Current Status and the Future of Fukushima Daiichi Nuclear Power Station

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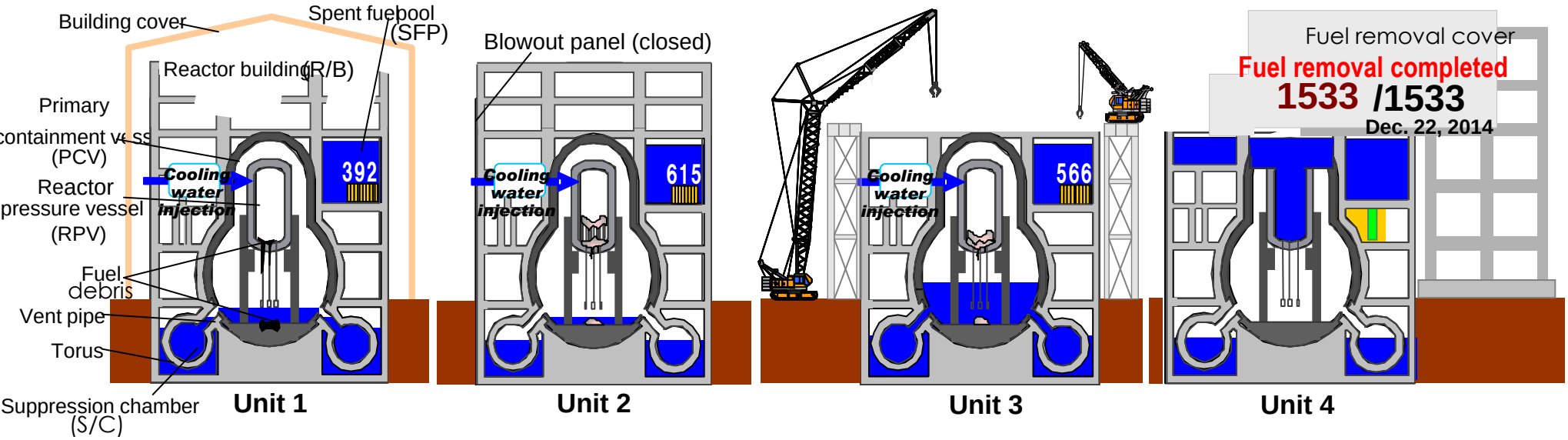
Today's Topics

1. Current status on Fukushima Daiichi NPS
2. Measures against contaminated water
3. Improving reliability of equipment
4. Fuel removal from the spent fuel pool
5. Toward fuel debris removal
6. Improving work environment
7. Promotion of decommissioning works

1. Current Status on Fukushima Daiichi NPS (Status of reactors and buildings)

All units maintain cold shutdown state



RPV bottom temp.	
Unit 1	15.3℃
Unit 2	21.6℃
Unit 3	18.2℃

PCV internal temp.	
Unit 1	15.5℃
Unit 2	25.1℃
Unit 3	17.7℃

Spent Fuel Pool temp.	
Unit 1	14.0℃
Unit 2	29.1℃
Unit 3	23.1℃

Amount of Water injection to reactor	
Unit 1	4.5㎥/h
Unit 2	4.5㎥/h
Unit 3	4.3㎥/h

Values as of 11:00 on March 25th 2015

※Removal of fuel rods in SFP at Unit 4 was completed on December 22, 2014.

1. Current Status on Fukushima Daiichi NPS（Current status and Tasks）

Unit 1

Current status

Building cover installed on reactor building (November 2011)
Removal of the building cover temporarily to see the condition of rubble accumulation (October to December 2014)

Tasks

Preparation for fuel removal
Removal of reactor cover and countermeasures for the dispersion of radioactive materials
Plan to remove rubble on reactor building and in SFP

Photo taken on 12 March 2011

Photo taken on 10 Oct 2014:Removing cover

Unit 2

Current status

Closed the blowout panel to avoid the dispersion of radioactive materials

Tasks

Radiation dose reduction measures
Due to higher radiation level compared with other units, research on contamination to be implemented

Photo taken on 10 April 2011

Photo taken on 15 Aug 2012

Unit 3

Current status

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

Tasks

Preparation for fuel removal from SFP
Due to high radiation levels, radiation dose reduction measures must be carried out safely and steadily with remote-controlled heavy machinery

Photo taken on 12 Feb 2012

Photo taken on 11 Oct 2013

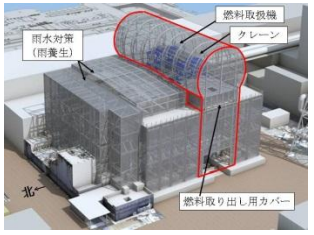


Image of cover for fuel removal

Unit 4

Current status

Fuel removal from SFP completed
(on December 22, 2014)

Tasks

Consider full scale decommission plan including demolition of building

Photo taken on 22 Sep 2011

Photo taken on 5 Jul 2012

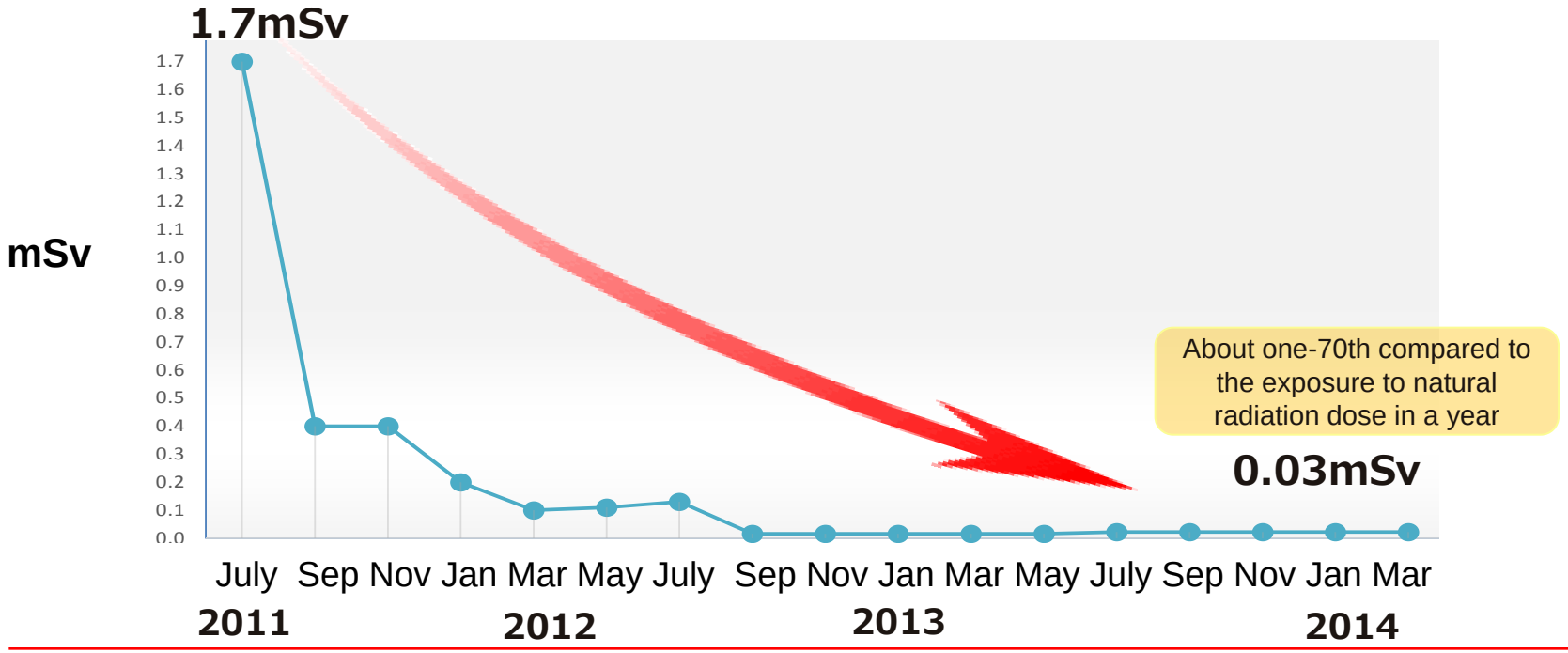
Photo taken on 12 Nov 2013

1. Current Status on Fukushima Daiichi NPS
(Status of airborne radioactive materials)

- **The amount of radioactive materials (cesium) released from Unit 1-3 PCVs is assessed based on airborne radioactive material concentrations (dust concentration) at the top of reactor buildings**
  - **→Calculated the assessed value of total release amount (as of July, 2013) as about 10 million Bq/hr.**
  - **→About one-80 millionth compared to immediately after the accident.**
- **Accordingly, assessed the exposure dose at site boundary as 0.03 mSv/yr. at maximum.**

(Excluding effect of already released radioactive materials)　Note: Exposure limit established by law is 1 mSv/yr.

