FY2014 Technology Research Association International
Decommissioning R&D Institution Symposium

Current Status on Fukushima Daiichi NPS

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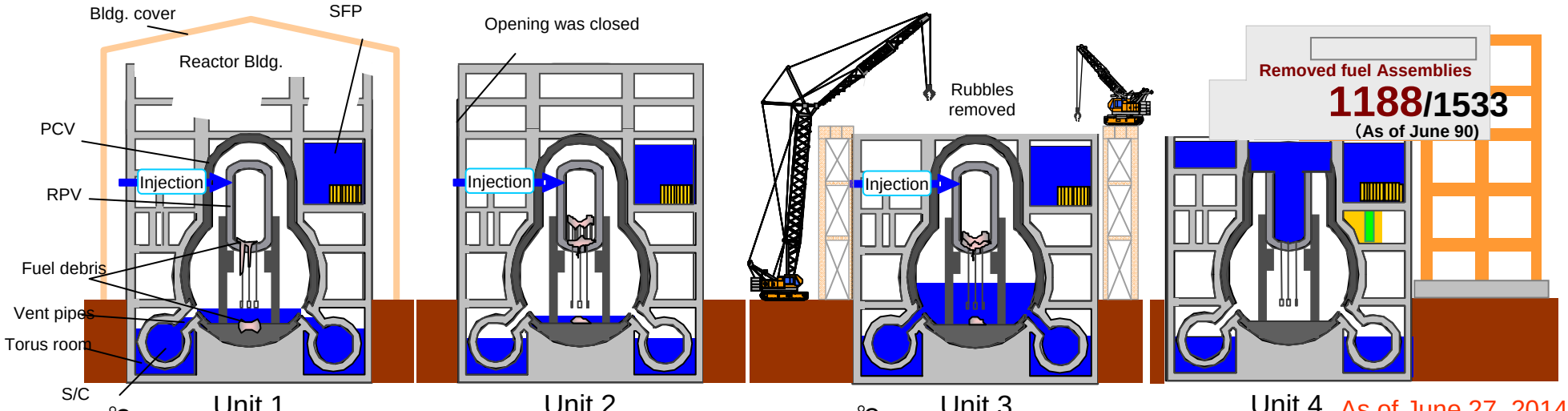
Naohiro MASUDA

Chief Decommissioning Officer,
Fukushima Daiichi Decontamination and
Decommissioning Engineering Company

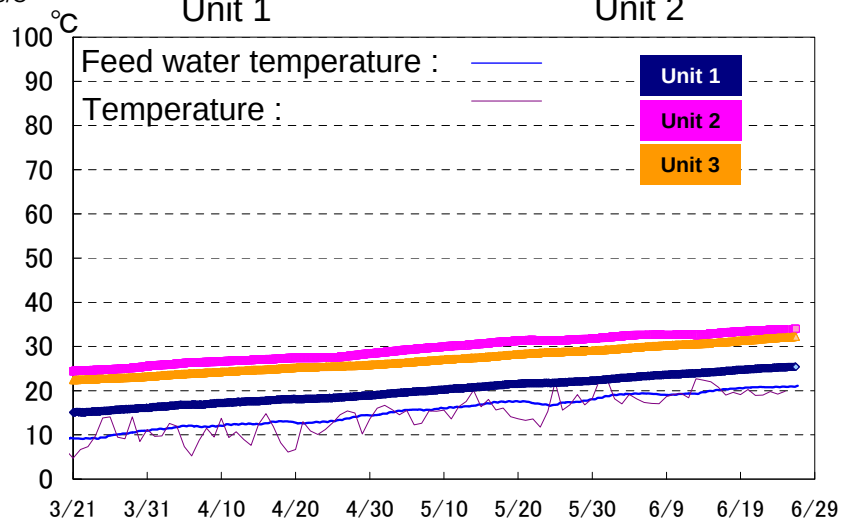
Tokyo Electric Power Company

Current Status on Fukushima Daiichi NPS (Status of Reactors and Buildings)

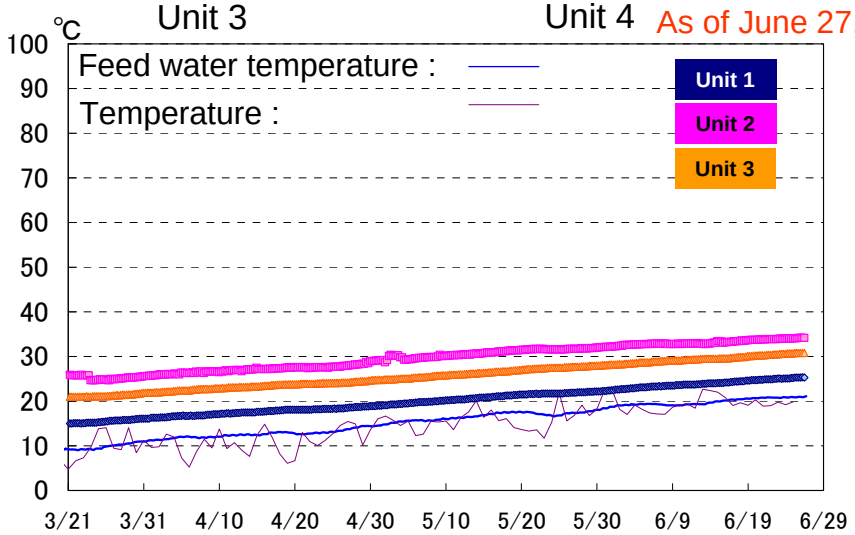
- All units maintain cold shutdown state



As of June 27, 2014



Temperatures of RPV bottom (for three months)



Temperatures inside PCV (for three months)

