Current status of Fukushima Daiichi NPS

- Efforts for Decommissioning and Contaminated Water Management -

Agency for Natural Resources and Energy, METI

March , 2017

The Current Status of each Unit

Unit 1

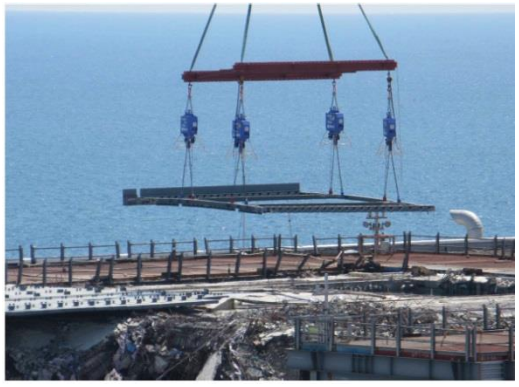
✓ Hydrogen explosion
✓ Core melt

<At the Time of the Accident> <Now>

・The building cover was installed to prevent dispersion of radioactive materials.
・Dismantling of the cover was completed in November 2016 for the fuel removal operation.

Unit 3

✓ Hydrogen explosion
✓ Core melt



<At the Time of the Accident> <Now>

- In December 2016, installing shields on the operating floor was completed.
- In January 2017, installing a Fuel-Handling Machine was started.

Unit 2

➢ No hydrogen explosion
✓ Core melt

<At the Time of the Accident> <Now>

- Installing a gantry to access the top floor of the building started in September 2016.

Unit 4

✓ Hydrogen explosion
➢ No core melt

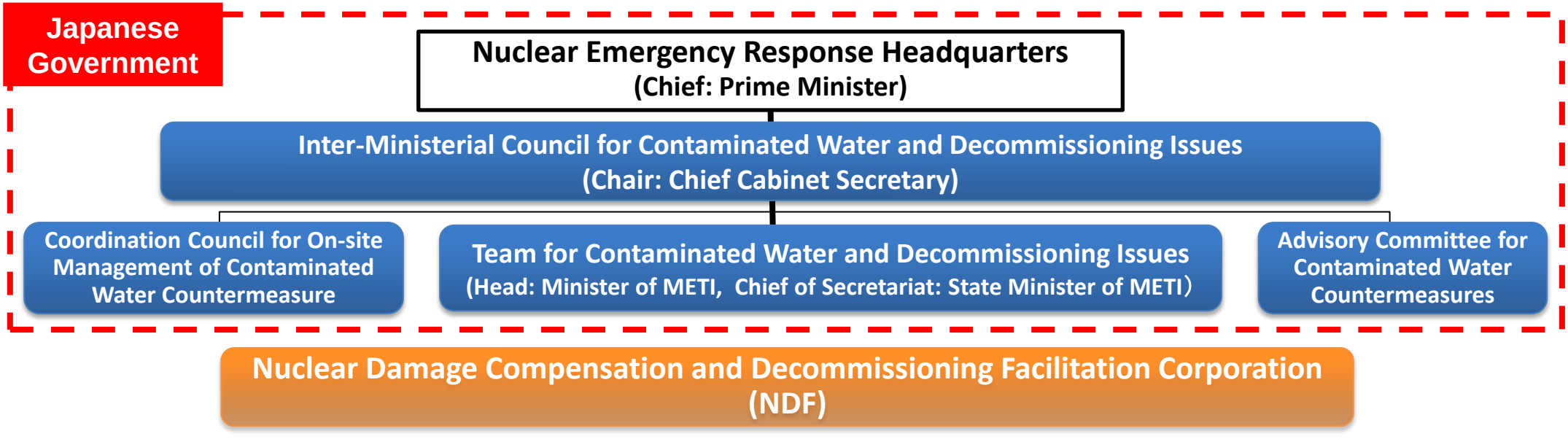
<At the Time of the Accident> <Now>

- On December 22, 2014, all (**1533**) fuel removal from Unit 4 SFP was completed.

Governmental Formation for Nuclear Accident Response

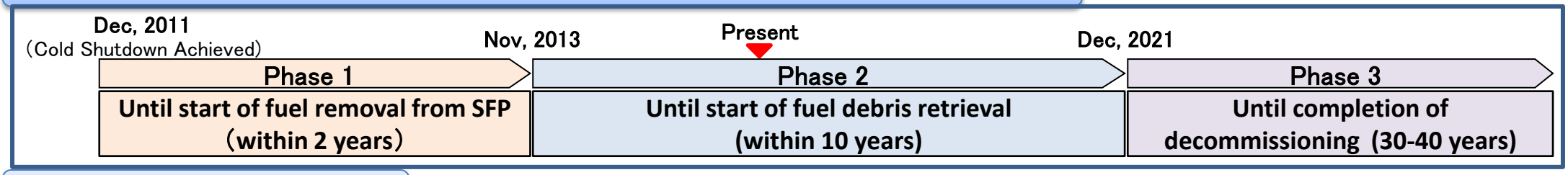
In order to strengthen the governmental response and the technical capability of total management,

- The Government of Japan established “Inter-Ministerial Council for Contaminated Water and Decommissioning Issues” and inter-agency “Team for Contaminated Water and Decommissioning Issues” under the Nuclear Emergency Response Headquarters. (September 2013)
- “Nuclear Damage Compensation and Decommissioning Facilitation Corporation” was constituted in August 2014 by law amended by parliament.



Overview of Decommissioning Strategy -The Mid-and-Long-Term Roadmap

Phases until completion of decommissioning (the Mid-and Long Term Roadmap)



Progress in Main Measures

		＜Completed＞	＜In Operation＞
Decommissioning		・Fuel removal from Unit 4 SFP【December, 2014】	・Dismantlement of Unit 1 building cover ・Installment of a Fuel-Handling Machine ・Investigation inside PCV by Robots, etc. ・Characterization of radioactive waste
Contaminated Water Management	**Removing**	・Covering seabed soil within the port【April, 2015】 ・Treatment of contaminated water in tanks【May 27, 2015】 (The treatment of contaminated water remained in the tanks is to be completed until dismantlement of tanks) ・Remove contaminated water from trenches【July 30, 2015】	
	Isolating	・Operation of groundwater bypassing system【may, 2014～】 ・Operation of sub-drains (wells around buildings)【September, 2015～】 ・Installation of land-side impermeable frozen walls【Freezing operation started in March 31, 2016 and was completed in October 2016 on the sea-side.】	・Installation of land-side impermeable frozen walls【on January 1, 2016, 94% of area on the mountain-side has frozen.】 ・Waterproof pavement【In March 2016, about 90% was completed】
	Preventing Leakage	・Installation of sea-side impermeable walls【October, 2015】 ・Heightening and doubling of tank fences【July, 2014】 ・Ground improvement by sodium silicate【March, 2014】	・Replacement of welding type tanks from flange (bolt) type

Major Milestones of the Mid-and-Long-Term Roadmap

➢ Clarify the short-term targets (green) for higher priority measures, while keeping the general framework (blue)

