove contamination source



- Highly contaminated water from immediately after the accident remains in underground tunnels (trenches) on the sea side of reactor buildings
- Highly contaminated water, which poses a risk of infiltrating or spreading into the surrounding area, will be removed (water in Unit 2 trenches was removed in June 2015, that in Unit 3 trenches was removed in July 2015)

Emergency Measure ③ To improve foundation of contamination area, pump up groundwater, pave surface

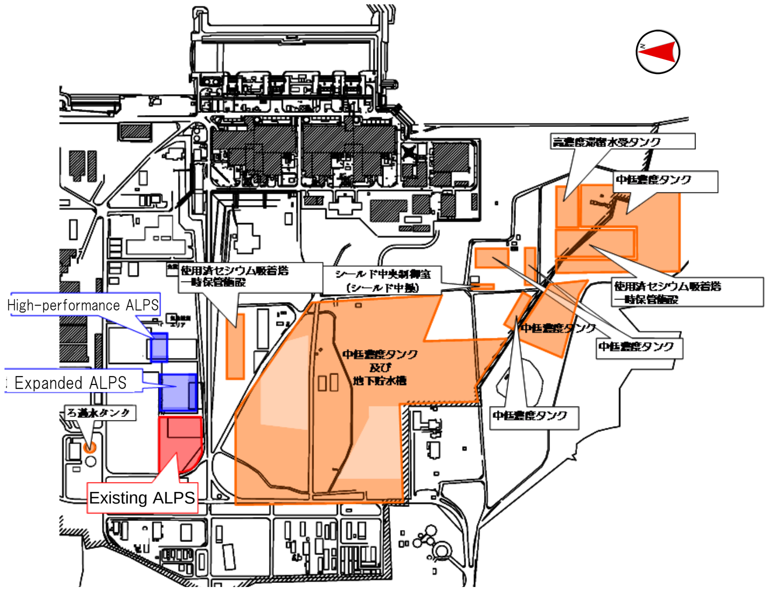
To prevent outflow into port



- Chemical grouting will be used to improve the foundation and control outflow of contaminated groundwater
- To inhibit infiltration of rainwater, surface will be paved with asphalt or other material

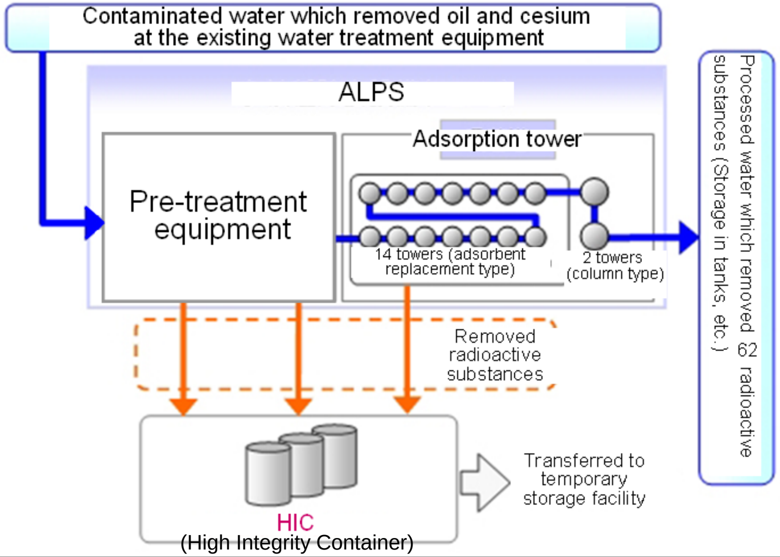
(8) The Status of the Advanced Liquid Processing System (ALPS) (Existing/ Expanded/ High-performance)

Installation Positions for the Expanded ALPS and High-performance ALPS



Summary of the Existing ALPS Facilities

- Introduce ALPS to enhance the processing of contaminated water
- ALPS is able to remove 62 radioactive substances (with the exception of tritium), in addition to cesium
- The system is now being tested to confirm purification performance.