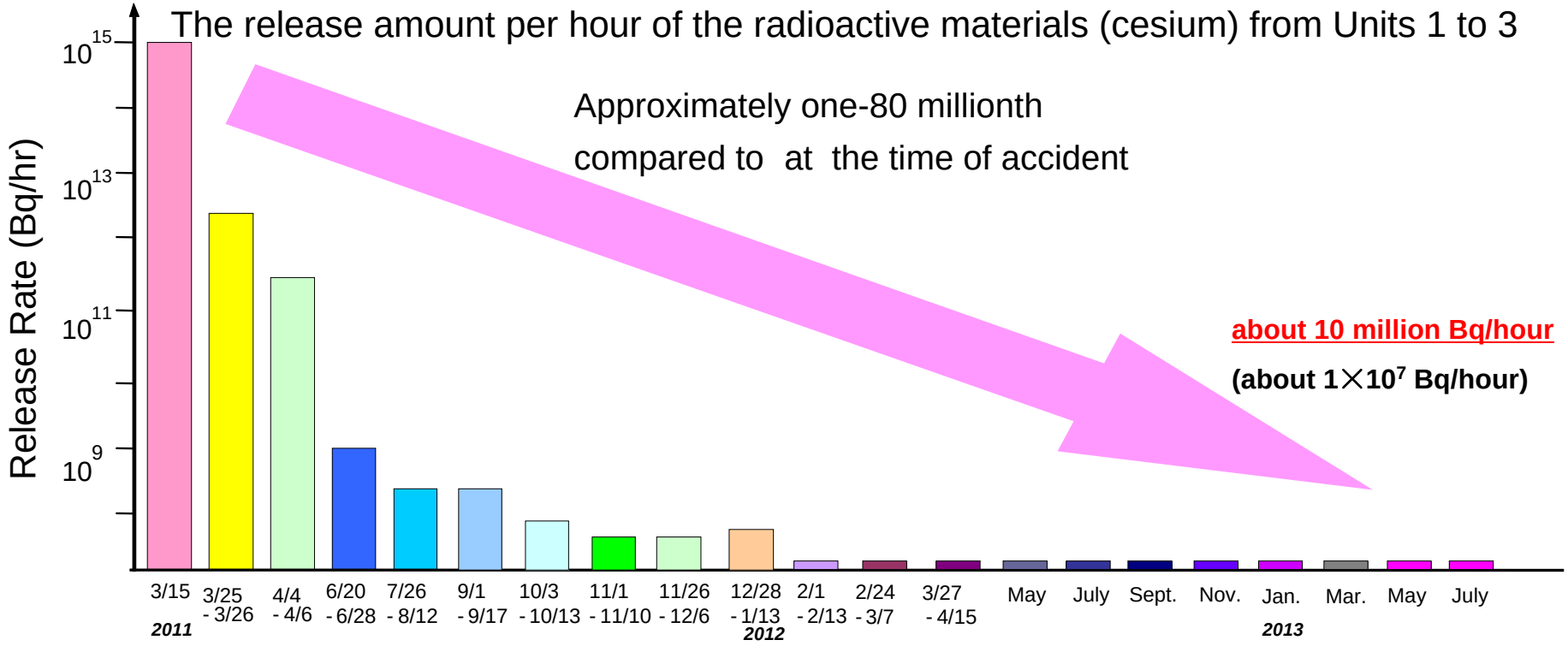
東京電力

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.**

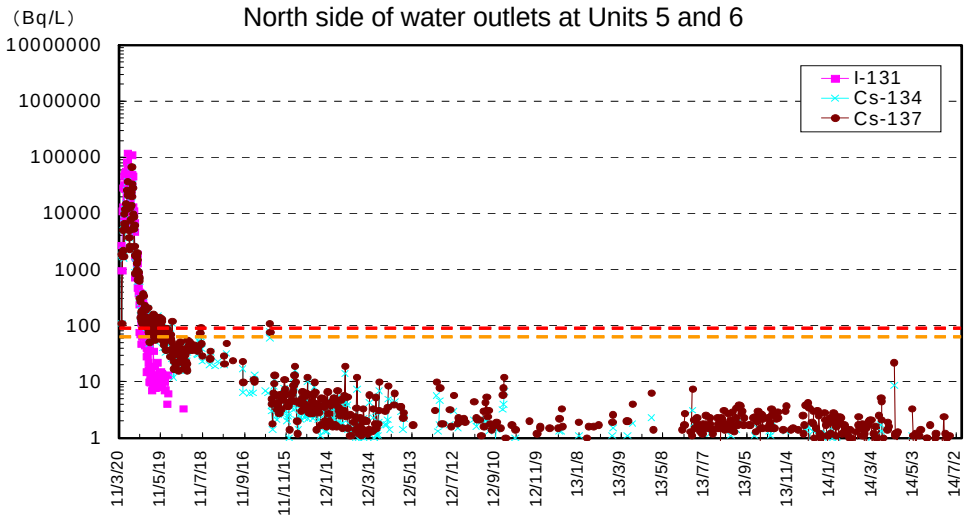
(Excluding effect of already released radioactive materials) Note: Exposure limit established by law is 1 mSv/yr.

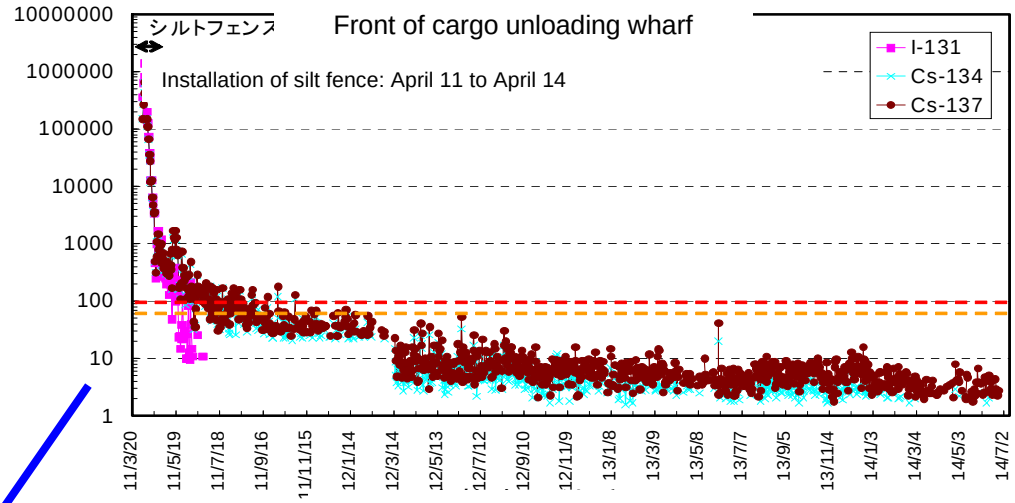


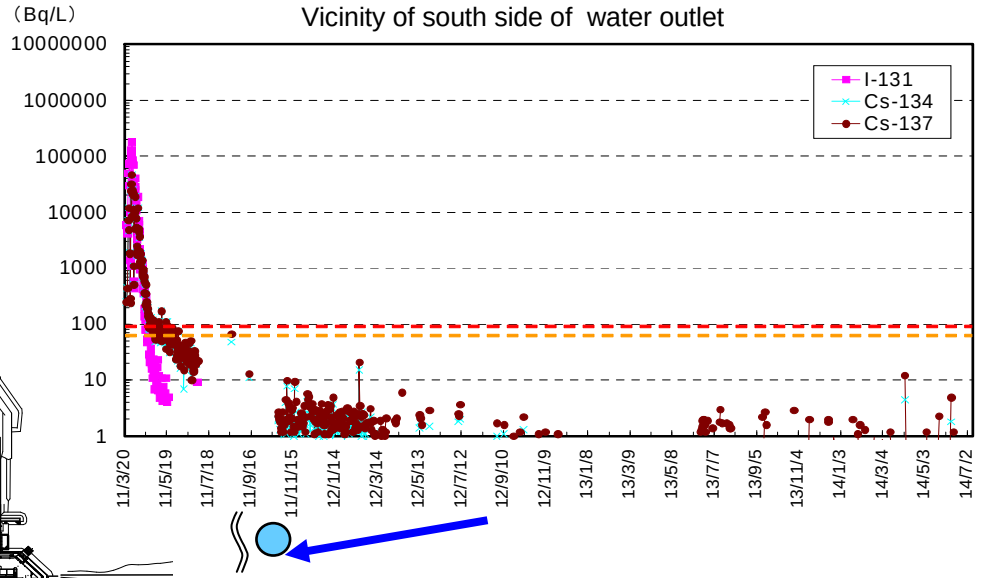
Radioactive particle (Cesium) release per hour from Units 1 to 3

Current Status on Fukushima Daiichi NPS (Status of monitoring port area)

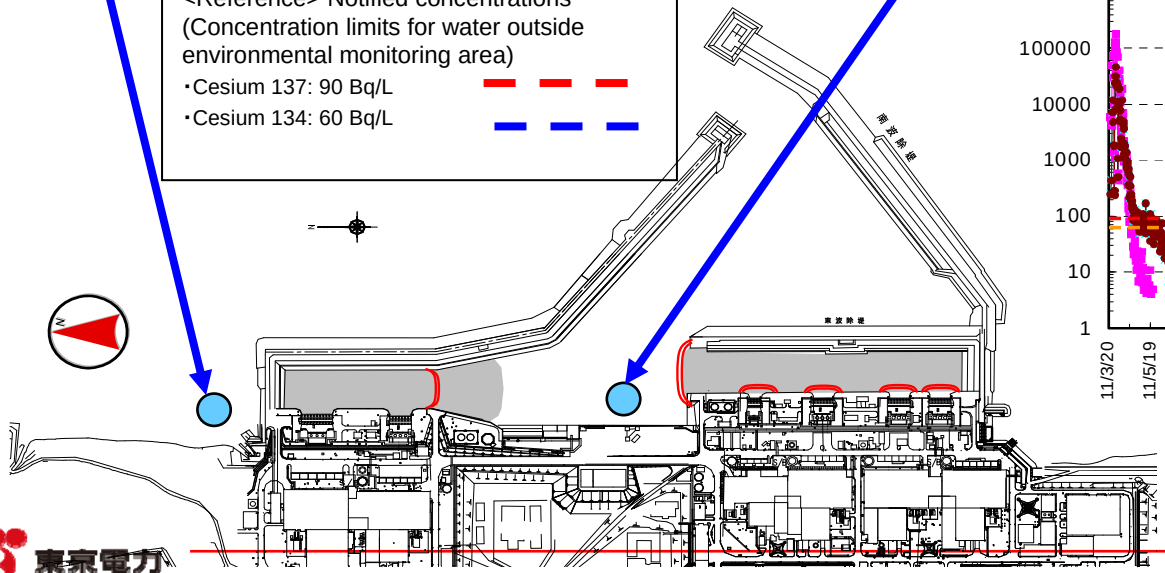
Concentration of radioactive materials has been reduced up to one-100,000th to one-1,000,000th as compared to the time right after the accident.