Overall	Completion of decommissioning		30 – 40 years
Contaminated water management	Completion of treatment of stagnant water in buildings	Minimizing the amount of increase of contaminated water and water inside the building, except cooling water	**2020**
Removing	Additional effective dose rate at the site boundary < 1 mSv/y	Achieving the risk reduction goal of exposure dose	FY2015
	Start of preparation to determine long-term management of ALPS-treated water		First half of FY2016
Isolating	Control inflow of groundwater into the buildings < 100 m3/day	Huge decrease in the amount of contaminated water increase	FY2016
Preventing leakage	Storage of all the water generated by treatment of highly contaminated water in welded-joint tanks	Huge reduction in risk of leakage from tanks	early FY2016
Stagnant water treatment	Reduction of radioactive materials in stagnant water in the buildings by half	Reduction in risk of leakage from buildings	FY2018
			NEW
Retrieval of spent fuel	Decision on methods for the treatment and storage of spent fuel		**around 2020**
	Start of spent fuel retrieval at Unit-1	Second half of FY2017 ⇨	FY2020
	Start of spent fuel retrieval at Unit-2	First half of FY2020 ⇨	FY2020
	Start of spent fuel retrieval at Unit-3	First half of FY2015 ⇨	FY2017
Retrieval of fuel debris	Policy on fuel debris retrieval from each Unit		Summer in 2017
	Decision on the method for fuel debris retrieval from the 1st implementing Unit		First half of FY2018
	Start of fuel debris retrieval from the 1st implementing Unit		2021
Radioactive waste	Establishment of basic concept of processing/disposal for solid radioactive wastes		FY2017

※The changes in milestones for SF removal are mainly due to "Measures for Safety and Securing more", including measures for preventing dust dispersion or reduction of workers' exposure dose, etc. Best efforts to avoid delay due to "troubles" or "delay in decision" should be made hereafter.

Progress and Future Prospects of the Decommissioning Measures

Measure		FY 2015	2016	2017	2018	2019	2020	2021	2022
Fuel Removal	Unit 1	Started dismantlement of building cover after preventing measures for dust dispersion【Removal of roof panels were completed on October 5, 2015】	To complete building covers dismantlement		<Image of fuel removal (FY2020)>				
	Unit 2	Determined dismantling areas in upper part of reactor building, before selecting the fuel removal plan【November 11, 2015】	To start construction of assembly bases to reach to the operating floor【FY 2016】		<Image of fuel removal plan (FY 2017)>				
	Unit 3	[Reference] Operating floor at the time of the accident Removal of the largest rubble (close to 25 tons) was completed【August, 2015】	Started installation of fuel removal equipment【Jan, 2017】 ・The decontaminated of the operating floor was completed【June, 2016】 ・Installing of shield was completed【Dec, 2016】		<Image: at the start of fuel removal(FY2018)>				
Fuel Debris Retrieval		Unit 1 ・Investigation inside PCV using cosmic ray, muon transmission method【May, 2015】 ・Investigation inside PCV using snake like robot【April, 2015】 Unit 3 Conducted pre-survey toward investigation inside PCV using robot【October, 2015】	Unit1: Detailed investigation inside PCV will start based on the result of previous investigation.【FY2016】 Naraha Remote Technology Development Center: Full-scale operation started from April, 2016 Unit2: ・Investigation inside PCV using cosmic ray, muon transmission method【July, 2016】 ・Investigation inside PCV using scorpion like robot【Feb, 2017】		Determine retrieval approach for each unit (Summer, 2017) Determine retrieval method (First half of FY 2018)		Continuously conduct R&D while gathering collective knowledge and wisdom from around the world.		

Unit 1: Water, 392体; Dismantlement of building cover → Rubble removal, Decontamination work, etc. → Installation of cover for fuel removal, etc. → Fuel removal (FY2020)

Unit 2: Water, 615体; Preparatory work → Dismantle upper part of the building, etc. → Fuel removal (FY 2020)

Plan 1 Install a common container: Fuel, Debris

Plan 2 Install separate containers: Fuel → After fuel removal → Debris

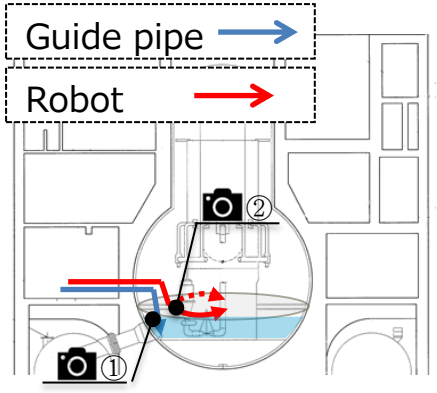
Unit 3: Water, 566体; Rubble removal, Decontamination work, etc. → Installation of cover for fuel removal, etc. → Fuel Removal (FY 2018)

Study on conditions inside PCV / Study on methods of fuel debris retrieval (R&D) → Engineering work, etc. → Preparation for fuel debris retrieval → Start retrieval at 1st unit

Fuel debris retrieval

The results so far

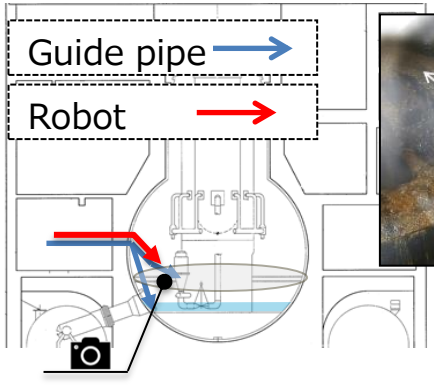
Unit 1

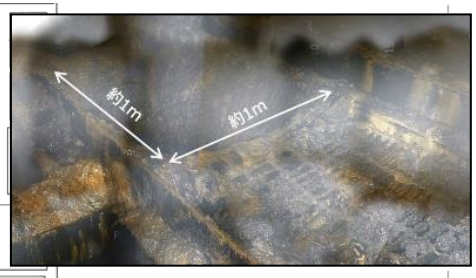


①Bottom of the PCV (Oct. 2012)

②Inside of the PCV（Apr. 2015）

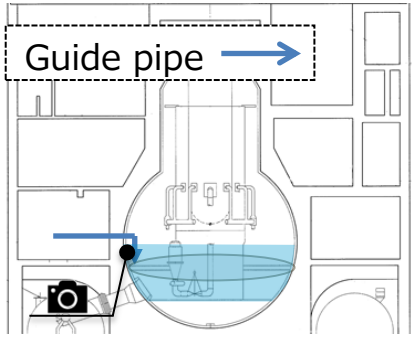
Unit 2





Inside of the PCV（Jan. 2017）

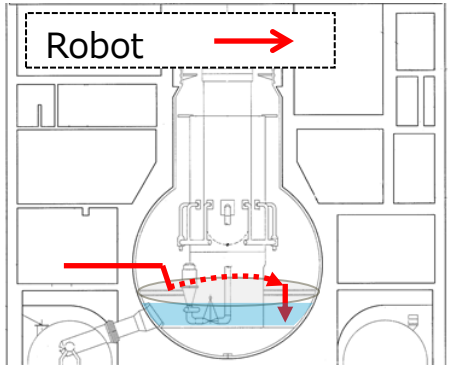
Unit 3



A structure inside of the PCV (Oct. 2015）

The future investigation

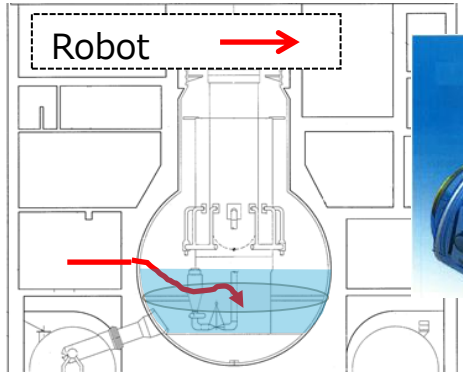
Unit 1



The investigation will be implement in FY 2016 ~~2018~~

See next page….