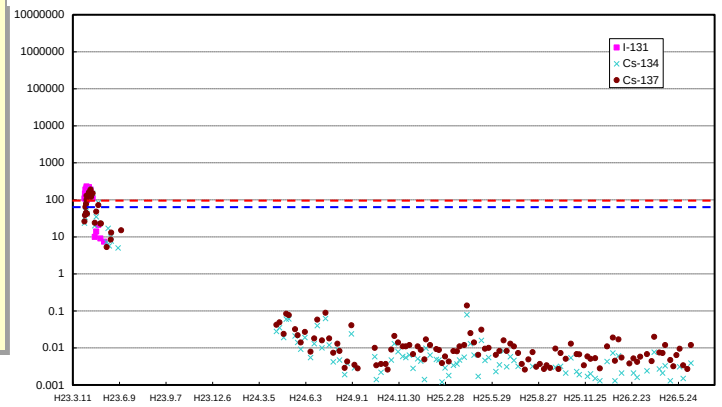
The exposure dose by the radioactive materials (cesium) from Units 1 to 4



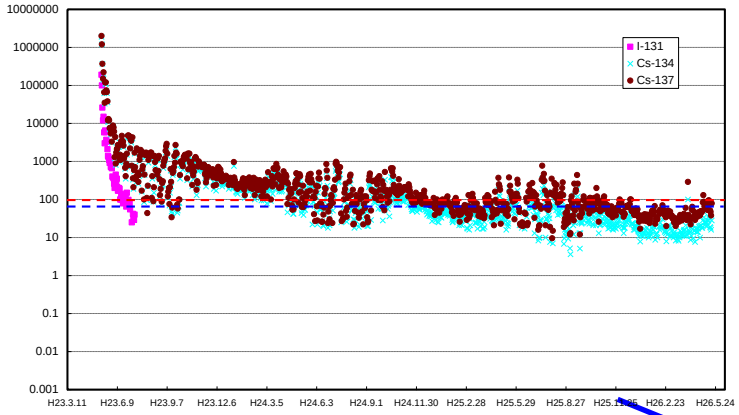
1. Current Status on Fukushima Daiichi NPS (Concentration of radioactive materials)

- Concentration of radioactive materials has been gradually decreased to about one-100 thousandth compared with the one after the accident and outside port are substantially below notified concentration.

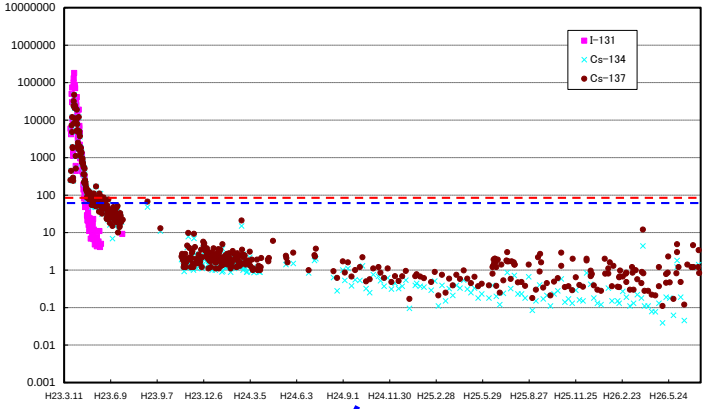
15 km off the coast of NPS (Bq/L)



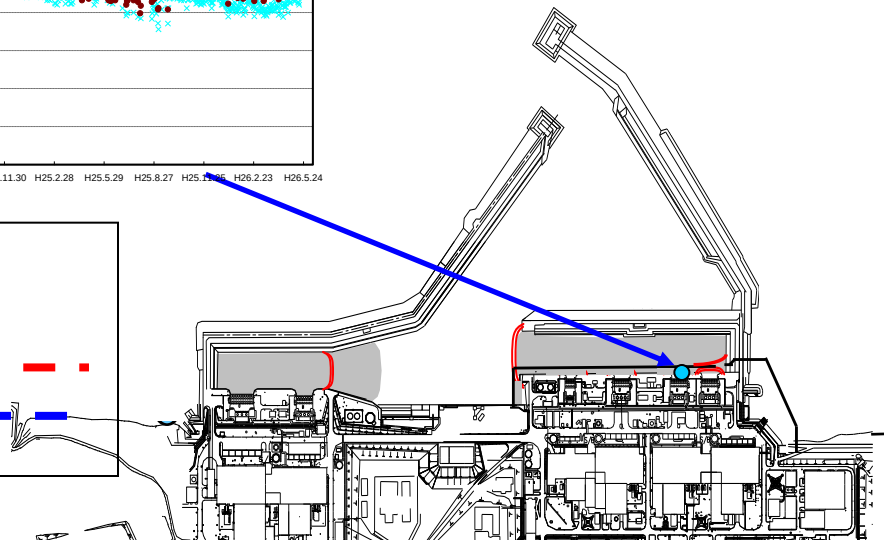
In front of Inlet of coolant at unit 3 (Bq/L)



At the south discharge outlet (Bq/L)



<Reference> Notified concentrations
(Concentration limits for water outside environmental monitoring area)
- Cesium 137: 90 Bq/L
- Cesium 134: 60 Bq/L



: Silt fence
: Impermeable wall

2. Measures against Contaminated Water (3 policies and concrete measures)

Policy 1. Remove source of contamination

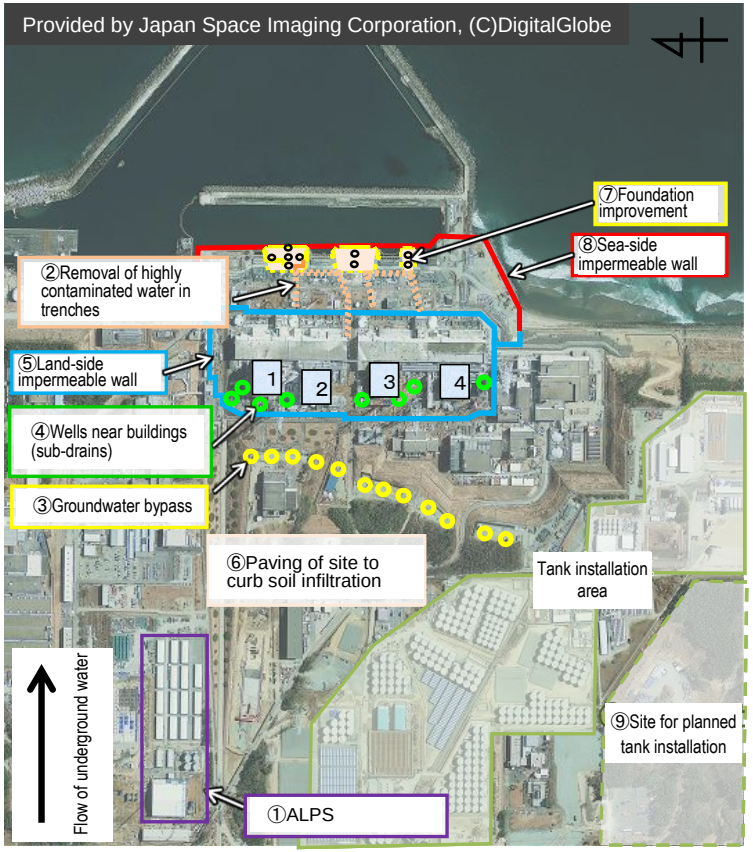
① Clean up contaminated water with Multi-nuclide removal equipment (ALPS)
② Remove contaminated water in trenches (Underground tunnel with piping)

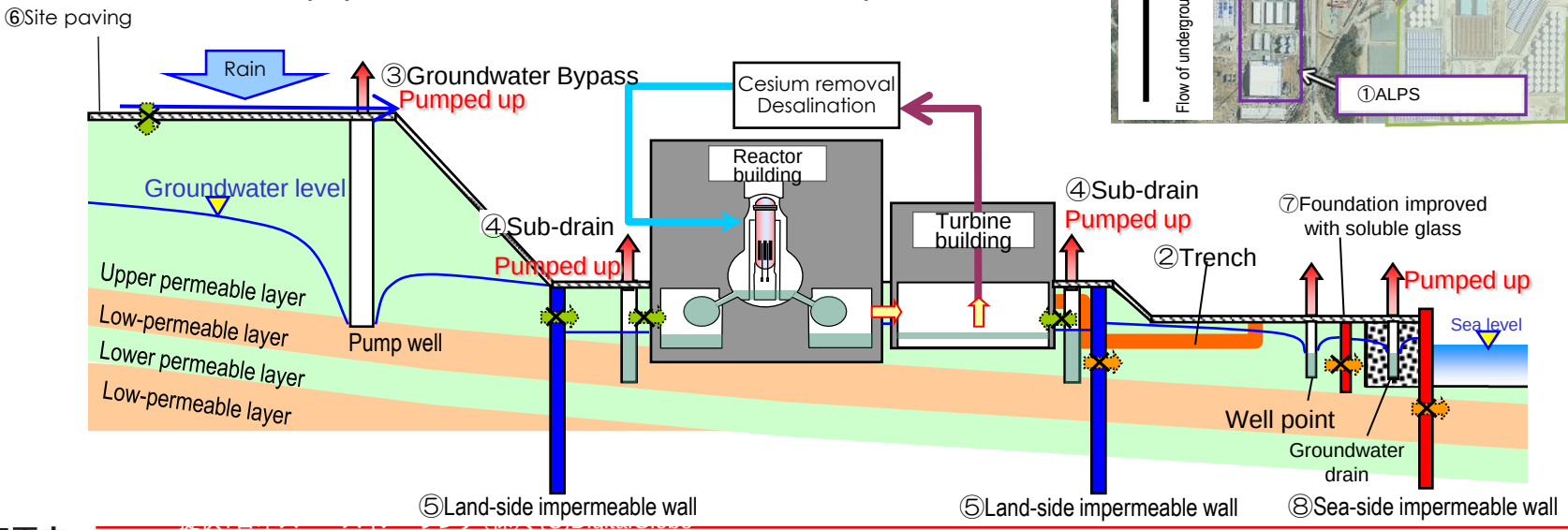
Policy 2. Isolating groundwater from contamination sources

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.)