Adsorption tower

Installation of Expanded ALPS and High-performance ALPS

- In addition to existing ALPS facilities, the following facilities were introduced for early treatment of reverse osmosis (RO)-concentrated saltwater*1 stored at Fukushima Daiichi NPS
  - Expanded radionuclide removal systems, Improved on the basis of operating experience from the current ALPS (changed adsorbent, extra adsorption towers) to reduce the radioactive concentration
  - High-performance ALPS (project subsidized by the Ministry of Economy, Trade and Industry)
- These are test-running now

Basic specifications comparison

Item	Existing ALPS	**Expanded ALPS**	**High-performance ALPS**
Treatment volume	250 m^3/day/system	At least 250 m^3/day/system	At least 500 m^3/day/system
Number of systems	3 systems	3 systems	1 system
Pre-treatment method	Coagulating sedimentation method	Coagulating sedimentation method	Filter type
No. of adsorption towers	14 + 2 towers	18 towers	20 towers
Seismic resistance class	Equivalent to class B	As on left	As on left
Radionuclide purification capacity	62 radionuclides to ND level	As on left	As on left
Waste generation	–	–	Around 1/20 of current ALPS facilities

*1 RO-concentrated saltwater is a byproduct left after accumulated water containing high-concentration radioactive substances has been treated by the cesium-removal system and the desalination system. Increasing at the pace of around 300 m^3/day.

Building for expanded ALPS

High-performance ALPS

(9) Dust Dispersion Suppression Measures During Unit 1 Building Cover Demolition and Rubble Clearance

The state of Unit 1 reactor building

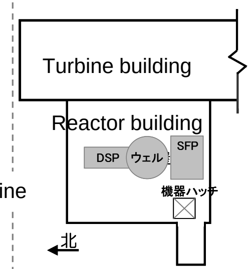
- The building covers were built in October 2011 to suppress the airborne dispersion of radioactive materials
- There is still an accumulation of scattered debris on top of the refueling level within the building cover
- The collapsed roof remains dropped onto the refueling level in a nearly flat shape

Building cover

Photographed around October 2011

Refueling level status

Photographed in October 2012 (balloon investigation of refueling level)



plan view

Overview of the refueling level (northwest side)

Photographed around June 2011

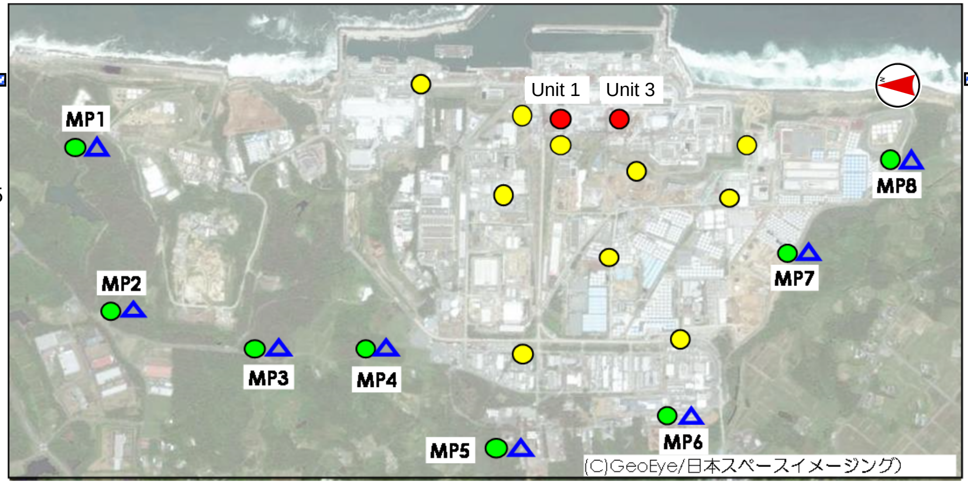
Temporary removal of roof panels

Photographed around June 2011

Monitoring framework for radioactive material concentrations

- The dust situation is monitored during work and also at night and days off

Approx. 25km to the Minami-Soma City Hall



Approx. 20km to J Village

● Dust monitors on the operating floor	Alert level: 0.005 Bq/cm^3
● Dust monitors within the site (10 locations)	Alert level: 0.0001 Bq/cm^3
● Dust monitors close to site boundaries (8 locations)	Alert level: 0.00001 Bq/cm^3
△ Monitoring posts (MP) close to site boundaries (8 locations)	

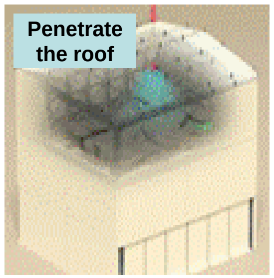
Dismantle the Unit 1 building cover

- Nov–Dec 2015, removed two roof panels and investigated
- From 16 March 2015, started preparing construction
- From 15 May 2015, started dismantling 15–20 May, sprayed anti-scattering agent
- 28 July 2015, started removal of roof panels