Unit 3



Robot in water

The investigation will be implement in early FY 2017 ~~2019~~

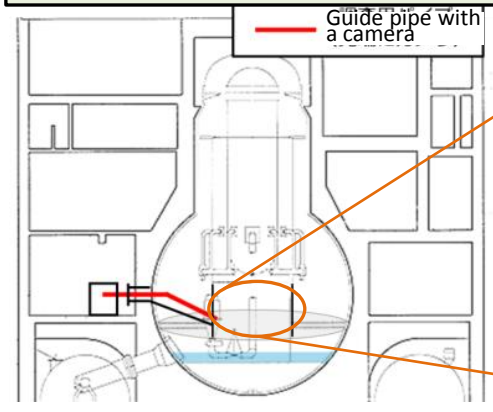
The progress of the investigation inside Unit 2 PCV

◇ To identify the status inside the unit PCV, a camera and a robot were inserted close to the PRV by remote control from 26th January to 16th February.

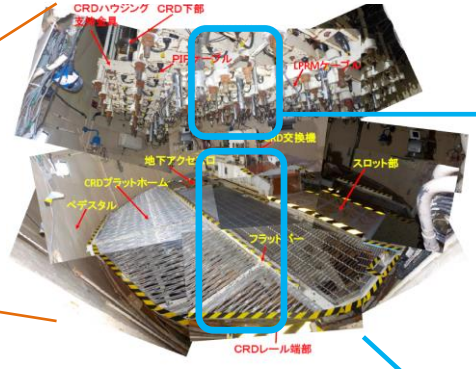
◇ From the result of this investigation, fallen scaffold below the RPV and the status of deposits were identified directly for the first time. In the PCV, many images were taken. Also, the actual measurement of radiation and temperature were implemented. Effort toward the decommissioning of Unit 2 is progressing steadily.

◇The consideration of the decision for the policy on fuel debris retrieval from each Unit will progress based on the analysis of a series of investigations. (the status Unit 1 and 3 will be investigated serially)

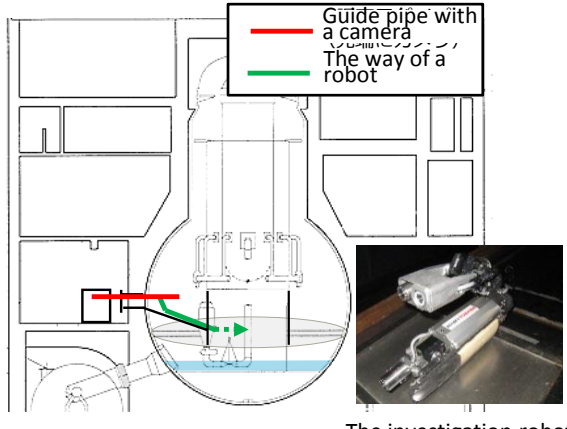
Camera investigation(26th Jan. and 30th Jan.)



※Before the accident

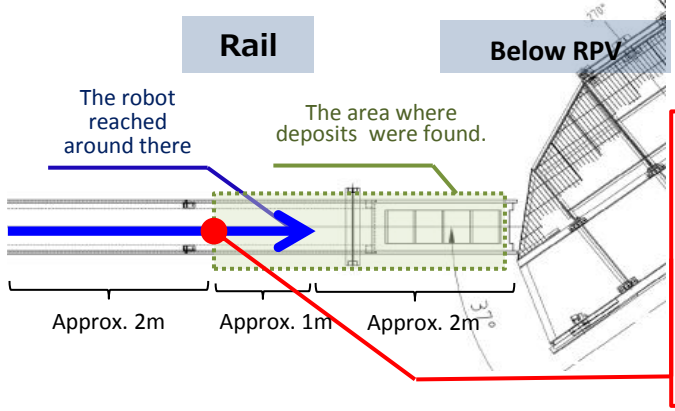


Robot investigation(16th Feb.)



The investigation robot

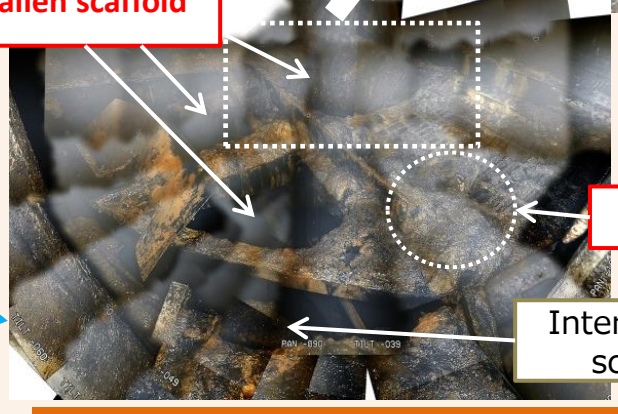
※Overhead view : the running rout of a robot



The status below RPV were identified for the first time

No massive damage of facilities below PRV

Fallen scaffold



Success of the actual measurement

Radiation dose：Approx. 210 Sievert per hour*

*This radiation dose is inside of the PCV shielded by thick steel vessel, and concrete. The radiation dose outside of the PCV is approx. 5 to 6 mSv/h. There was and will be no effect by the radioactive material to the outside the PCV.