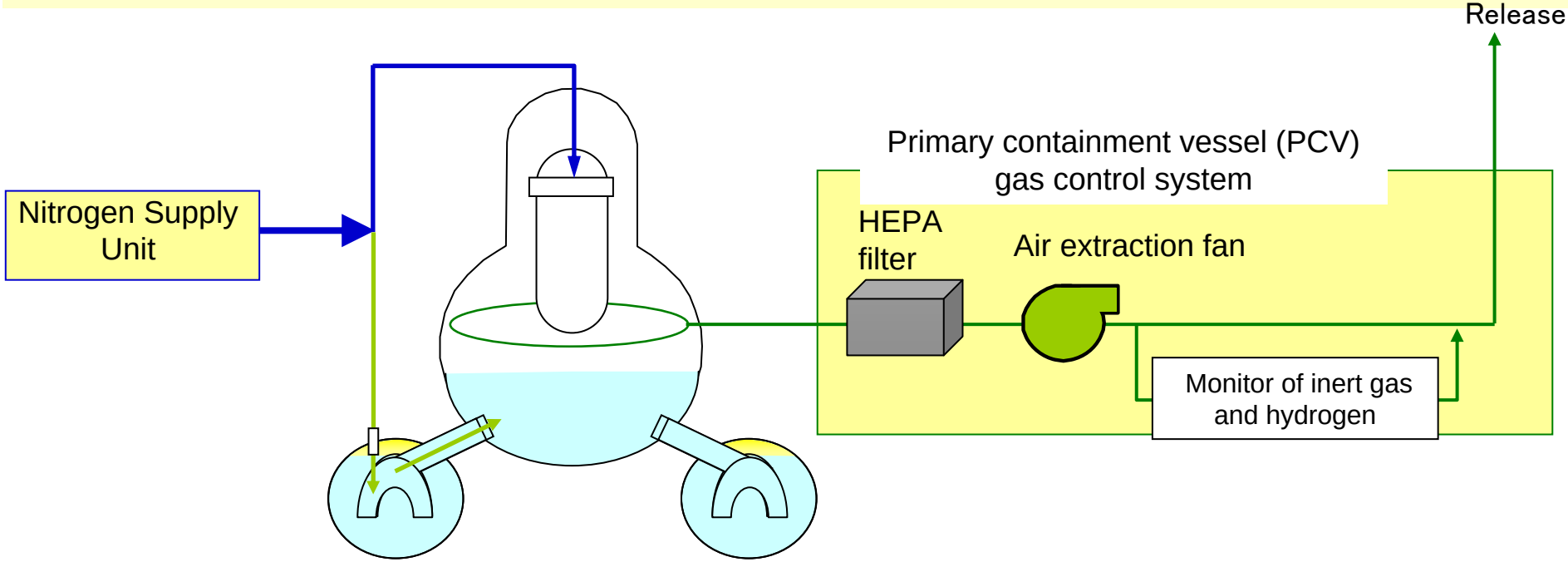


<Reference> Notified concentrations
(Concentration limits for water outside environmental monitoring area)
・Cesium 137: 90 Bq/L
・Cesium 134: 60 Bq/L



Current Status on Fukushima Daiichi NPS (Plant stabilization)

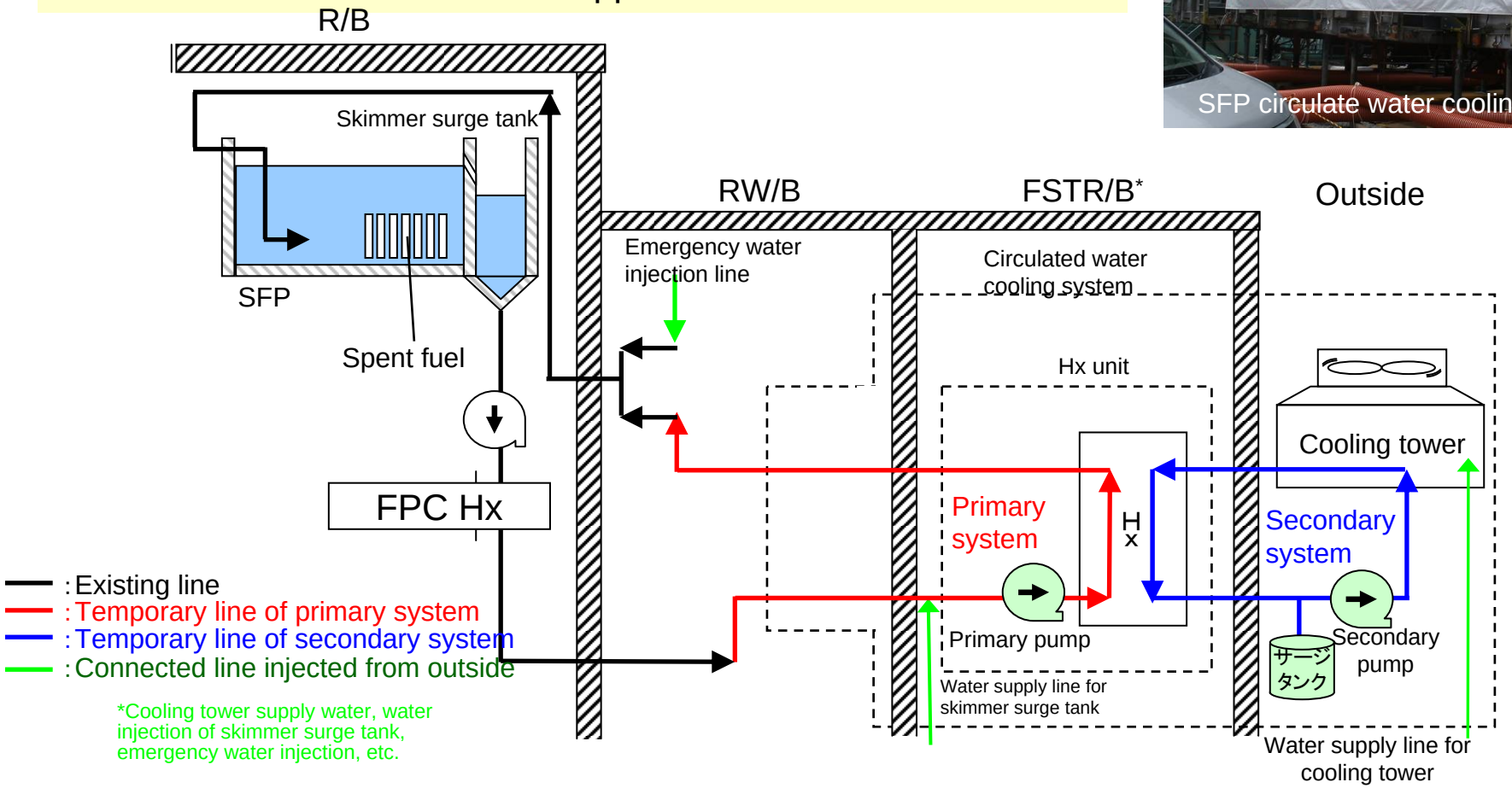
- Hydrogen concentration has been kept below inflammability limit by nitrogen injection into PCV and RPV to prevent hydrogen explosion.
- Gas is extracted from PCV and filtered, radioactive materials released into environment are reduced.
- Concentration and amount of radioactive materials released into atmosphere are monitored.
- Subcritical state is also monitored by monitoring radioactive concentration of short-lifetime nuclides (Xe-133, Xe-135).