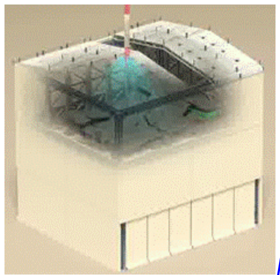
* The processes may be changed by process adjustment with other constructions, other progress, and reinforcement of scattering restraint measures

Dust dispersion suppression measures

- Spray anti-scattering agent

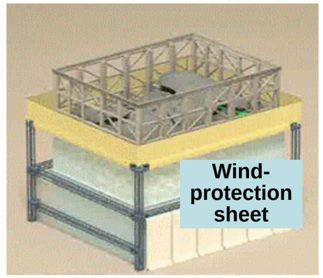


- Spray anti-scattering agent during removal



- Suction the dust and rubble
- Set sprinkling facilities

- Set wind-protection sheets (after removal of wall panels)



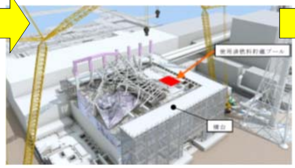
(10) Related Topics

Debris removal situation on the Unit 3 operating floor

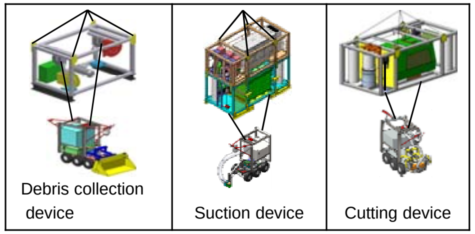
- It is necessary to complete the removal of debris from the upper part of the reactor building, decontaminate and remove debris from within the spent fuel pool in order to prepare for the extraction of the Unit 3 spent fuel.
- Debris removal work shall be carried out carefully with the utmost priority placed on the safety of those engaging in the work and everyone within society.

Situation on the refueling floor prior to debris removal (taken from directly above)

Remove debris using remote-controlled heavy equipment



Situation on the refueling floor after debris removal (taken from directly above)



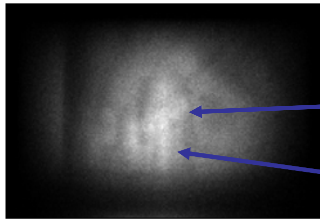
Self-propelled decontamination device

Removal of a fuel handling machine from the spent fuel pool (Aug, 2015)

Reactor imaging technology for fuel debris detection by cosmic ray muon (Measurement status report in Unit-1)

- Fluoroscope technology development using cosmic ray muon is under progress by IRID and HIGH ENERGY ACCELERATOR RESEARCH ORGANIZATION (KEK).
- Currently, large lumps of fuel (measuring more than 1 m) have not been confirmed at the reactor core where the fuel used to be located. This result is basically consistent with TEPCO's previously announced estimation of the reactor and the containment vessel conditions.
- The result measured this time will be very relevant information to determine the debris location and proceed with the decommissioning operation.

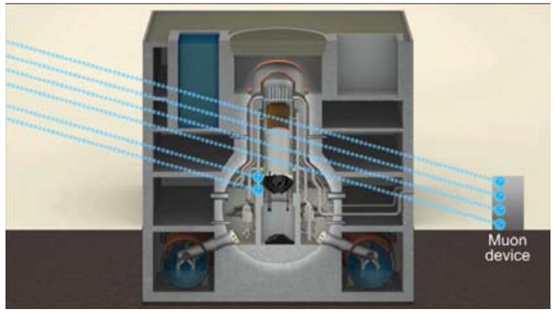
Installation



Measurement result taken by detector-1

Primary containment vessel (PCV)

Reactor pressure vessel (RPV) and shielding wall

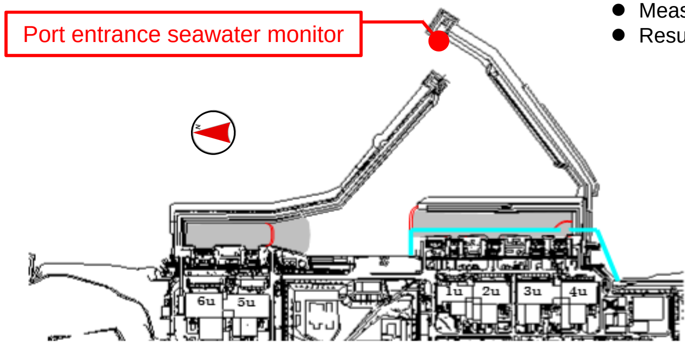


Courtesy of the International Research Institute for Nuclear Decommissioning (IRID)

Installation of a seawater radiation monitor

- A seawater radiation monitor targeting major nuclides such as cesium-134, cesium-137, and beta radiation nuclides was installed in front of the port entrance on 1 April 2015. The purposes are understanding the impact if any new leak should occur to the ocean from the site of Fukushima Daiichi and increasing the frequency of trend monitoring by performing ocean monitoring at all times rather than periodically.