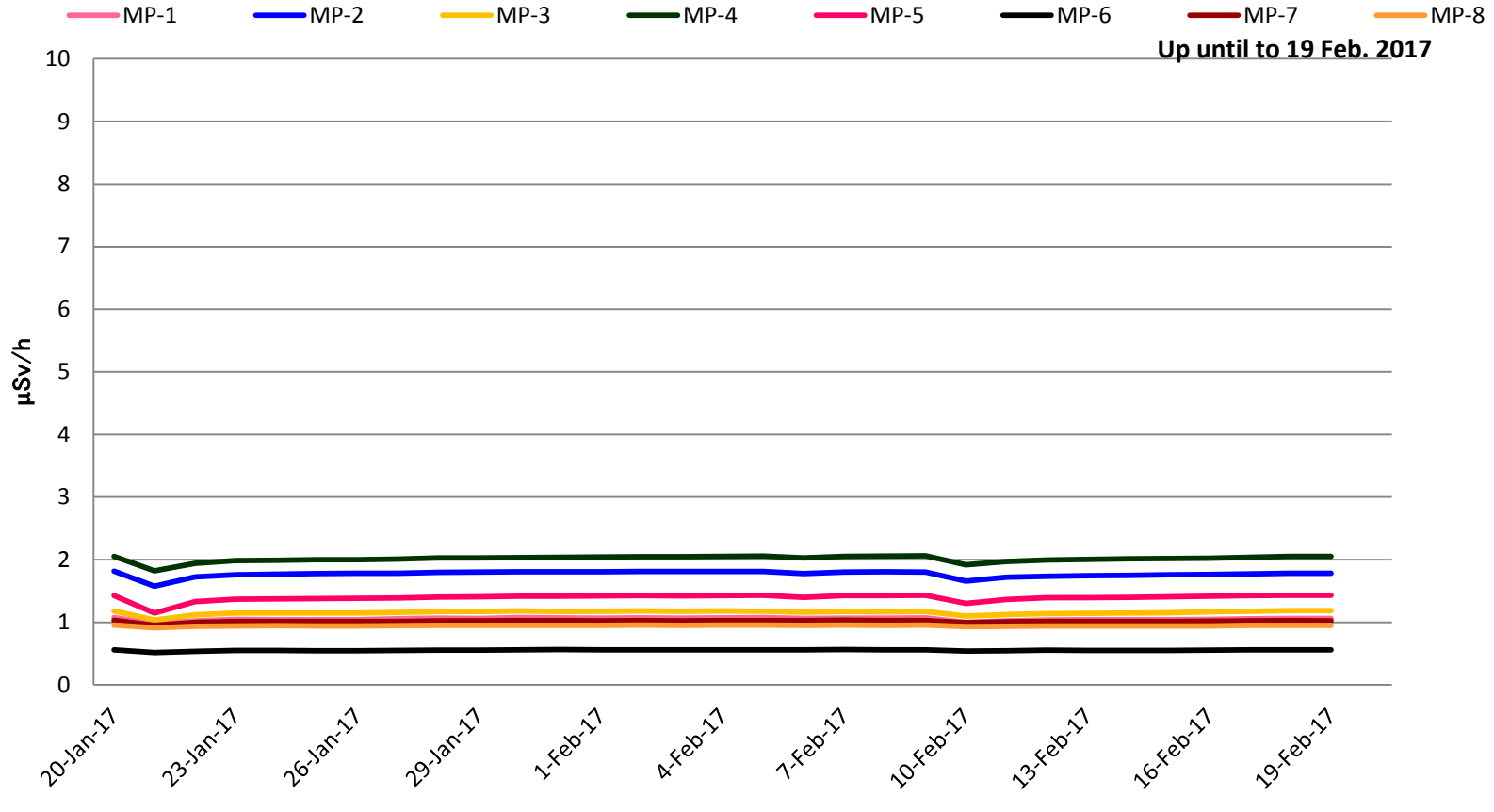
Temperature ：Approx. 16.5 degree**

It is almost the same temperature as one by a constantly monitored thermometer (18.7 degree). **There is no abnormality in the cold shutdown condition.

Radiation dose at the site boundaries of Fukushima Daiichi NPS

- The result of this investigation does not mean that some new phenomenon inside the PCV has occurred.
- The inside of the PCV is shielded by thick steel vessel, concrete and zinc-plate inside the building and the gas inside PCV are controlled well.
- The status inside the PCV is still stable and there are no changes in radiation levels at the site boundaries of Fukushima Daiichi NPS. Through this investigation, there was and will be no effect by the radioactive material to the outside the PCV.

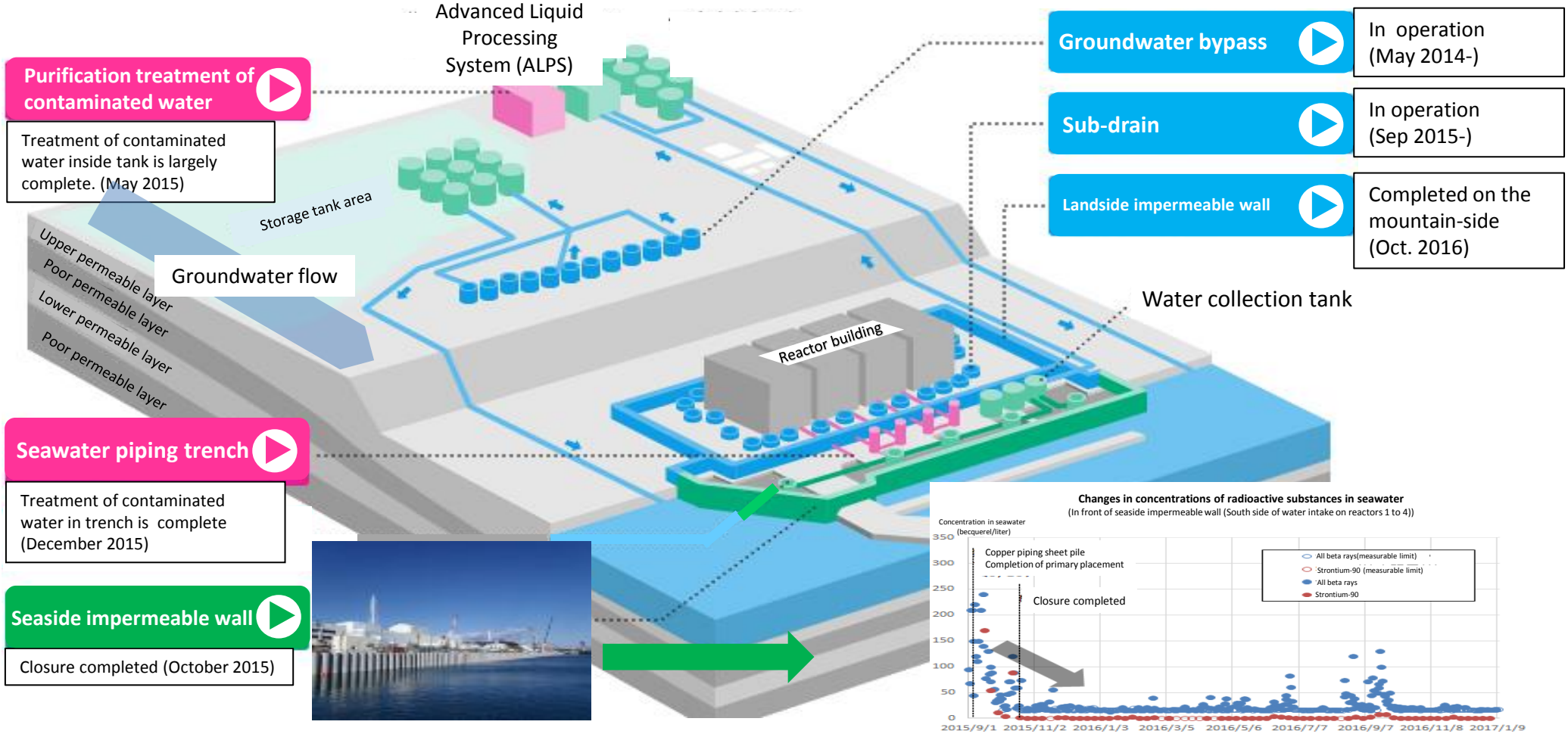
Change of radiation dose at the site boundaries of Fukushima Daiichi NPS



Overview of Contaminated Water management

3 Basic Policies

- **"Isolating"** groundwater from contamination source (→Control amount of contaminated water by reducing groundwater inflow into building)
- **"preventing leakage"** of contaminated water (→Reduce outflow of radioactive substances into sea)
- **"Removing"** the contamination soueces (→Remove radioactive substances from contaminated water in tanks)