Nitrogen injection and gas control system (Unit 1)

Current Status on Fukushima Daiichi NPS (Cooling of SFPs)

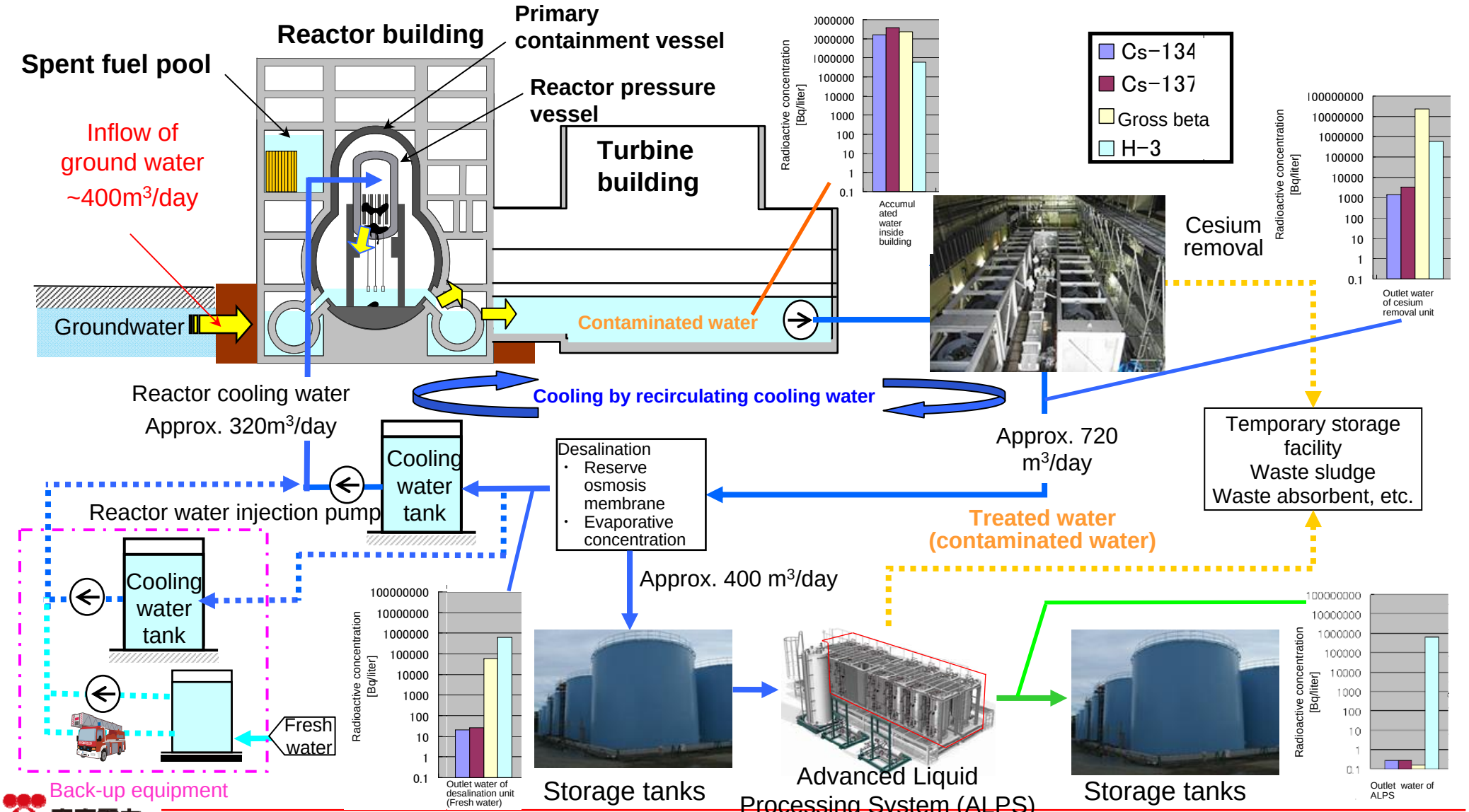
- To continuously remove decay heat generated from fuel in SFP, water in SFP is cooled by using both existing facilities and newly installed facilities.
- Chlorine concentration was decreased by mobile reverse osmosis (RO) no later than March 18, 2013. It is regularly monitored to be less than 100 ppm.



SFP alternate circulate water cooling system (Unit2)

Current Status on Fukushima Daiichi NPS (Reactor cooling)

- Plants have been stabilized with sufficiently low temperature by continuous circulation water cooling.
- Plant conditions have been monitored at seismic isolated building on a 24-hour basis.



Current Status of Fukushima Daiichi NPS (Contaminated water storage)

Status on contaminated water storage

- Tonal amount of 490,000m^3 * is stored in tanks.
- Current available storage capacity* is 520,000m^3.
- Available storage capacity will be increased up to 800,000m^3. (by the end of March 2015)

Steel square type tank


Flange type steel cylindrical tank


Welded type steel cylindrical tank


Steel horizontal tank

【Amount of contaminated water stored in tanks*】

Fresh water: approx. 24,000m^3

Waste water generated by evaporative concentration: approx. 9,000m^3

Concentrated salt water at RO device: approx. 366,000m^3

Water treated by ALPS: approx. 92,000m^3

【 Available amount of storage tank*】

Steel square type tank: approx. 3,000m^3

(Accumulated water in Units 5 and 6, concentrated salt water at RO device)

Flange type steel cylindrical tank: approx. 291,000m^3

(Fresh water, concentrated salt water at RO device, water treated by ALPS)

Welded type steel cylindrical tank: approx. 174,000m^3

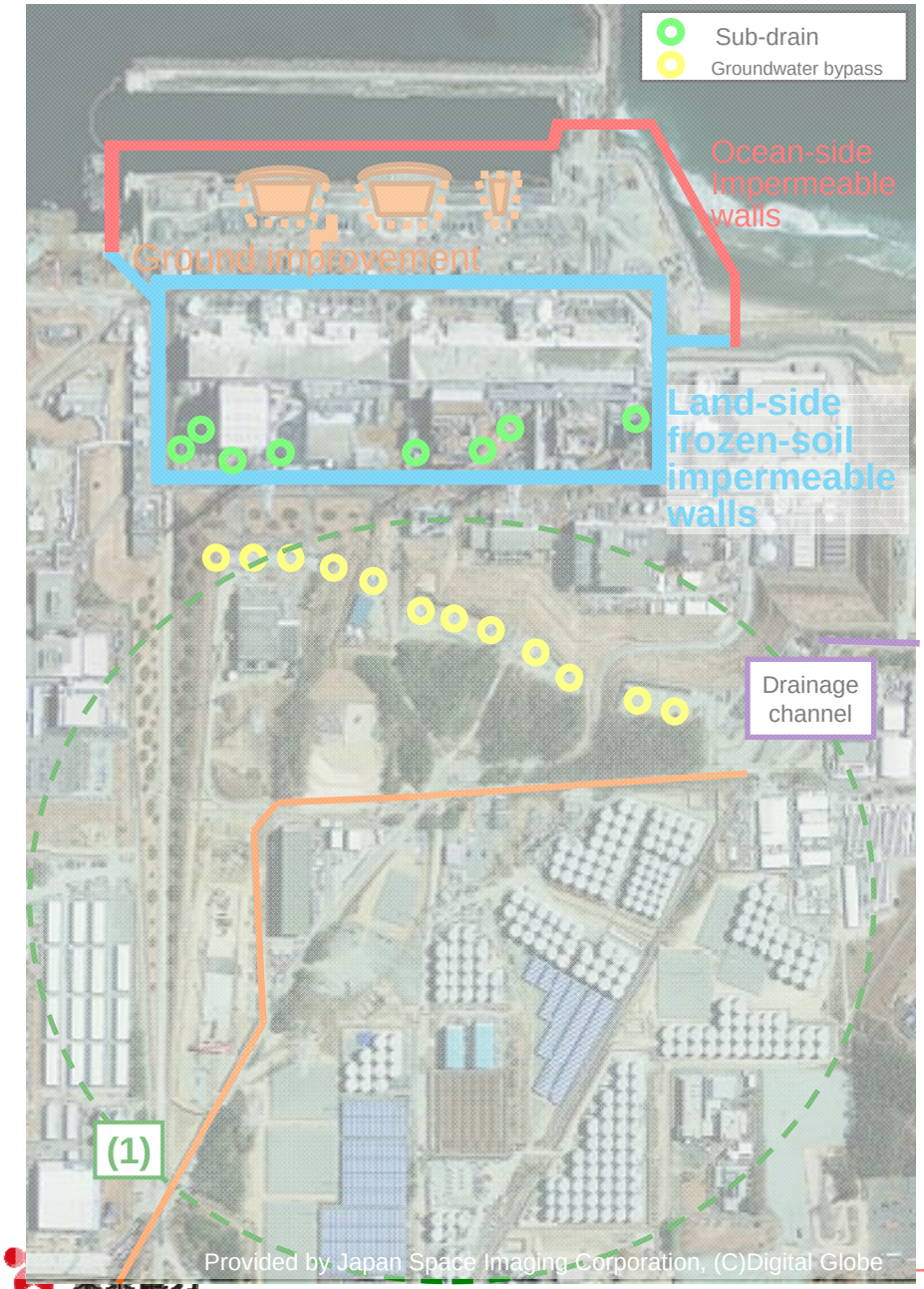
(Concentrated salt water at RO device, water treated by ALPS)