2.Measures against Contaminated Water (multiple risk mitigation measures)

Mobile strontium removal equipment

【A, B systems】In operation
【Second system】In operation
Treatment Volume：300m^3/d × 2systmens、480m^3/d × 4 units
Radionuclide purification capacity ：mitigate strontium level to 1/10～1/1,000

Multi-nuclide removal equipment (ALPS)

In operation
Treatment Volume：250m3/d × 3 systems
Radionuclide purification capacity： 62 radionuclide to ND level

Expanded Multi-nuclide removal equipment

In operation
Treatment Volume：250m^3/d × 3 systems
Radionuclide purification capacity： 62 radionuclide to ND level

Cesium absorption apparatus

In operation
Treatment Volume：600m^3/d
Radionuclide purification capacity：mitigate strontium level to 1/100～1/1,000

Multiple Risk Mitigation Measures

High Performance Multi-nuclide removal equipment

In operation
Treatment Volume：more than 500m3/d
Radionuclide purification capacity： 62 radionuclide to ND level

Second cesium absorption apparatus

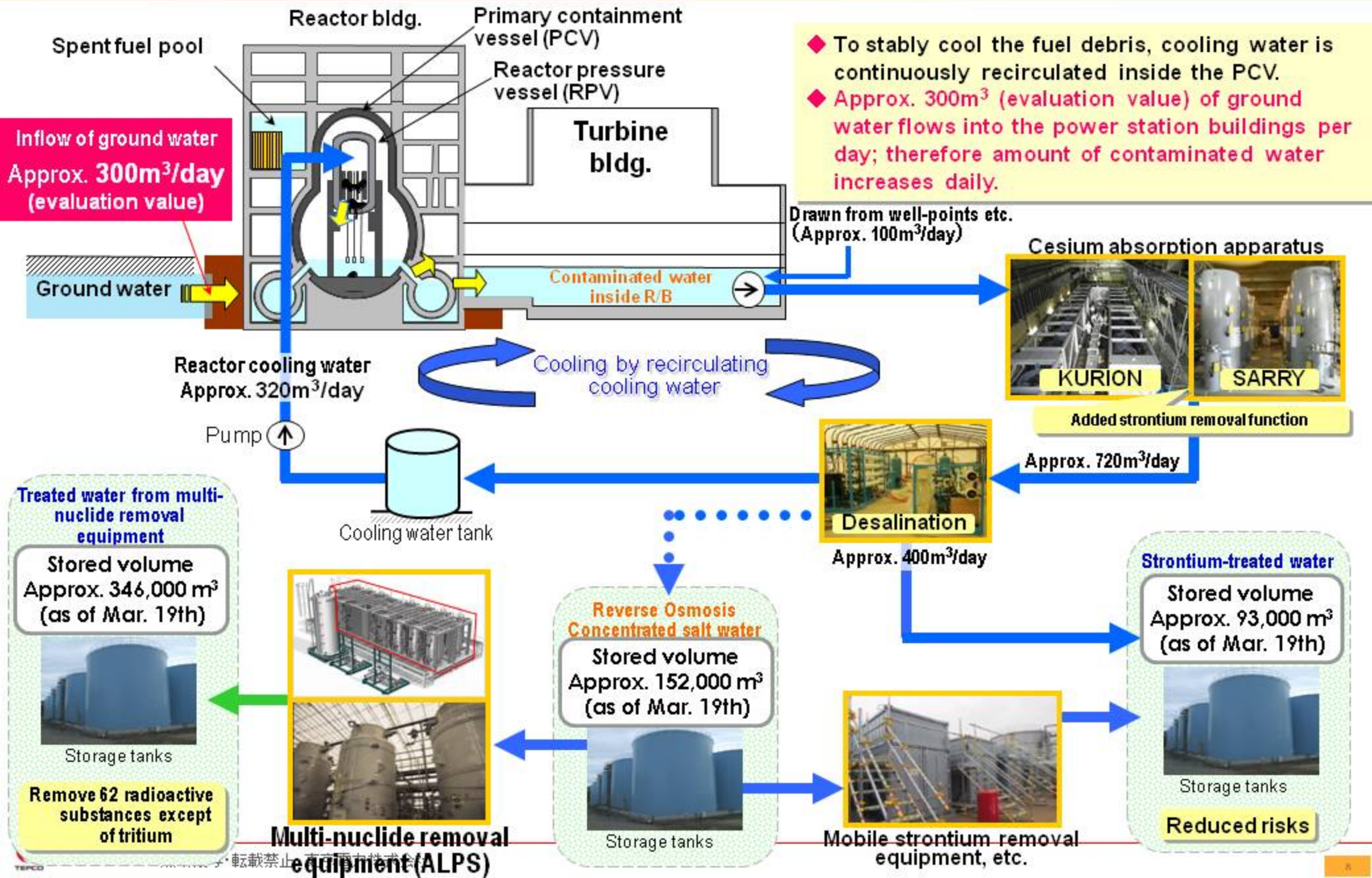
In operation
Treatment Volume：1,200m^3/d
Radionuclide purification capacity：mitigate strontium level to 1/100～1/1,000

RO concentrated water treatment equipment

In operation
Treatment Volume：500 to 900 m3/d
Radionuclide purification capacity：mitigate strontium level to 1/10 to 1/100

★With multiple measures, risk for contaminated water reduced

2.Measures against Contaminated Water (recirculating cooling water)



- To stably cool the fuel debris, cooling water is continuously recirculated inside the PCV.
- Approx. 300m³ (evaluation value) of ground water flows into the power station buildings per day; therefore amount of contaminated water increases daily.

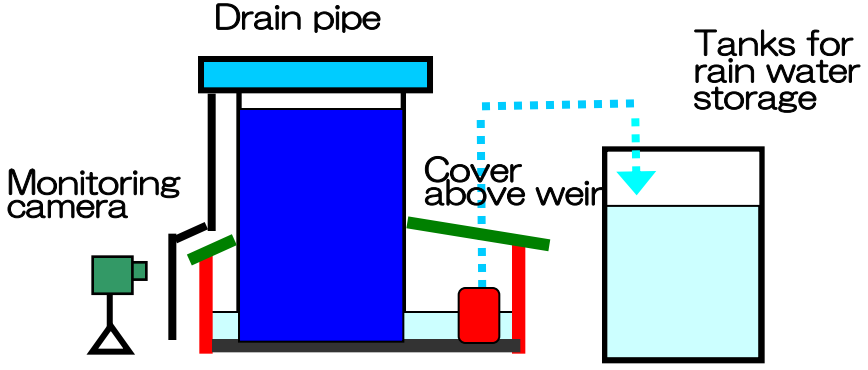
Improving pipe installation

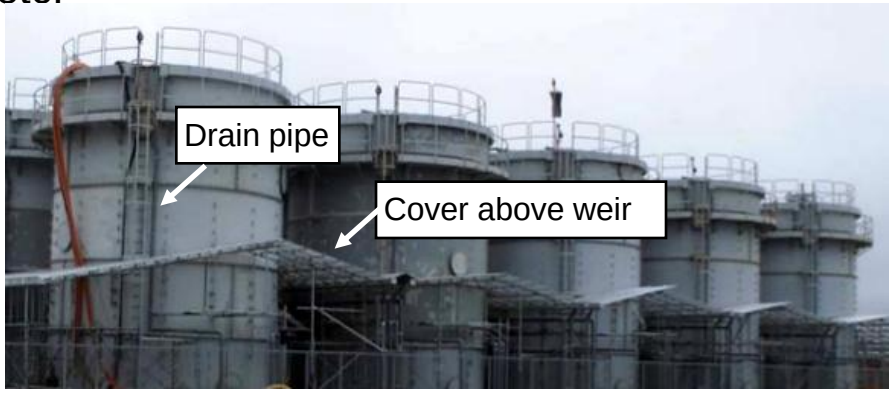
Photo taken in April 2012

Photo taken in September 2014

Improving tank equipment

Based on troubles in the past the following measures were taken including ①Construct higher weir around tanks, ②Mitigate the volume of rainfall (drainpipe, cover above weir), ③Increase in volume of tanks for rain water storage, ④Strengthen pump capacity for transfer, ⑤Install monitoring cameras for weir etc.