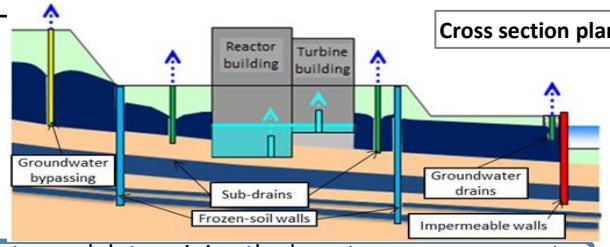


Progress and Future Prospects of the Contaminates Water Management

		Measures and Progress (~March 2016)			Future Prospects
Isolating	Groundwater inflow Approx. 400m³/day (2011.6~2014.5)	Operating groundwater bypasses [2014.5~] Approx. 300m³/day (2014.5~2015.9)	Operating sub-drains [2015.9~]	Pavement of the surface (92% completed) [2016.12] Approx. 200m³/day (2015.9~2016.12)	Closure of frozen soil wall (The landside impermeable wall) [Freezing started in 2016.3] [Freezing on the sea-side completed in 2016.10] [Freezing two of the seven parts on the mountain side started in 2016.12] Groundwater inflow to be decreased under 100m³/day [FY2016]
Preventing Leakage	Concentration of radioactive materials in the surrounding sea area Approx. 10,000Bq /L (2011.3) Concentration of Cs 137 Near the South Outlet (monthly average)	Soil improvement by water glass [2014.3] * Pumping groundwater from the well-point started [2013.8]	Closure of the seaside impermeable wall [2015.10] * Pumping groundwater from the groundwater-drains started[2015.11]	Increased the welding type tanks [2016.12] * The welding type tanks is approx.830,000t of the total amount of tanks for water treatment, approx.960,000t Not Detectable (Under 0.7 Bq/L) (2016.12) Concentration of Cs 137 Near the South Outlet (12/25-12/31 average)	Increasing of the number of tanks * Tanks will be increased about approx.173000t additionally by Sep. 2017. The flange type tanks which is approx.299,000t in Oct, 2016 will be replaced with the welding type which will be increased until approx.523,000t.
Removing	Additional effective doses at the site boundary Approx. 11mSv/yr (2012.3)	The decontamination process was almost completed [2015.5] → Approx.760,000m³ has been treated * Continuing the treatment by ALPS.	The decontamination of the contaminated water in trenches has completed [2015.12] →Approx.10,000m³ has been treated Approx. 1mSv/yr (2016.3)		Preparation toward determining the long-term management of ALPS treated water [2016. 9]
Stagnant water treatment		The turbine building of the Unit 1 was separated from a circulation water discharge line [2016.3]	Removing high-density contaminated water in Unit 1 condenser was started. [2016.10]		Completion of removal of stagnant water retained in the buildings [until 2020]

* Production of contaminated water is affected by the inflow of groundwater to the building , and also by the amount of water transferred from the wells at the seaside of the building such as groundwater drain to the building. This, however, will be expected to decrease by the effect of closure of frozen soil wall (the landside impermeable wall) .

Floor Plan



Cross section plan

<Others>

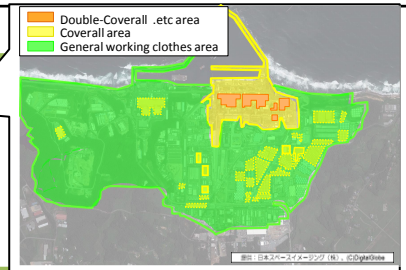
○Completed the reconfiguring of "Drainage K" path [2016.3]

○A certificate of gratitude was awarded to the work teams involved in decommissioning and contaminated water management [2016.4]

○Terminated Demonstration Project for Verification Tests of Tritium Separation Technologies [2016.3]

○The area where workers can work with general working clothes was expanded [2016.3]

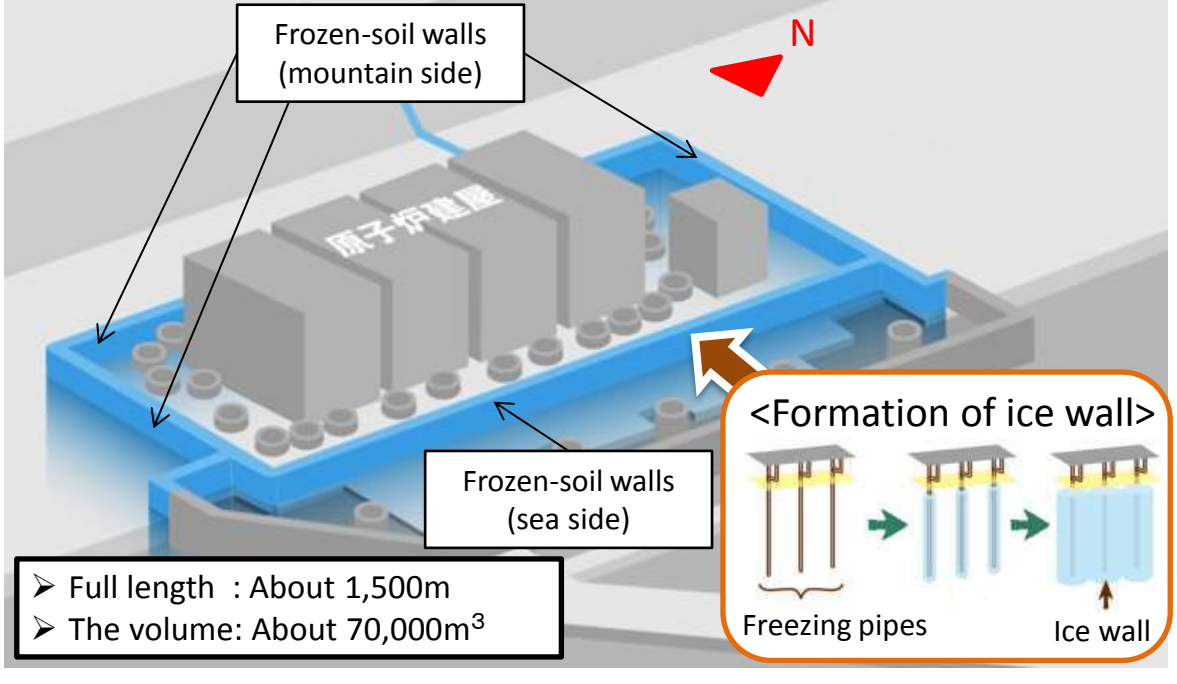
○Compiling basic concept of processing and disposal of solid radioactive wastes [FY 2017]