Steel horizontal tank: approx. 38,000m^3

(Concentrated salt water, waste water generated by evaporative concentration)

*As of June 17, 2014

Measures against contaminated water



< Overview on groundwater flow around buildings at Units 1 to 4>

- Approx. 800 m^3/day of groundwater flows into the site from the mountain side. It is assumed that approx. 400 m^3/day out of 800m^3/day flows into the buildings and the remaining (approx. 400 m^3/day) flows into the sea.
- As the groundwater flowing into the buildings becomes contaminated, it needs processing.

Three basic principles of measures against contaminated water

1. Removal of contamination source ●
2. Isolation of water from contamination source ○
3. Leakage Prevention of contaminated water ◆

Emergency measures

1. Removal of highly contaminated water from trenches ●
2. Ground improvement at contaminated area with water glass, pavement of ground surface with asphalt, etc. and pumping up groundwater ○◆
3. Pumping up groundwater from the mountain side (Groundwater bypass) ○

+

Fundamental measures

4. Pumping up groundwater by sub-drain ○
5. Installation of ocean-side impermeable walls ◆
6. Installation of land-side frozen-soil impermeable walls ○
7. Installation of contaminated water processing facilities with higher performance ●

etc.

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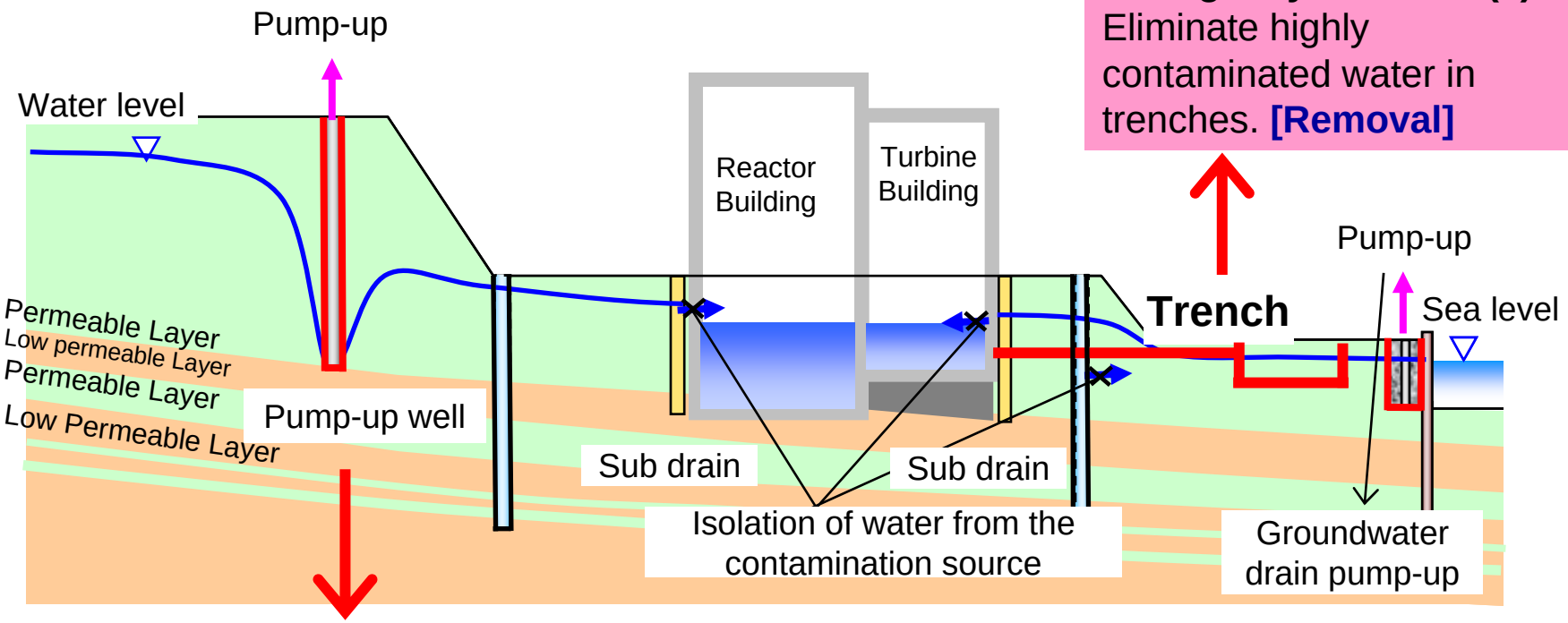
Main preventive measures

Additional measures taken against inflow of groundwater (consideration of facing) ○ , etc.

Measures against contaminated water – Emergency measures –

Groundwater pump up (Groundwater bypass)



Emergency measure (1) Eliminate highly contaminated water in trenches. **[Removal]**

Emergency measure (3) Pump up groundwater from the mountain side (groundwater bypass) **[Isolation]**

- April 9,2014, pumping up ground water at the wells was started.

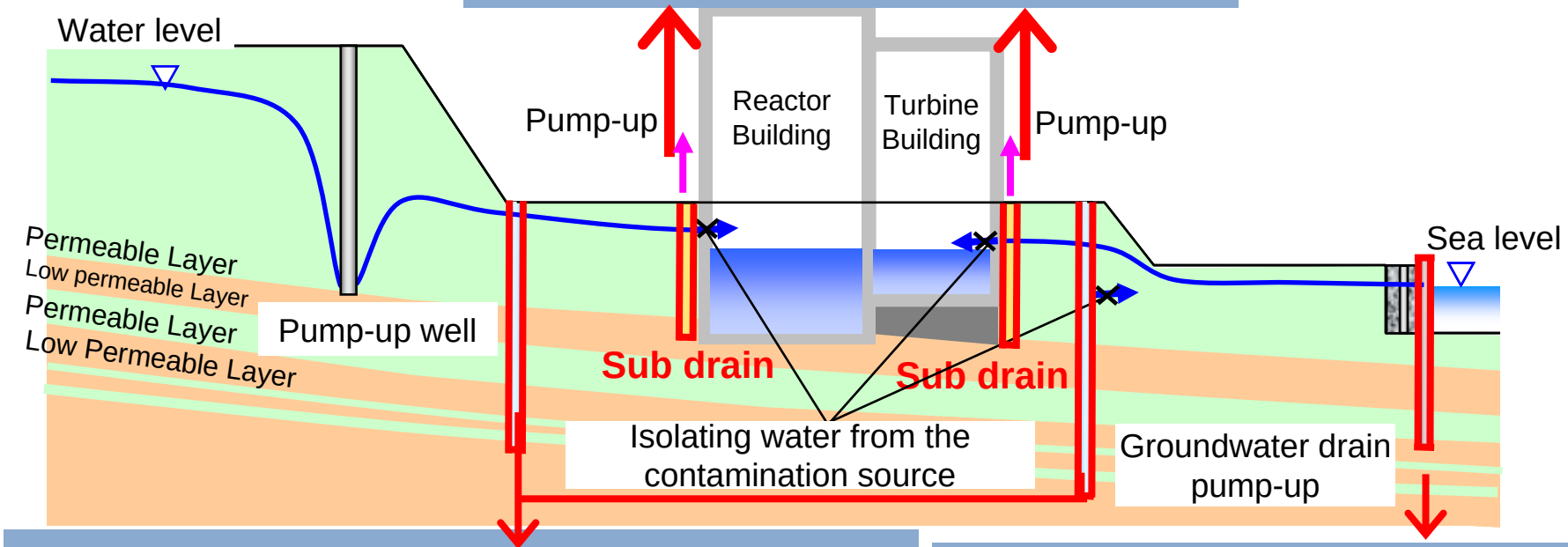
Pump-up well

Emergency measure(2) Improve ground at the contaminated area with water glass, pave the ground surface with asphalt and pump up groundwater. **[Isolation], [Leakage prevention]**