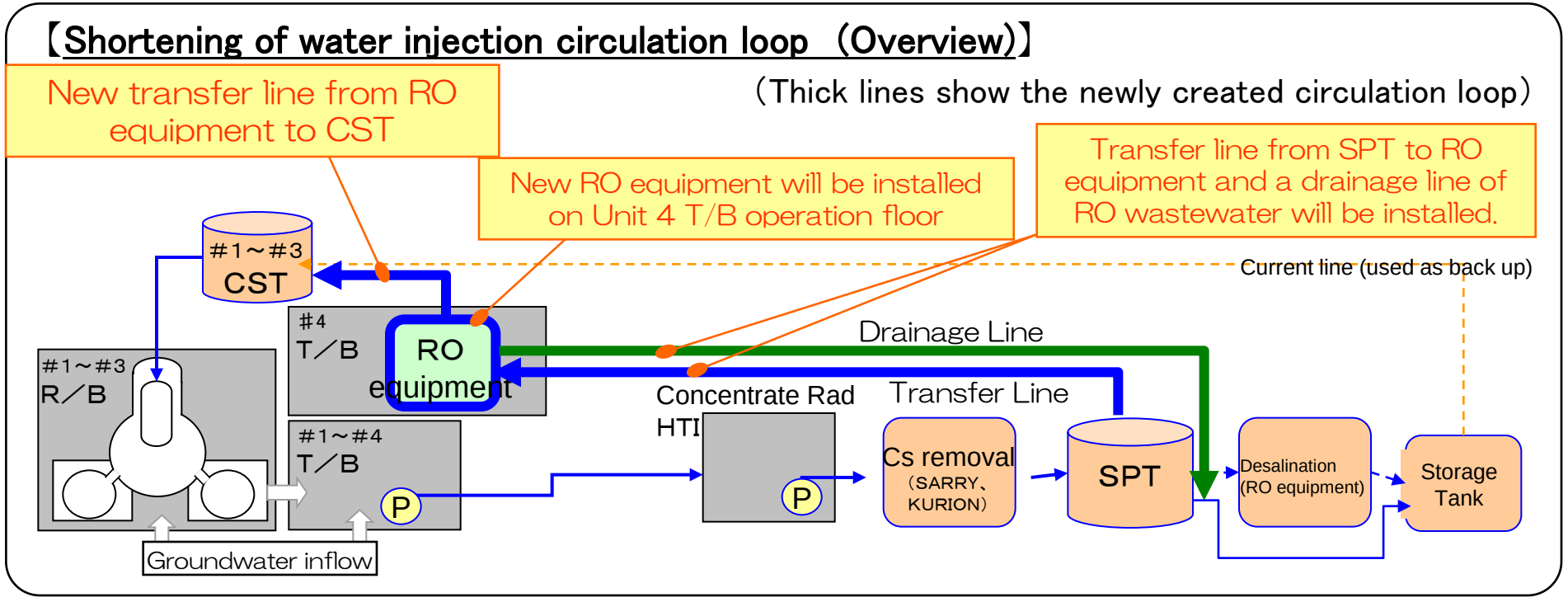




3. Improving reliability of equipment (Shortening of water injection circulation loop)

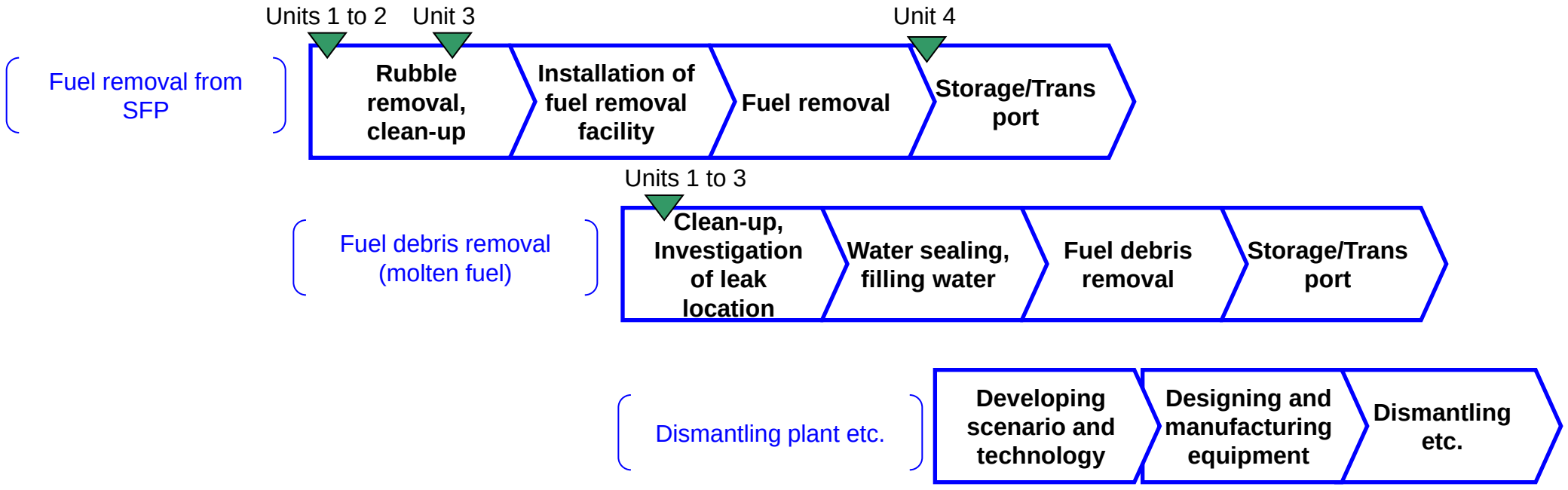
- New RO equipment will be installed on Unit 4 T/B floor so that water injection circulation loop is shortened and risks for leakage from transfer pipe is reduced. (To be implemented in the first half of FY 2015)
- This makes water injection circulation loop shorten from 3 km to 0.8 km. (If transfer line to storage tank is included, the whole length of the loop is about 2.1 km.)

【Shortening of water injection circulation loop (Overview)】



4. Fuel removal from the spent fuel pool
(Major work items for decommission and the current status of each unit)

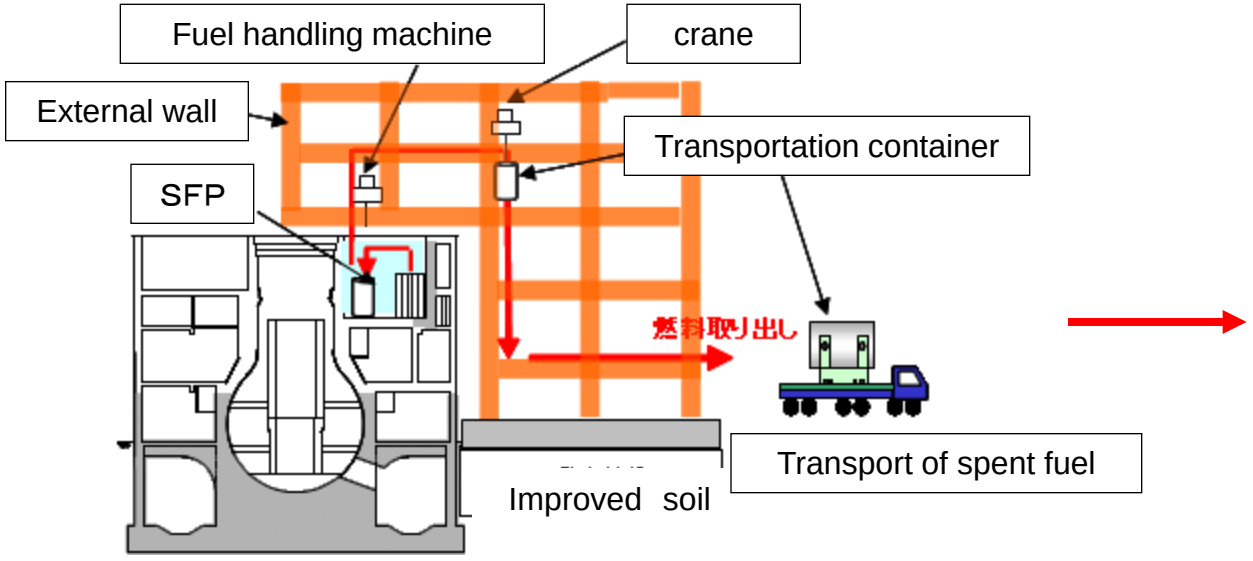
- The major work items for decommissioning include fuel removal from SFP, fuel debris removal (molten fuel), dismantling plant etc.
- Removing fuels from Unit 4 SFP is completed as of 22 Dec 2014 and we are preparing for starting fuel debris removal in Units 1 to 3.



4. Fuel removal from the spent fuel pool (Removing fuel rods at Unit 4)

- **The fuel assemblies (1533 rods) stored inside the Unit 4 spent fuel pool were transferred to the common pool.**
- **External wall for removing fuel rack was built (4,000 tons of steel used, construction period : March 2012 to May 2013)**
- **The transfer started on 18 November 2013 and completed on 22 December 2014.**

① Relocate the fuel assemblies stored in the fuel rack inside the spent fuel pool, one by one, into a transportation container (cask) underwater using a fuel handling machine.
② Lift up the cask from the spent fuel pool using a crane.
③ Conduct, on the floor as high as the operating floor, such works as closing the lid of the cask and decontaminating the cask.
④ Lift down the cask toward the ground using the crane to lay it on a trailer.
⑤ Transport the cask to the common pool using the trailer.