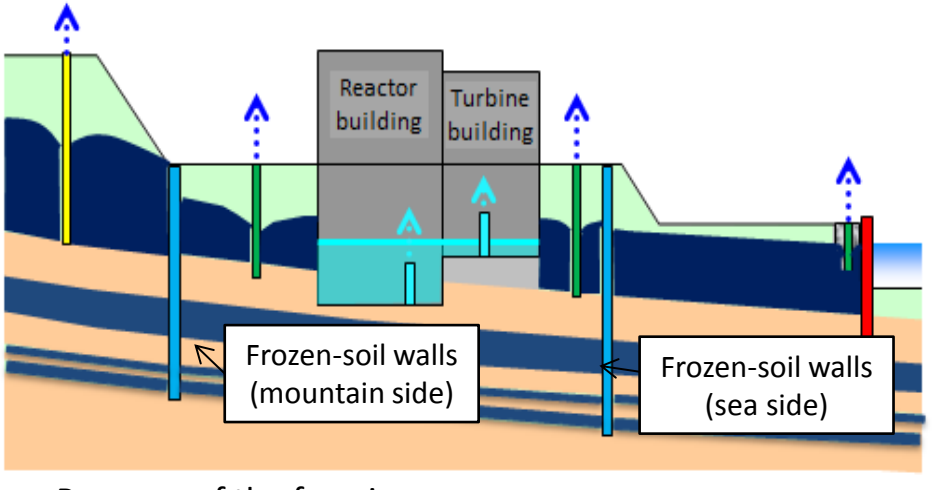
Frozen-soil Impermeable Walls [Isolating]

- To suppress the generation of contaminated water by blocking groundwater inflow into the buildings, impermeable walls, made of frozen-soil, have been constructed to surround the buildings.
- All the freezing pipes had been installed (Mountain-side: September, 2015; Sea-side: February, 2016)
- On the sea side, freezing started in March 2016 and completed in October 2017. The pumped up groundwater has declined. That is, the effect of the impermeable walls has been seen.