- Improve ground and pump up groundwater
- Pave ground surface with asphalt to curb rainwater infiltration

Measures against contaminated water – Fundamental measures –

Fundamental Measure(4) Pump up groundwater by sub-drains. **[Isolation]**



Fundamental Measure (6) Install the land-side frozen-soil impermeable walls on the mountain side to curb increase contaminated water generated by groundwater flowing into buildings. **[Isolation]**

- Freezing began in March, 2015. [Supported by METI]

Fundamental Measure (5) Install the ocean-side impermeable walls. **[Leakage prevention]**

Measures against contaminated water

Groundwater bypass

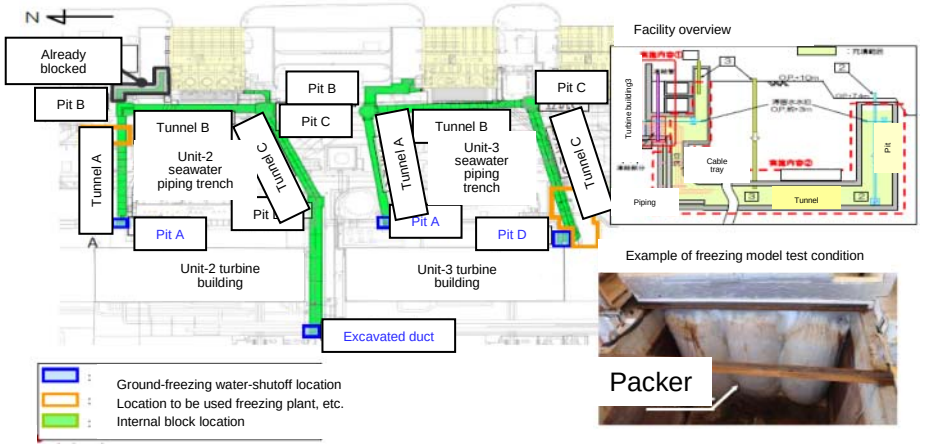
<Discharged water date/amount>

Unit: ton

	Date	Discharged amount
1	May, 21	561 ton
2	May, 27	641 ton
3	Jun, 2	833 ton
4	Jun, 8	1,563 ton
5	Jun, 14	1,443 ton
6	Jun, 20	1,765 ton
7	Jun, 26	1,829 ton
8	Jul, 2	1,858 ton
9	Jul, 8	1,725ton

- Groundwater will be pumped up from the mountain side and discharged into the ocean (Groundwater bypass). It is expected that the amount of inflow into the buildings is to be reduced by tens to 100 tons of water at maximum.
- The water pumped up from pump-up wells is temporarily stored in tanks to measure the radioactivity. It is ensured that the values are less than the target values prior to discharge.

Removal of highly contaminated water from trench

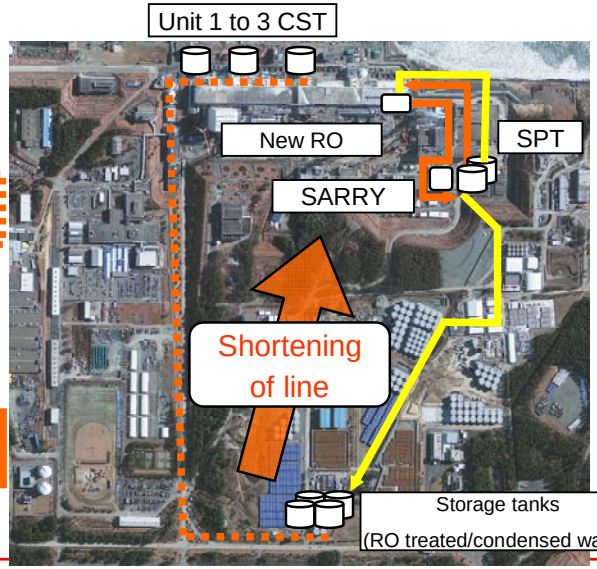


- Right after the accident, contaminated water flew out to the ocean from the seawater inlet through trenches, etc.
- Outflow locations were sealed. However, the contaminated water stayed in the underground structures should be extracted, and the structure should be blocked.
- Treatment of the water stayed in trench has been conducted with mobile processing units (Commencing on Nov. 14, 2013 at Unit 2; on Nov. 15, 2013 at Unit 3)
- Freezing and water removal are prepared/underway. (Unit 2: Starting freezing on Apr. 2, 2014. It was expected that freezing would be completed in June 2014, but freezing is not going on as planned. Freezing is still continuing. Unit 3: Planned to complete freezing in Aug. 2014)

Shortening of circulating cooling water line

Approx. 3 km

Approx. 0.8 km



- By installing a new RO system inside the Unit 4 turbine building, the length of the circulating cooling water line for the reactor will be shortened to approx. 0.8 km from current 3 km by the end of March, 2015 in order to reduce the risk of leakage and avoid radiation dose of workers.

Measures against contaminated water
(Improvement on processing efficiency of ALPS)

● For more efficient contaminated water processing (ALPS with high-performance by government support)

- Current ALPS has three trains. These trains are currently in operation.
- Additional ALPS will also have three trains. Operation commencement is planned in the middle of FY2014.
- High-performance ALPS will have one system. Operation commencement is also planned in the middle of FY2014.