Common pool

4. Fuel removal from the spent fuel pool (Status on operating floor at Unit 3)

Before removing large rubble

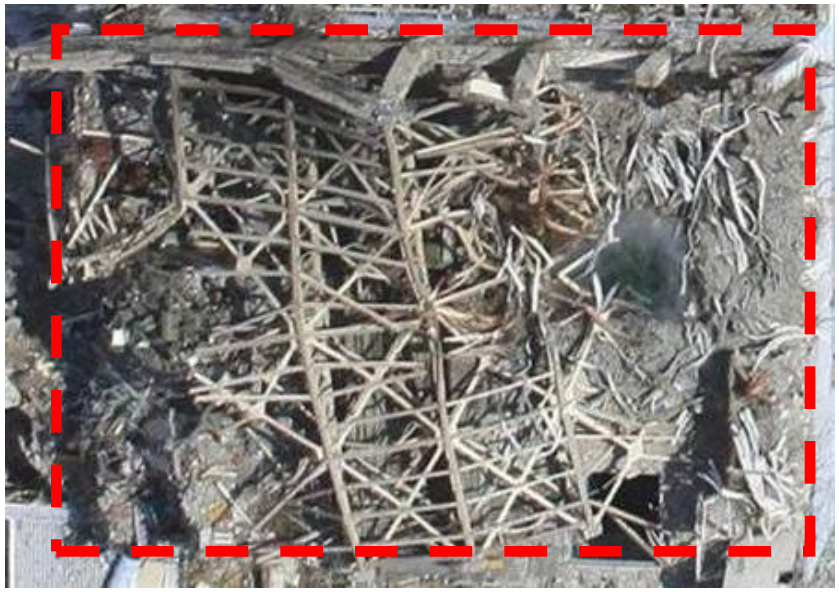


Photo taken in March 2011

Current status (decontamination work in progress)

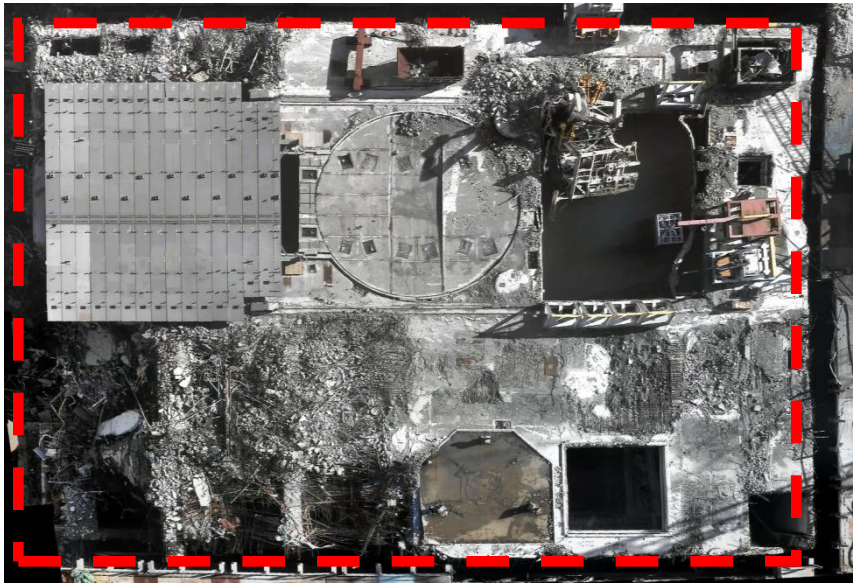


Photo taken in December 2014

【Current status on operating floor (at present)】

- Removal of rubble has been completed and decontamination and shielding work is underway
  →Anti-scattering measures are taken during decontamination work as used in removing rubble.
- Removing rubble in SFP is in progress
  →As debris are in the pool, no anti-scattering measures taken for this task.

【Work schedule in the future】

①Removing rubble → **②Decontamination and rubble removal in SFP** → ③Install shield → ④Install cover for fuel removal

4. Fuel removal from the spent fuel pool（Status on operating floor at Unit 1）

Conditions on the top of operating floor of R/B

Overview of refueling level
Photo taken in June 2012

Overview of refueling level
Photo taken in June 2012

Building cover installed (at present)

Photo taken in December 2014

【 Current status on the top of operating floor (at present) 】

・Roof panels were replaced after temporary removal （Replacement completed on 4 Dec 2014）

【 Work schedule in the future 】

①Building cover removed → ②Removal of rubble → ③Decontamination work → ④Shielding → ⑤Installation of cover for fuel removal

4. Fuel removal from the spent fuel pool
(Status of refueling floor at Unit 1)

Ceiling crane

Rubble

Picture 1

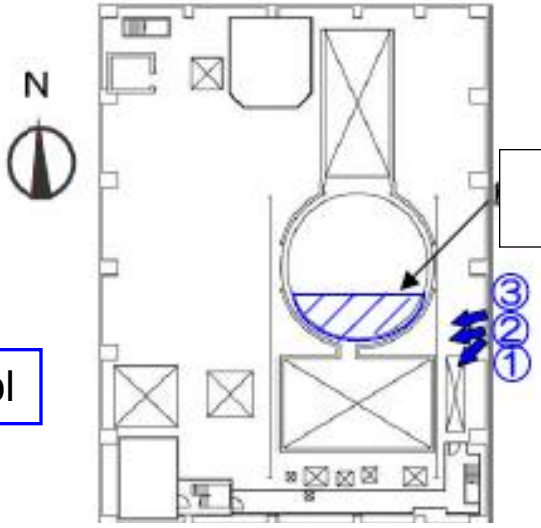
Picture 3

Cover of reactor well

Ceiling crane

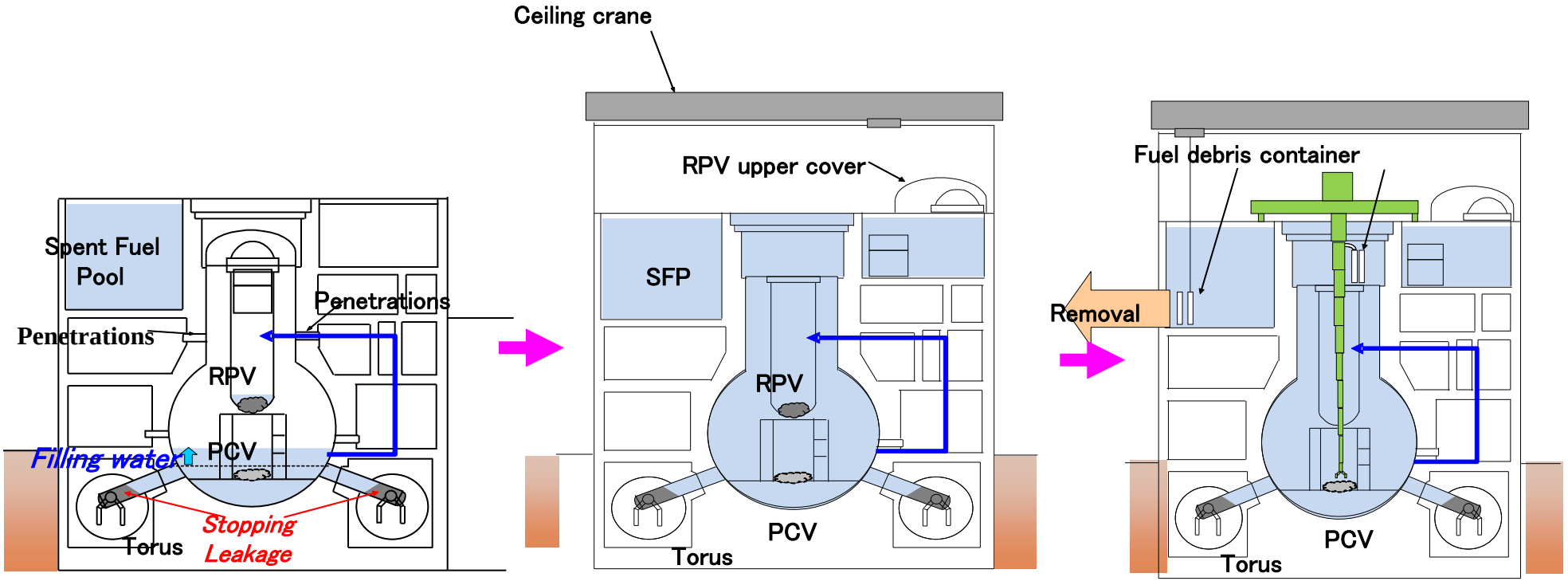
Surface of fuel spent pool

Picture 2



Location of photograph taken

4. Fuel removal from the spent fuel pool (Work image toward fuel debris removal)



Repair of leakage point at PCV

(Stopping leakage to filling lower PCV with water) (image)

Removal of fuel debris

(image)

Work image toward fuel debris removal

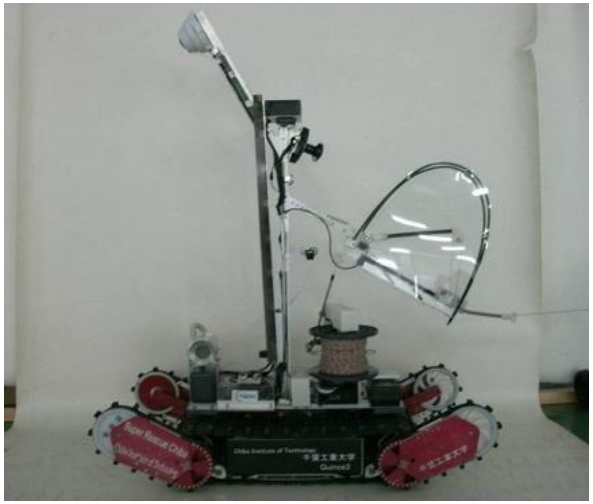
5. Toward fuel debris removal (Development of new robots)