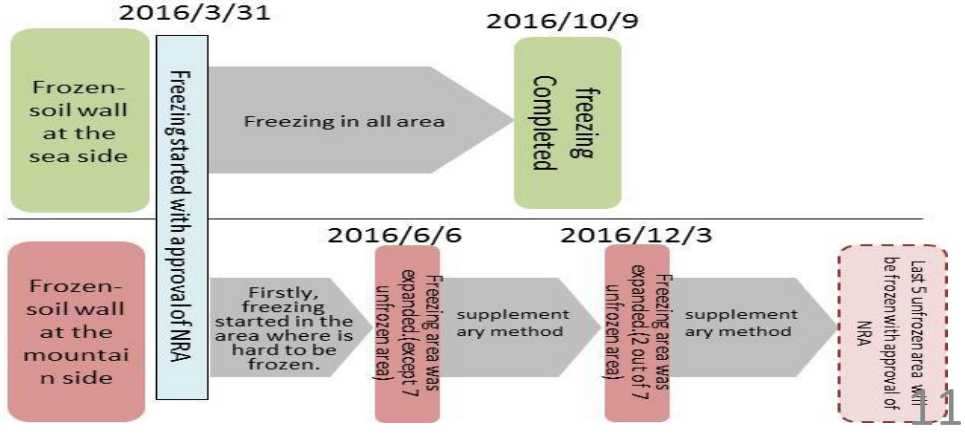
Panorama image of the walls



Cross-sectional image

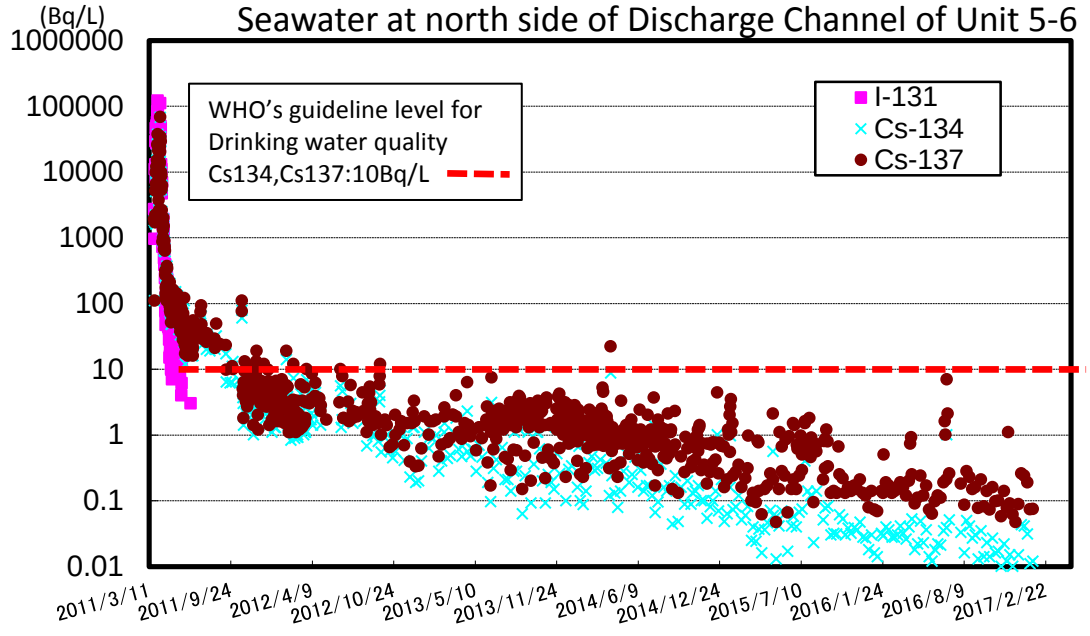


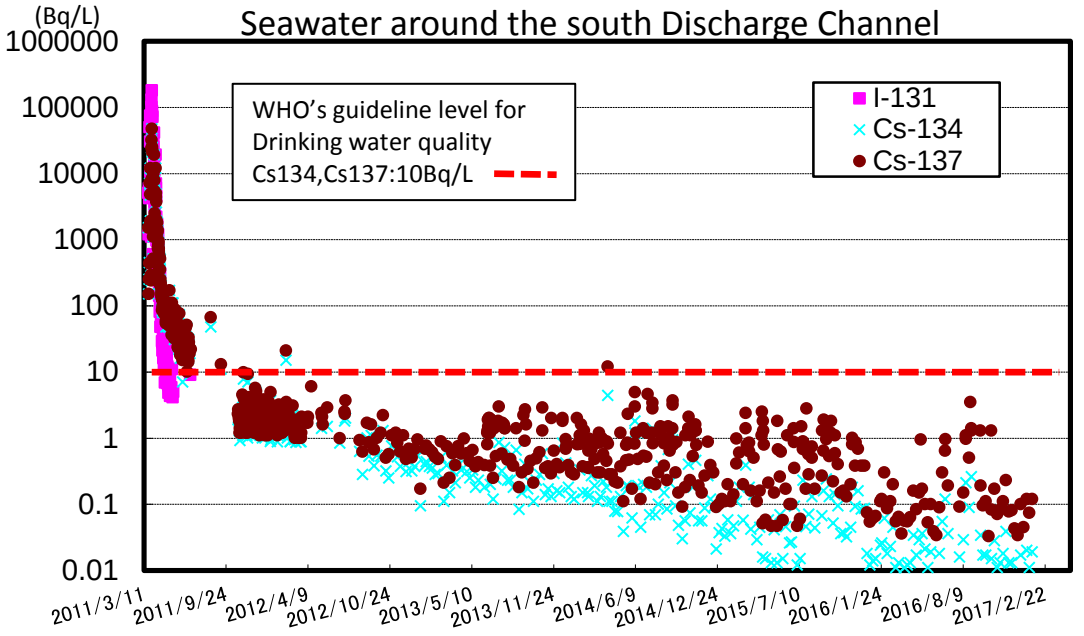
Progress of the freezing

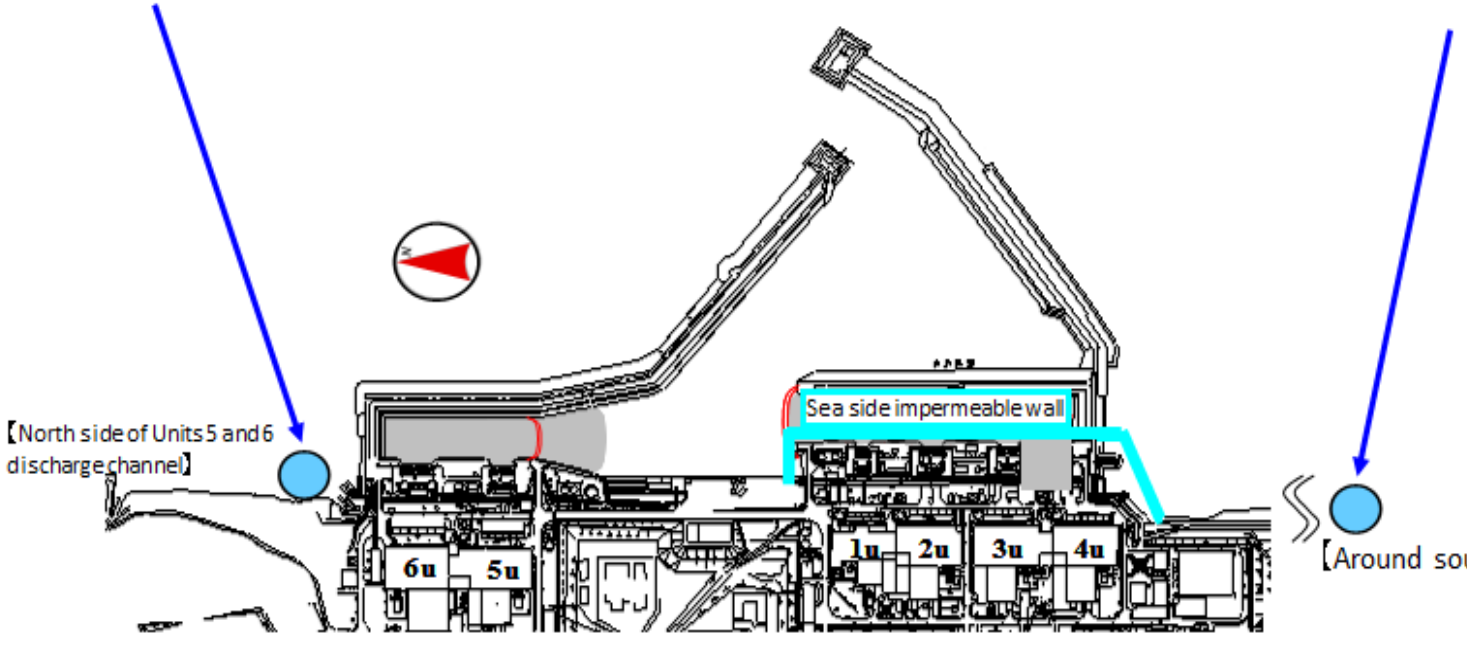


Status of seawater monitoring around outside of the port

＜Changes of the seawater monitoring point near the FDNPP＞







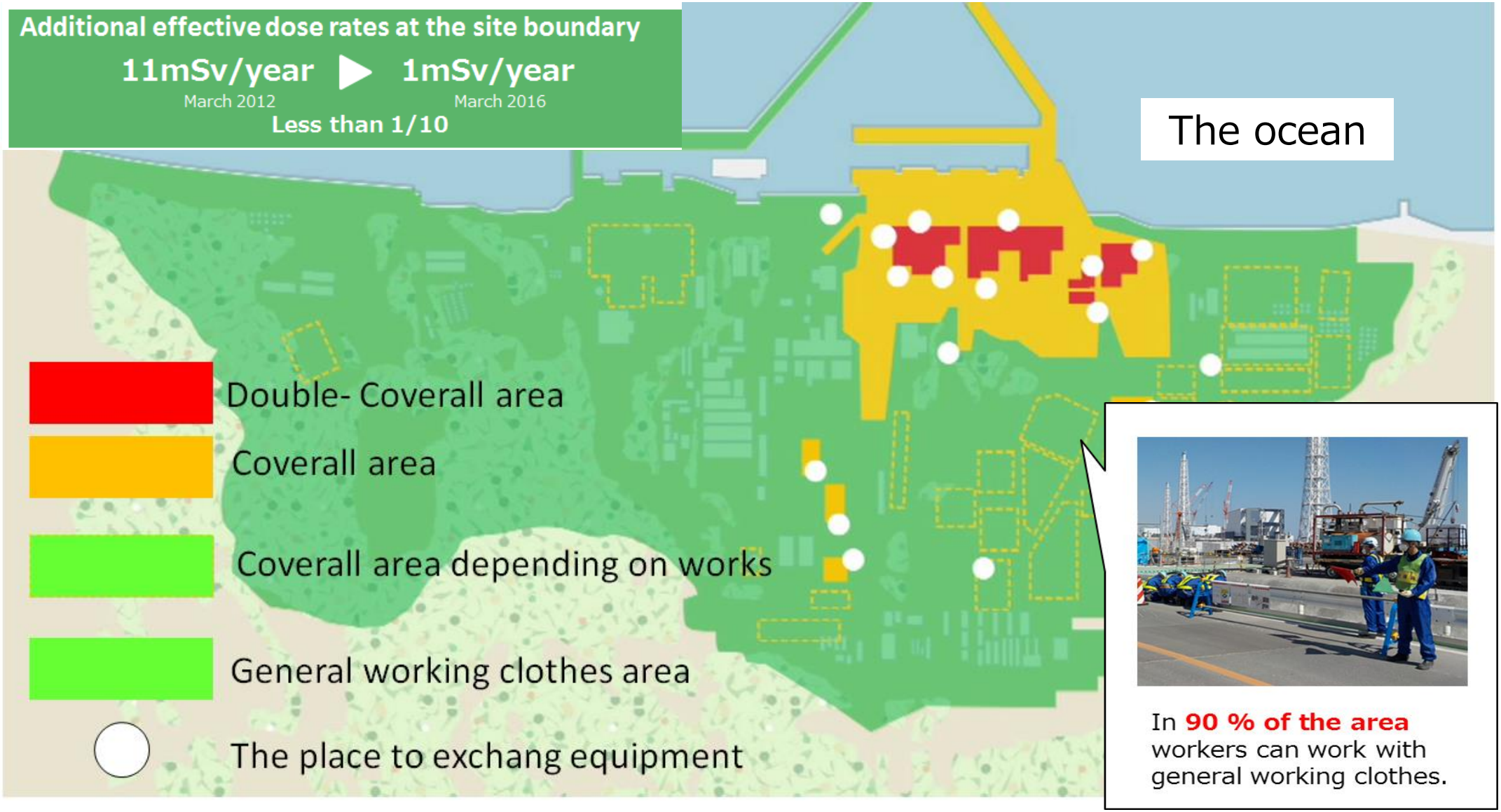
Concentration of radioactive materials in the surrounding sea area

About 10,000 Bq/L (March 2011 near the south outlet) ▶ Less than 1/10,000 ▶ Not Detectable (Under 0.7Bq/L) (March 2016 near the south outlet)

※Concentration of Cs137

Current status of Fukushima Daiichi NPS

- At March 2016, the area where workers can work with general working clothes was expanded to 90% of the site.