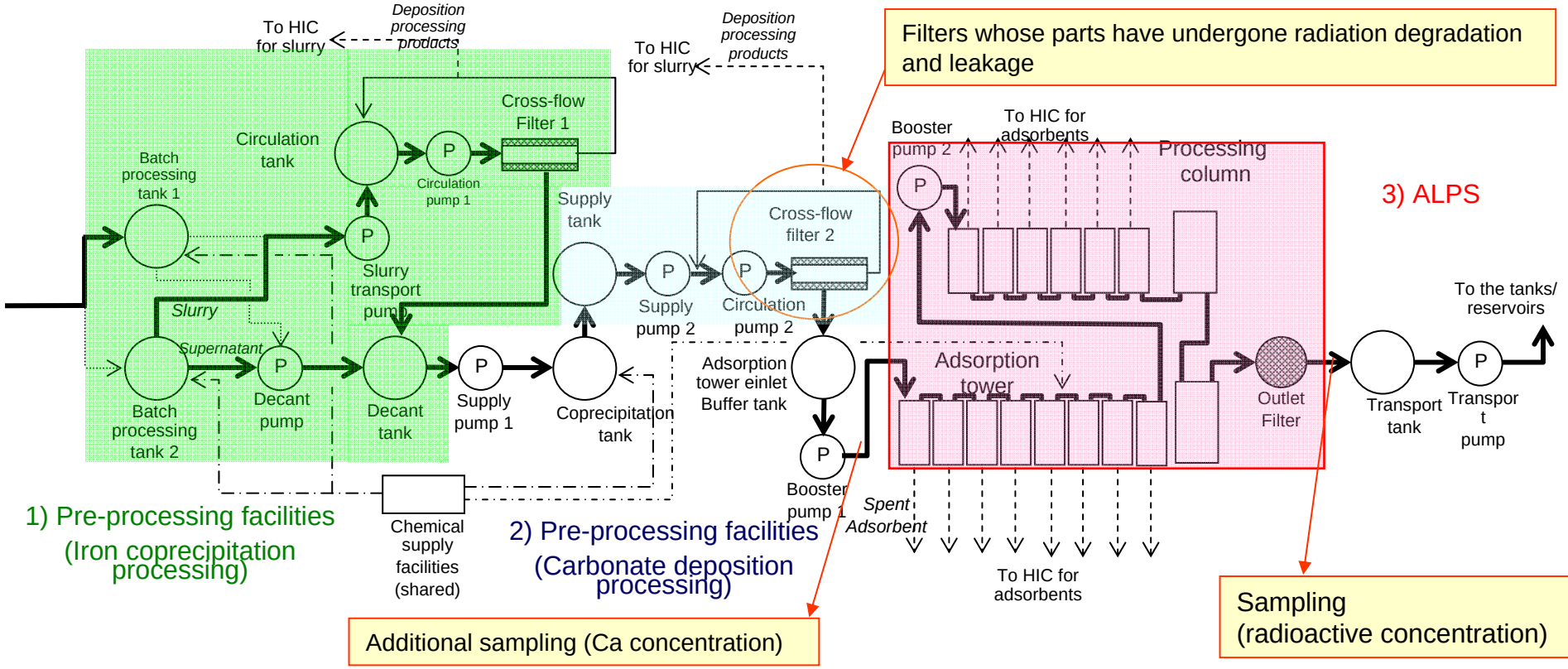
	Current ALPS	Additional ALPS	High-performance ALPS*
Processed amount	750 m^3/day	750 m^3/day	500 m^3/day or more
Number of trains	3 trains (250 m^3/train)	3 trains (250 m^3/train)	1 train
Target nuclides to remove	Concentration limit by law or less for 62 out of all 63 nuclides (except for tritium).		
Waste generation amount	–	–	1/20th compared with existing ALPS
Operation commencement	March 2014	Middle of FY 2014	Middle of FY 2014

* Conducted as a project with expense support form Government of Japan.

* Implemented to greatly reduce the amount of secondary waste generated as deposit after water processing (80% or more) and to improve the processing performance.

Measures against contaminated water
(Status on response to ALPS trouble)

■ Configuration of existing ALPS



Ca concentration at outlet of booster pump 1

Sampling train	Sampling date	Ca concentration
train-A	3/27	11 pm
train-A	5/17	11 ppm
train-C	5/20	6.2 ppm

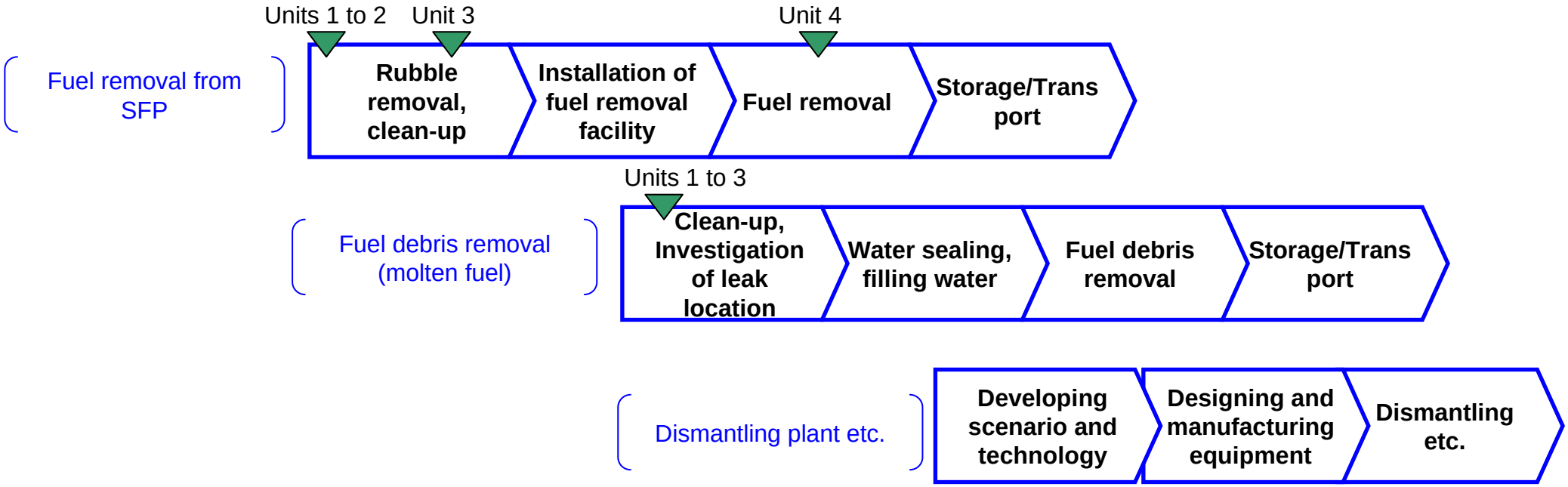
Water radioactive concentration at train outlet (Gross beta level)

Sampling location	Sampling date	Radioactive concentration (Gross beta level)
train B outlet water	3/18	10^3 to 10^4 Bq/cc
train-A outlet water	5/17	2.4×10^{-1} Bq/cc
train-C outlet water	5/19	4.0×10^{-1} Bq/cc

- In train-B, filter components have degraded due to radiation, causing contamination to moving downstream. The parts were replaced with those higher resistant against radiation, and operation of train B restarted on May 23.
- In trains A and C, measures are taken to allow earlier detection on contaminant (additional sampling) to prevent them from moving downstream.
- Operation of train A was also restarted on June 9 after the filter were replaced with another one. Operation of train C was restarted on June 22 after taking same measures.

Major work steps for decommissioning and current status of respective Unit

- The major work items for decommissioning include fuel removal from SFP, fuel debris removal (molten fuel), dismantling plant etc.
- Currently removing fuels from Unit 4 SFP and simultaneously preparing for starting fuel debris removal in Units 1 to 3.



Current Status of Unit 1

Current Status

- Building cover installed (November, 2011)
- Sustained stable reactor cooling, which has reduced the generated amount of radioactive materials

Tasks

- Removal of the building cover
- Identification of the status of debris on the defueling floor and inside the pools
- Countermeasures for the dispersion of radioactive materials during the removal of the building cover
- Shortening the period of the time of removing the building cover

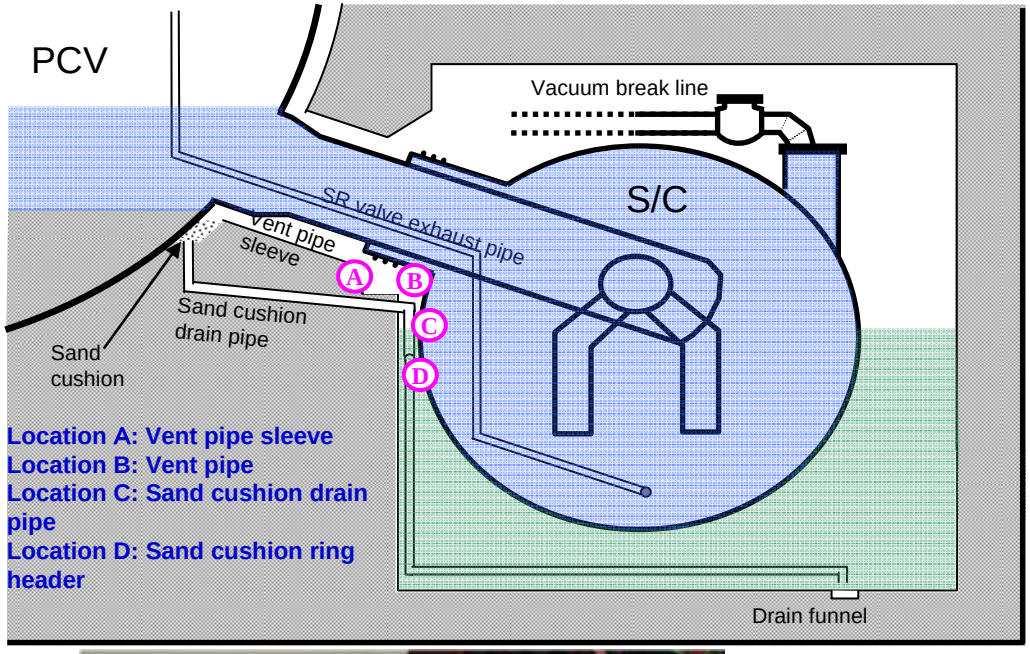
As of Mar. 12, 2011

Completion of building cover structure
Present

Toward fuel debris removal (Preparation for fuel debris removal)