- Measurement: every hour
- Results disclosure: every day on TEPCO website



Port entrance seawater monitor

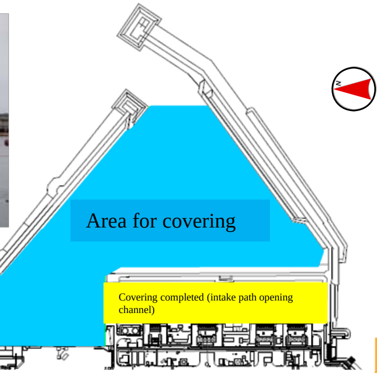
Overview of seabed covering work

Purpose: coat the seabed surface within the port to prevent the diffusion of seabed contaminants

Coverage area: approx. 180,000 m^2

Period of construction : 17 April to 23 May 2015 (completion of diffusion prevention)
From 23 June 2015, additional construction was started

Covering work

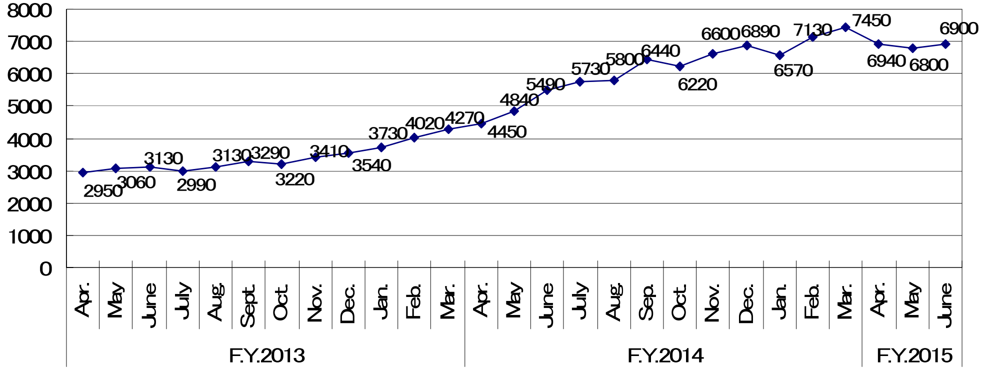


(11) Efforts for Securing Workers and Improving Work Environment

- Efforts are being made to secure personnel over the long term, while being sure to manage workers' radiation exposure.
- Further efforts are also being made for continuous improvement of the working environment, while understanding the needs of the site.

Changes in the number of workers

- The number of workers per weekday (employees from TEPCO and contractors) engaged in work during July is assumed to be approximately 6,660 people.
- The percentage of locally born workers is approximately 45% in June.



Change in the average number of workers (actual value) per weekday in the months following 2013.

Ensuring stable employment over the long term

- The importance of arranging for an environment in which the people from contracting companies and other local businesses can work over the long term was confirmed in order to steadily move forward with decommissioning work for 40 years.
- In addition to the physical environment arrangements, currently approximately 90% of orders are fulfilled by negotiated contracts.
- By securing long-term workers, more deliberate personnel assignment and human resource development is possible.

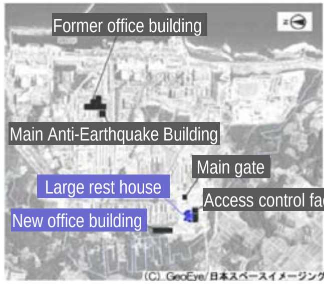
Surveys for improving the working environment

- Surveys for improving the working environment are continuously conducted for the workers at Fukushima Daiichi. The opinions received are compiled and utilized for further improving the work environment.

Improving the work environment

- Improving convenience
  - A large rest house with a capacity of approx. 1,200 workers was established and its operation commenced on 31 May 2015.
  - A new office building was constructed in 2014 allowing for smooth communication with areas close to the field.