Decontamination robot

As the inside of reactor buildings are highly contaminated, robots for decontamination were developed. (Following photos are robots for lower level)

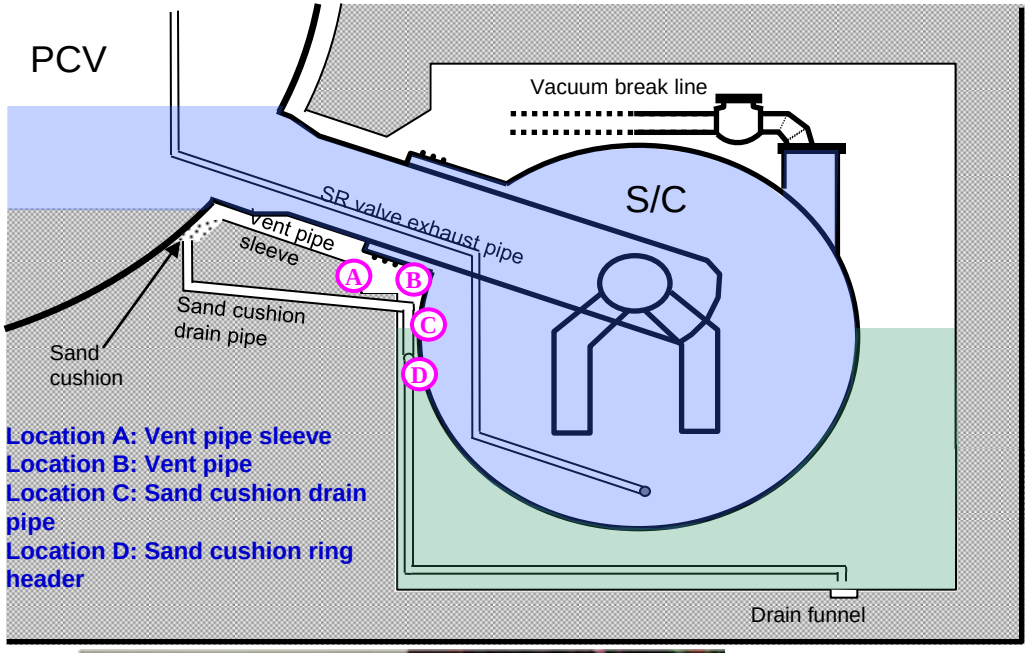
Research robot

In order to measure radiation dose and take photos inside buildings, robots with camera which can move on debris were developed.



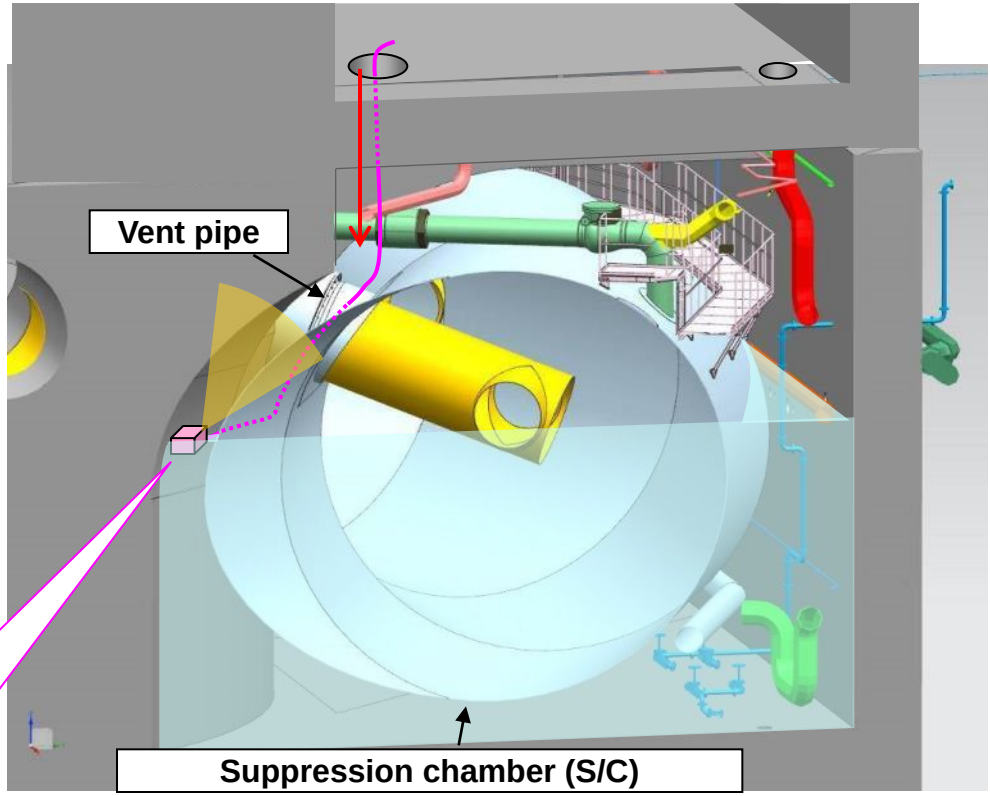
Investigation under vent pipes in Unit 1 (Overview)

- To repair (seal the water leak locations of) the PCV in preparation for the fuel debris removal, investigation under vent pipes was conducted to identify the leak locations in the PCV.
- With the images taken by the camera equipped with the water boat, it was checked whether there is any water flow from the sleeve ends of vent pipes or not, and the status of the sand cushion drain pipes was also checked (by viewing appearance).



Water boat: trial operation at the plant

Water boat

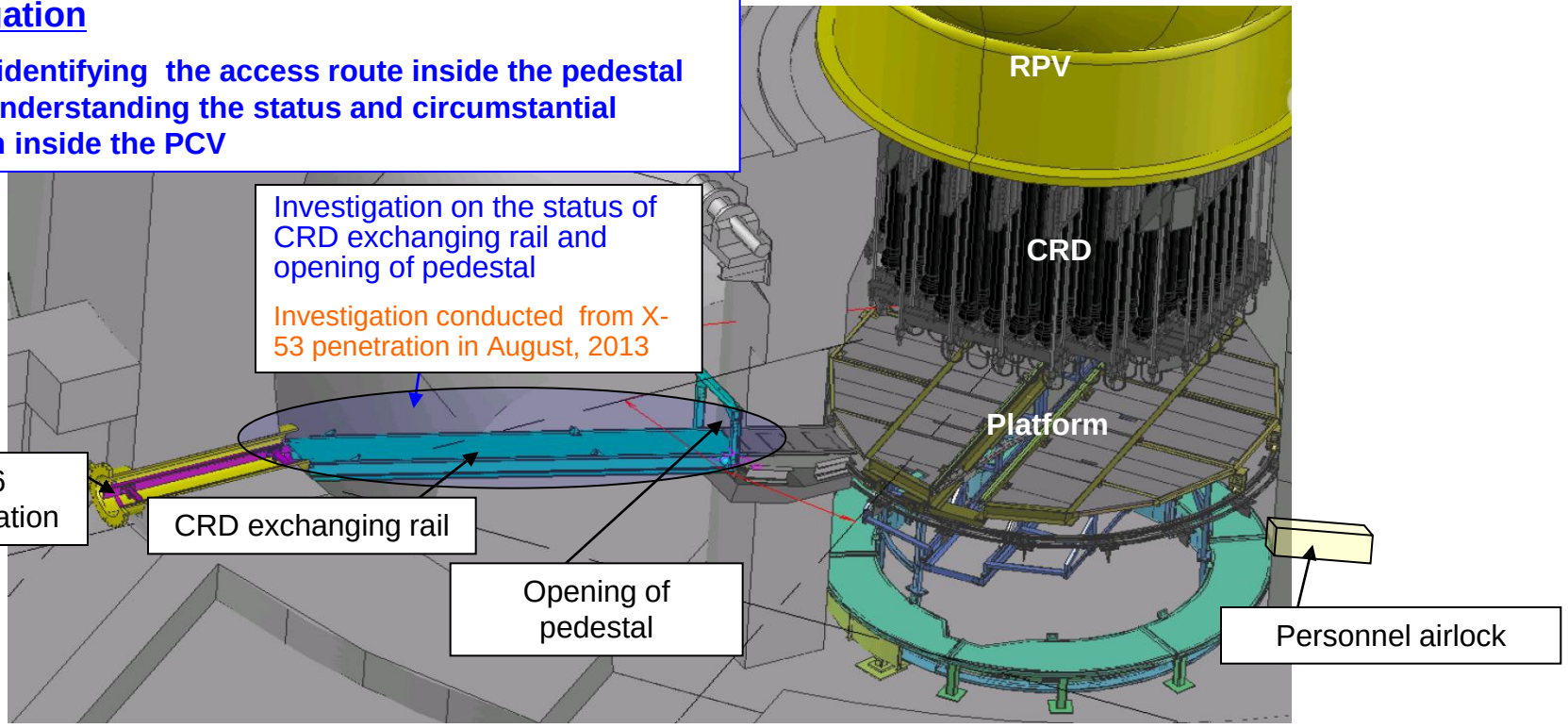


PCV (inside of pedestal) investigation in Unit 2 (Provisional plan)

- Investigation is planned by putting the investigation device into pedestal via X-6 penetration, CRD exchanging rail and opening of pedestal so that location (distribution) of fuel debris in pedestal can be identified.
- Status was checked from CRD exchanging rail to opening of pedestal as preliminary investigation.