Source: JAPAN SPACE IMAGING CORPORATION , (C)DigitalGlobe

Cooperation with International Communities

International Organizations

IAEA International Atomic Energy Agency

- Peer Review Missions (April, 2013 -)
- Expert Visits
- Expert Meetings
- Comprehensive information on the website (December, 2013 -)
- Side Event in the General Conference
- "The Fukushima Daiichi Accident" (September, 2015) (Reported by the Director General)

OECD BETTER POLICIES FOR BETTER LIVES NEA NUCLEAR ENERGY AGENCY

- BSAF Project
  (Benchmark Study of the Accident at the Fukushima Daiichi NPS)
- SAREF Meeting
  (Senior Task Group on Safety Research Opportunities Post-Fukushima)
- EGFWMD Meeting
  (The Expert Group on Fukushima Waste Management and Decommissioning R&D)

Bilateral Frameworks

U.S.-Japan Bilateral Commission on Civil Nuclear Cooperation
- Decommissioning and Environmental Management Working Group
- Civil Nuclear Energy R&D Working Group

UK-Japan Nuclear Dialogue
- Decommissioning Working Group

Japan-France Nuclear Committee

Japan-Russia Energy Initiative Council Meeting
- Nuclear Working Group

Review Mission from IAEA

- A review mission from IAEA to review Japan's effort toward decommissioning TEPCO's Fukushima Daiichi NPS has started since April 2013. The third review was conducted from February 9 to 17, 2015, and Japan received its final report on May 13, 2015.
- Since December 2013, Japan has submitted the comprehensive information on the progress of recovery operations at Fukushima Daiichi NPS to IAEA. IAEA has uploaded it to IAEA's website with review comments.

＜Third Review Mission＞

Written Examination

Site Visit on Fukushima Daiichi NPS

＜The Points of the Third Mission Reports＞

IAEA International Atomic Energy Agency

○Acknowledgement

- The situation on-site has been improved since the last mission.
  Several important tasks were accomplished such as:
  - ✓ Completion of the fuel removal from SFP on Unit 4
  - ✓ The improvement and expansion of contaminated water treatment systems
  - ✓ The installation of new tanks and associated systems for contaminated water storage
  - ✓ The operation of underground water by-pass
  - ✓ The clean-up of the site resulting in a reduction in radiological dose rate

○Advisory Point on Tritiated Water Management

- It is necessary to find a sustainable solution to the problem of managing contaminated water. This would require considering all options, including the possible resumption of controlled discharges to the sea. Final decision making requires engaging all stakeholders. *(The same comment as the previous mission)*

International Forum on the Decommissioning of the Fukushima Daiichi Nuclear Power Station

- "The 1st International Forum on the Decommissioning of the Fukushima Daiichi Nuclear power Station" was held on April 10th -11th, 2016, in Iwaki City, Fukushima Prefecture.
- The forum was attended by as many as 641 people from 15 countries (including Japan), and main subjects were "Communications with Local Communities" and "World-leading Technical Session regarding Decommissioning." . "Decommissioning Technology Exhibition" was also held with 37 institutions (16 from overseas).
- The 2nd Forum will be held on 2 and 3 July 2017 at Hirono-town and Iwaki city respectively.

The 1st Forum

Photo Session

Main Venue of the Forum

Fukushima Consortium of Robotics Research for Decommissioning and Decontamination, Fukushima Exhibition

Decommissioning Technology Exhibition

The 1st Forum Keynote Speakers

W. D. Magwood IV
Director General, OECD/NEA
"Decommissioning the Fukushima Daiichi Site: *A Global Challenge*"

J. C. Lentijo
Deputy Director General, IAEA
"IAEA Support to Japan on Decommissioning of Fukushima Daiichi NPS"

M. Weightman
Former Chief Executive, ONR
"The Regulation of Decommissioning and Associated Waste management"

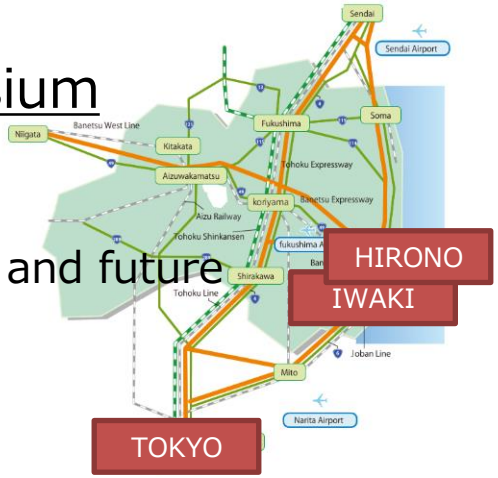
NDF 2nd International Forum on the Decommissioning of Fukushima Daiichi NPS

July 2nd and 3rd, 2017 at Fukushima, JAPAN

- Program

✓ Day 1 (July 2nd) @Hirono-town General Gymnasium
For mainly the local community

- Introduction on the decommissioning of Fukushima Daiichi
- Exchange of opinions with the local, regarding present state and future



✓ Day 2 (July 3rd) @Iwaki Washington Hotel
For mainly technical experts

- The latest technical situation of 1F
- Discussion on related technology globally
- Technical poster session

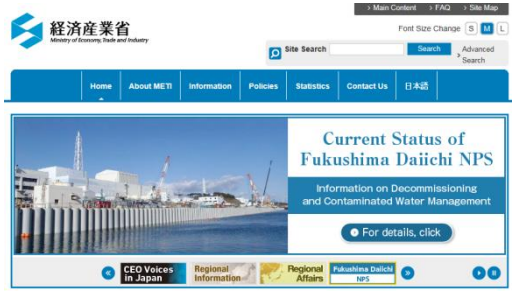
- Web site
http://ndf-forum.com/index_en.html

- Contact
For questions, please contact to:
forum@ndf.go.jp

[Reference] Related Links

◆ ANRE, METI

Contaminated Water Issue at TEPCO's Fukushima Daiichi NPS :
http://www.meti.go.jp/english/earthquake/nuclear/decommissioning/index.html#links



◆ Movie (METI & Cabinet Office)

Fukushima Today (1.5 min)
http://www.meti.go.jp/earthquake/nuclear/hairo_osensui/#movie

Fukushima Today – for a bright future – (5 min)
http://www.meti.go.jp/english/earthquake/nuclear/decommissioning/index.html#video

◆ TEPCO

Decommissioning Plan of Fukushima Daiichi Nuclear Power:
http://www.tepco.co.jp/en/decommision/index-e.html
TEPCO CUUSOO : https://tepco.cuusoo.com

◆ IRID (International Research Institute for Nuclear Decommissioning)

http://irid.or.jp/en/