Large rest house



New office building and office

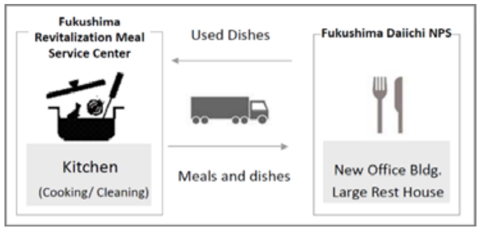
- Workplace environment improvements

Before work / After work / Before work / After work

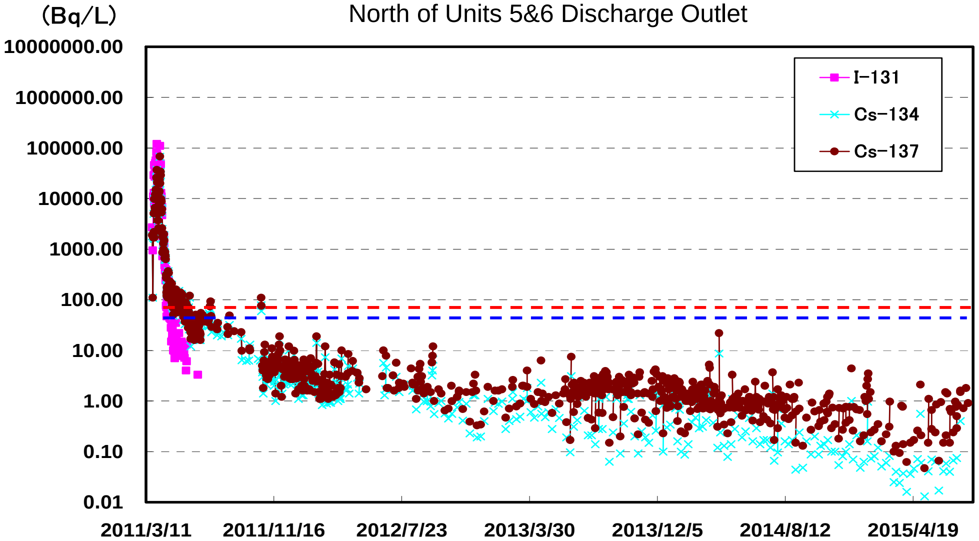
In front of the Unit 4 T/B / Tank area

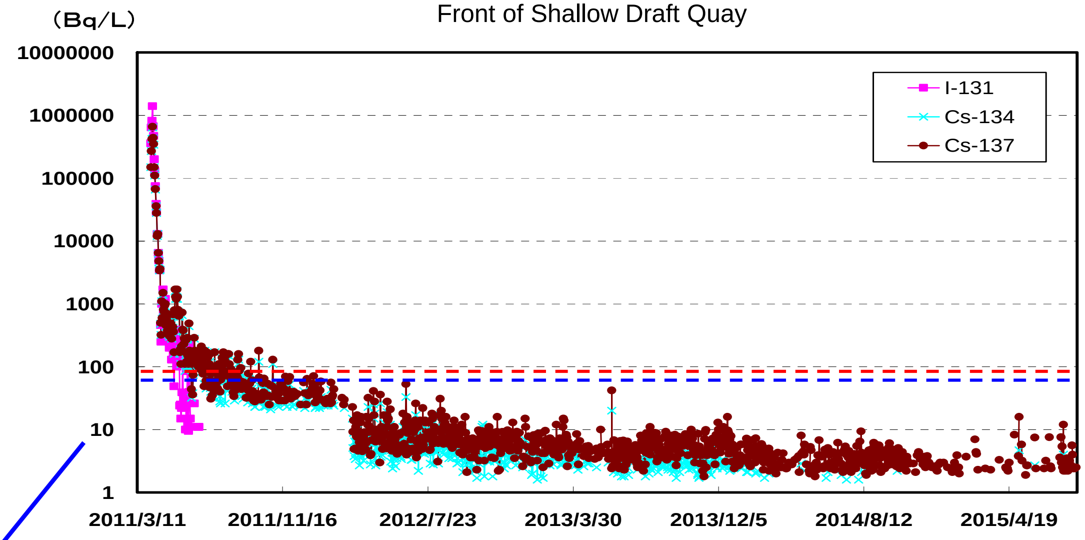
- Fukushima Revitalization Meal Service Center