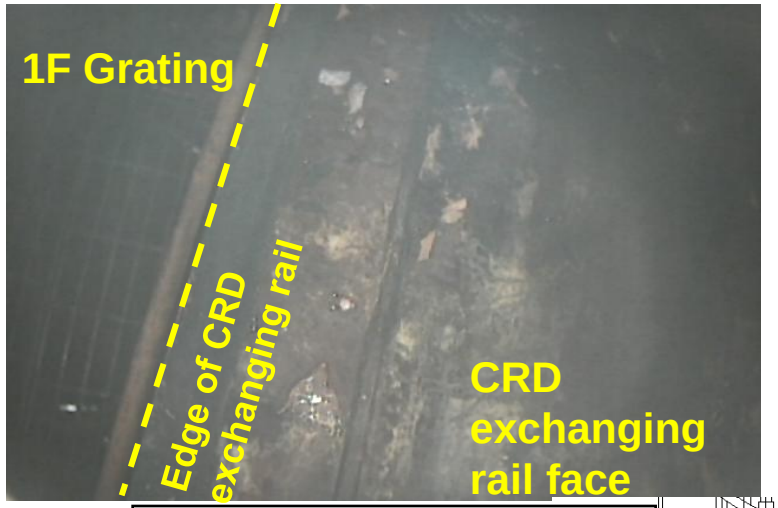
Investigation

Both for identifying the access route inside the pedestal and for understanding the status and circumstantial condition inside the PCV



PCV (inside of pedestal) investigation In Unit 2 (Investigation results)

①



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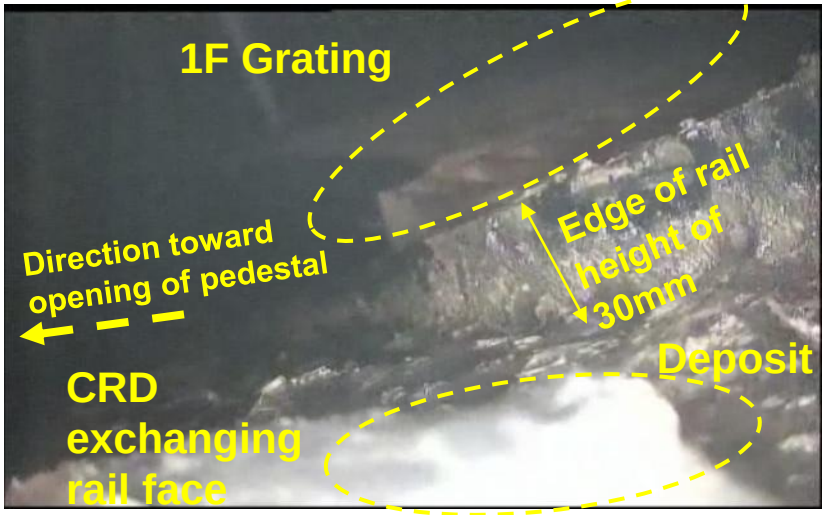

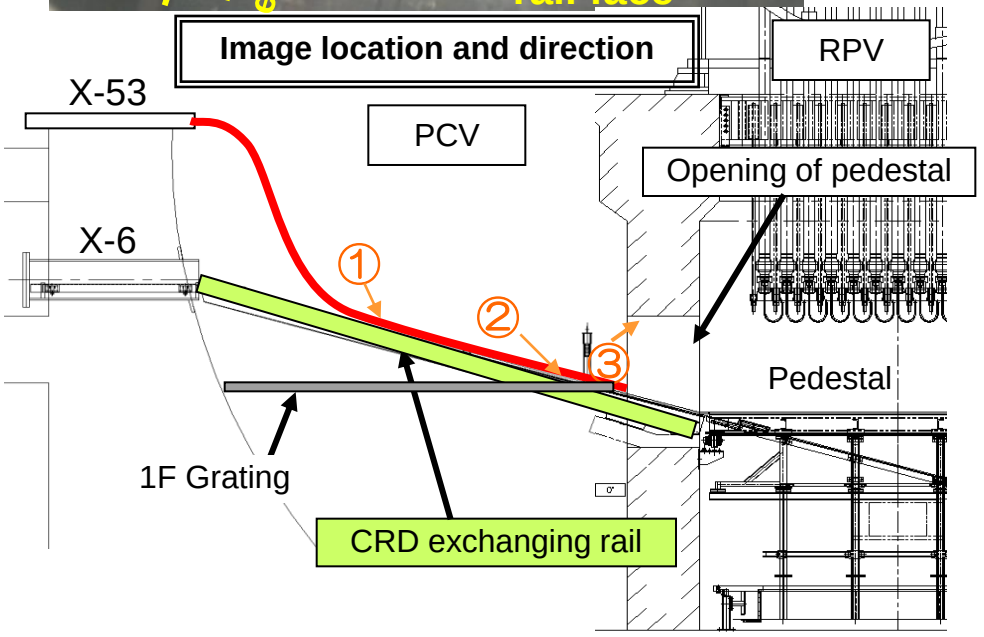

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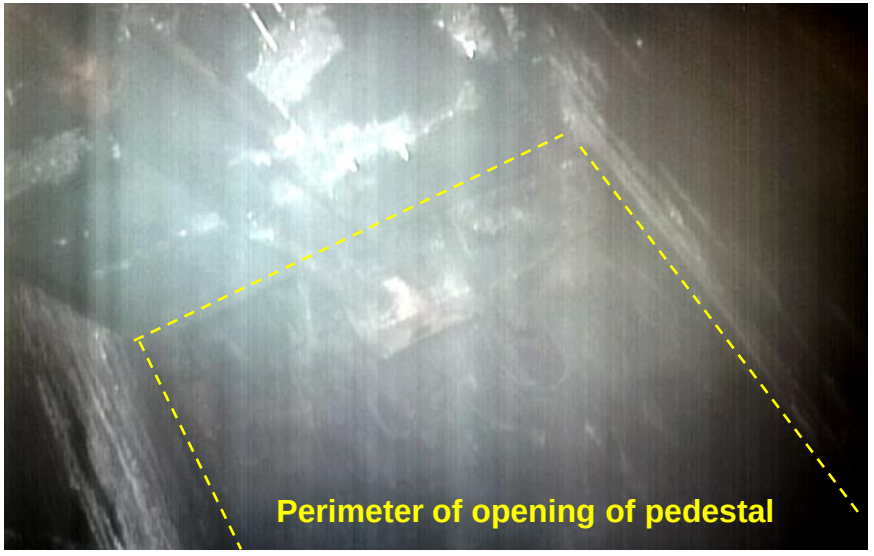


Photo ① to ③ with image processed

5. Toward fuel debris removal（Establishment of Research Facilities by JAEA）

- In order to establish technical basis, JAEA will build ①Remote-control and Device Development Facility (Mock-up Testing Facility) and ②Radioactive Material Analysis and Research Facility, with supplementary budget of 2012. These facilities will be managed in a manner that is easily accessible by domestic and international researchers in various fields.

①Mock-up Testing Facility

- The Facility will provide real size equipment of nuclear power plant to examine operation procedure of the remote control equipment and to train operators.
- In May 2013, it was decided that the facility would be located at Naraha-town and ground breaking ceremony was held on 26 Sep 2014. It will start its operation at the end of FY 2015.

Image of Mock-up Testing Facility

②Radioactive Material Analysis and Research Facility

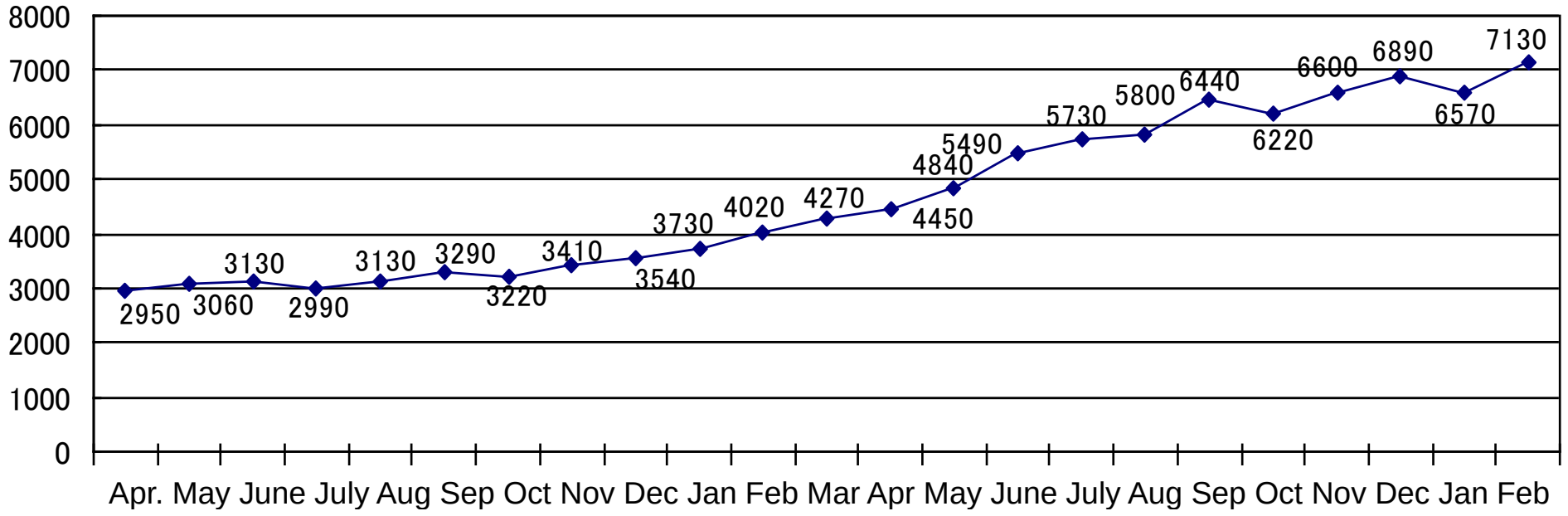
- Fuel debris from Fukushima site will be brought to shielded facilities and analyzed with grove box and manipulator.
- In November 2013, the terms and conditions for the location of the facility were decided and the operation is scheduled to start in 2018.

Grove box

Manipulator

6. Improving working environment (Staff management)

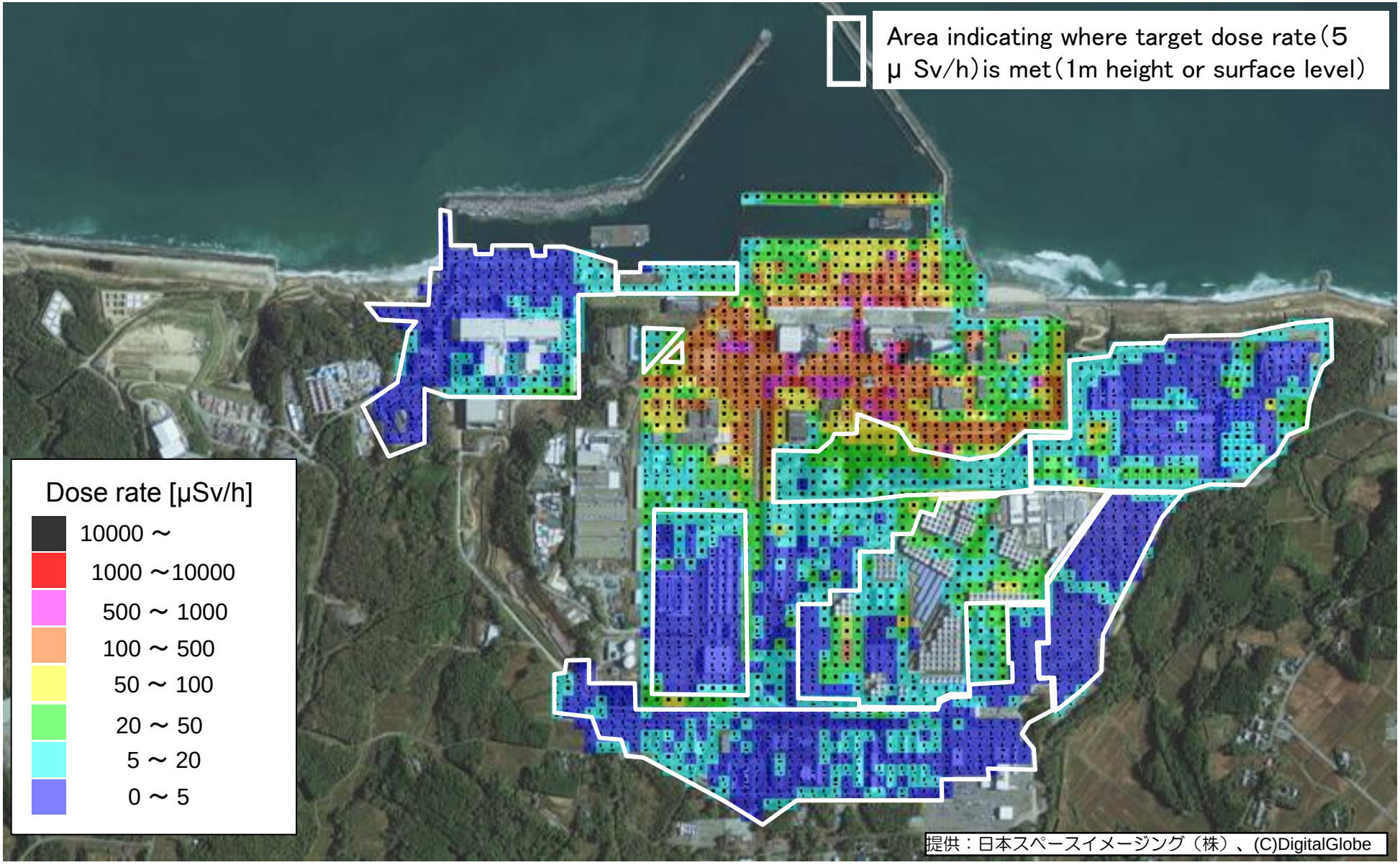
- The number of workers (TEPCO and contractors) at Fukushima Daiichi has been growing and goes beyond 7000 in February 2014. By talking with main contractors, TEPCO makes sure that sufficient work force will be available in the future.



Trend of number of workers at Fukushima Daiichi after April 2013

6. Improving working environment

(Dose level distribution at site －30m x 30m mesh, 1m height －)



6. Improvement of working conditions (Comparison before and after work)

Removal of rubble

Before work

After work

In front of the Unit 2 T/B

Radioactive Waste Management Building

In front of the Unit 4 T/B

Sort out in tank areas

Before work

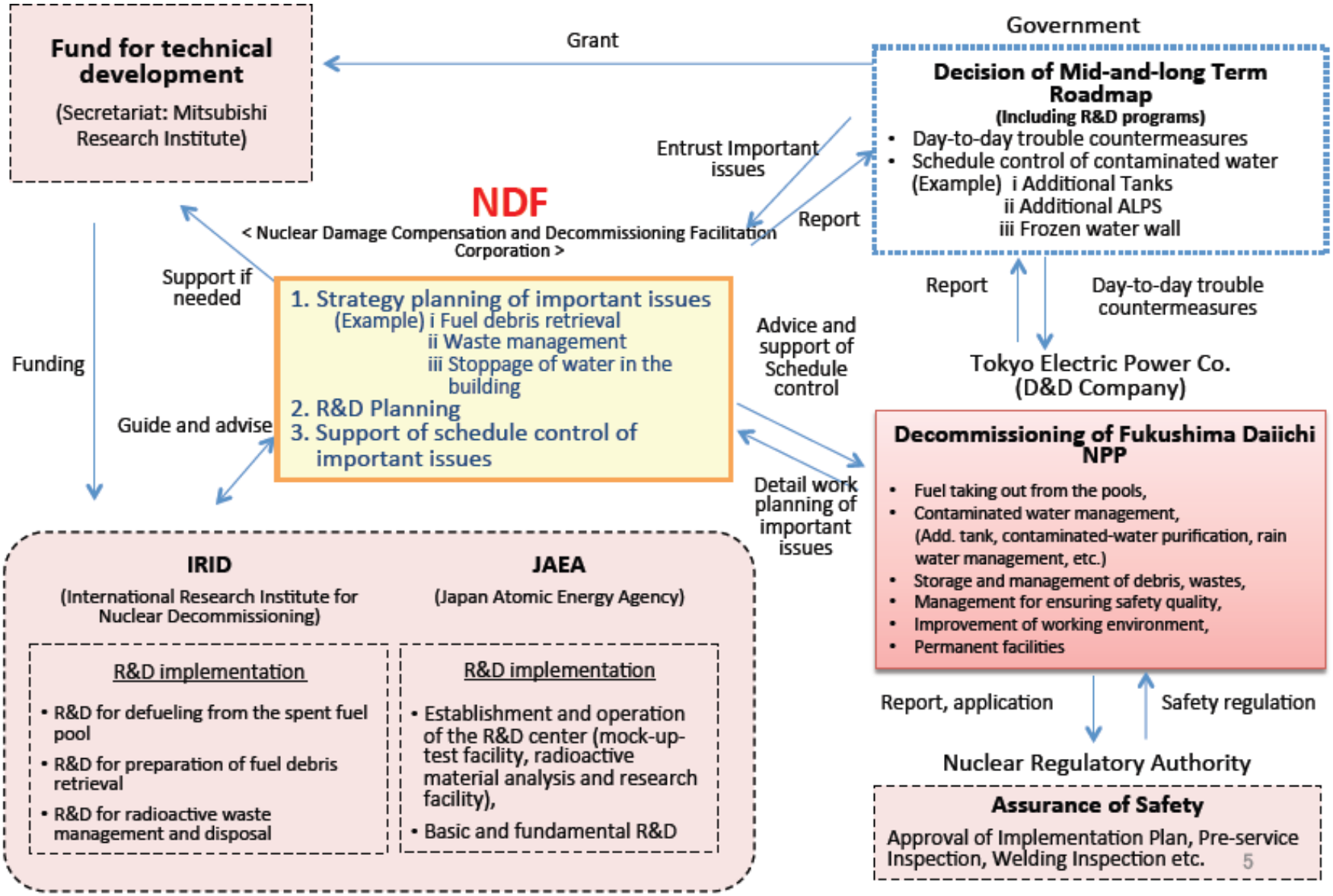
After work

Pavement at coastal side

Before work

After work

7. Promotion of decommissioning works



Source : Presentation by NDF

Thank you for your kind attention