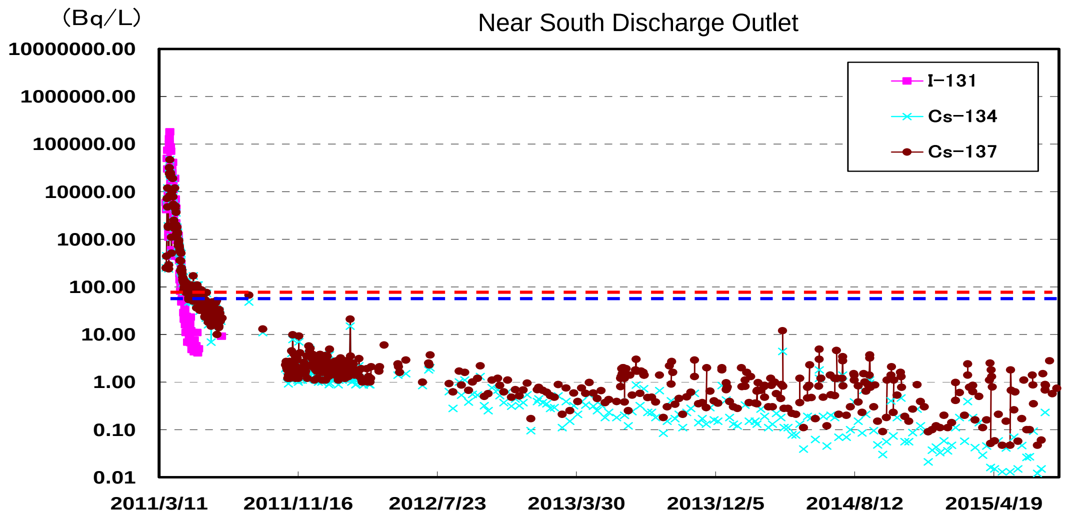
  Construction was finished on 31 March 2015
  - Providing warm meals
  - Creation of employment opportunities in association with the construction and operation of the meal service center
  - Dispelling of harmful rumors through the use of Fukushima - produced cooking ingredients and local employment.



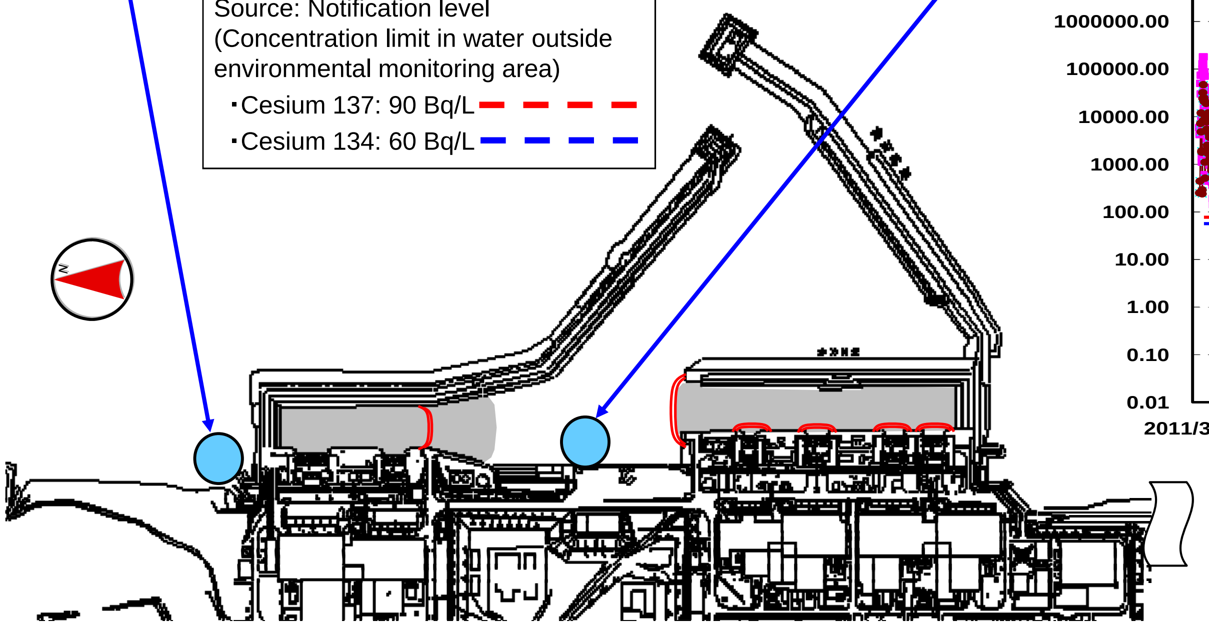
- The radioactive material concentration in the sea area decreased by one-in-100,000 to one-in-1,000,000 after the accident







Source: Notification level
(Concentration limit in water outside environmental monitoring area)
・Cesium 137: 90 Bq/L
・Cesium 134: 60 Bq/L



Fukushima Daiichi NPS Map

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