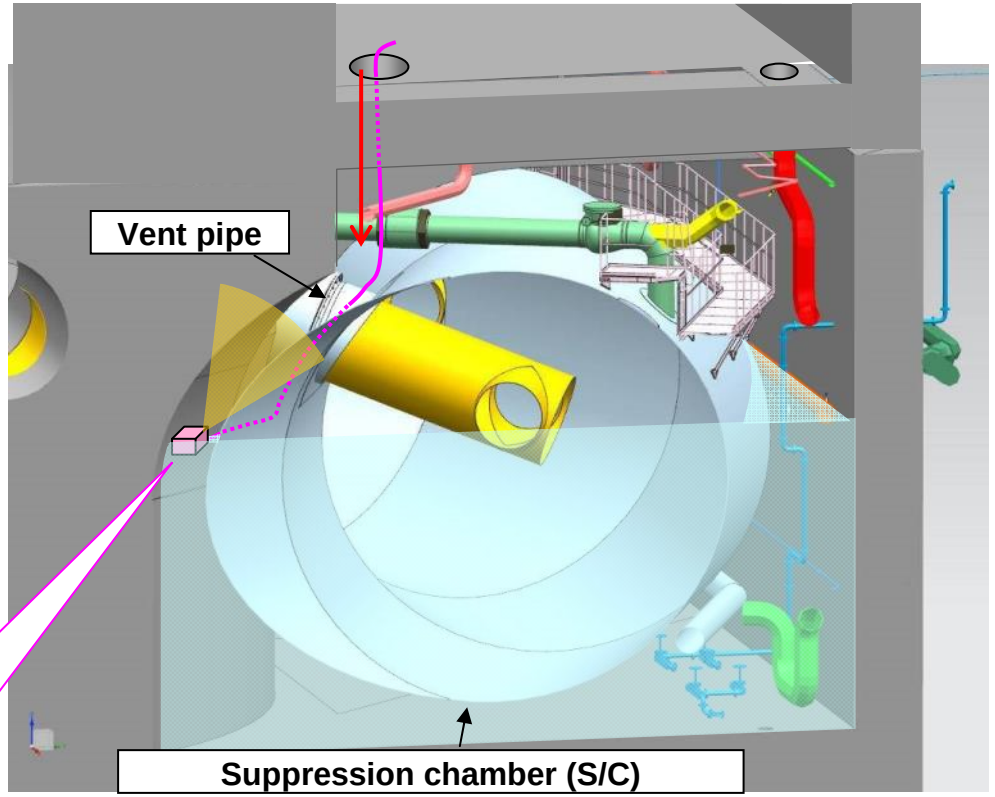
Investigation under vent pipes in Unit 1 (Overview)

- 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



Finding of leakage at the Unit 1

- By deploying a remote controlled robot on the cat walks in the torus room in the Unit 1 from May 27, a leak from the protective cover of a expansion joint on vacuum break line was identified.
- The investigation results will be reflected into the planning for further investigation and sealing the water leak location of the PCV for filling the PCV with water in the future.

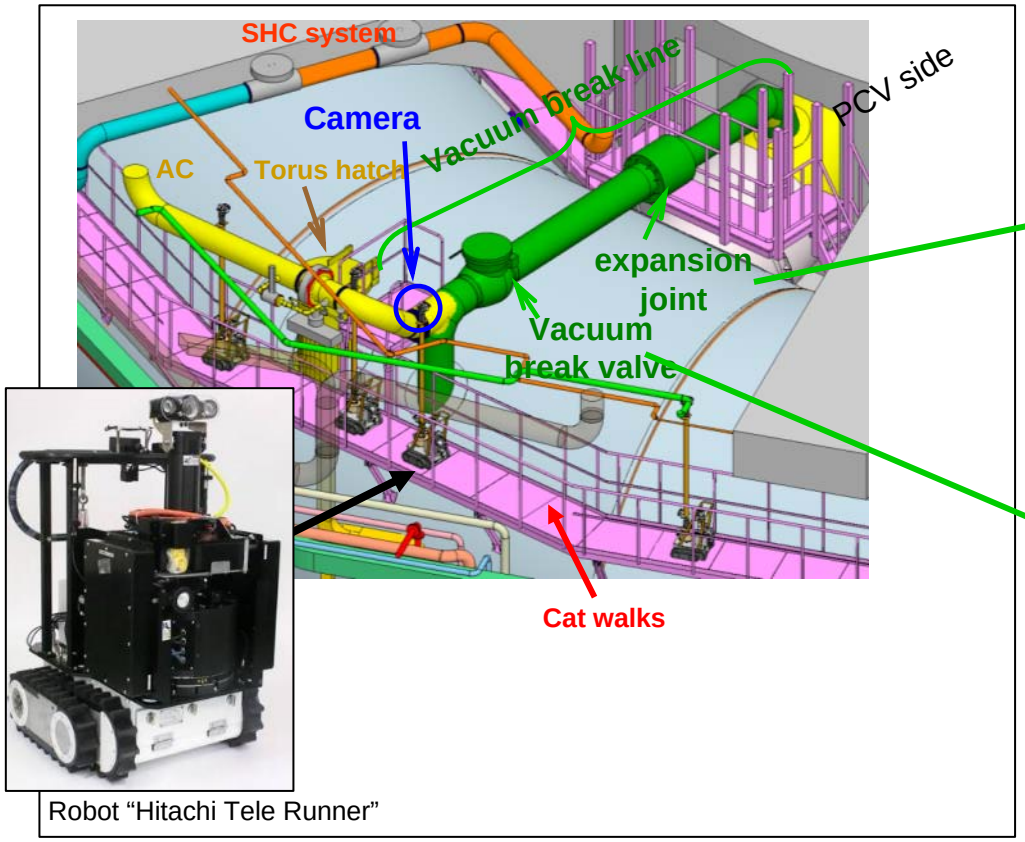
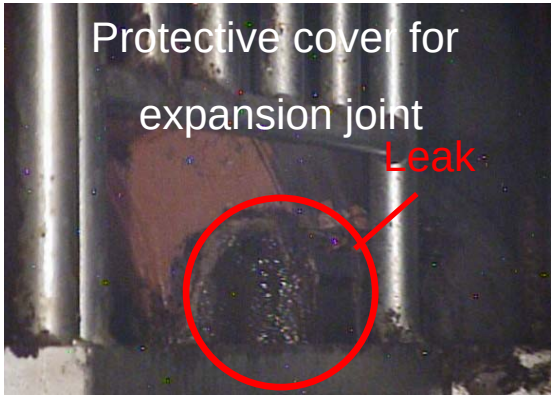
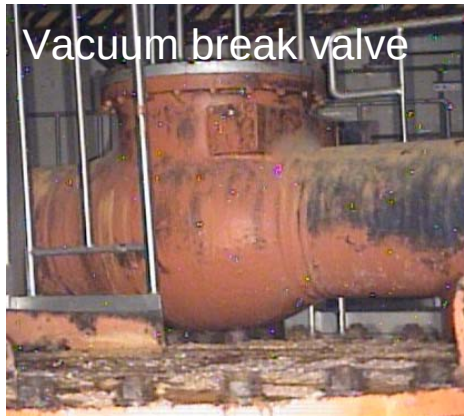


Image of investigation on upper part of suppression chamber





Current Status of Unit 2

Current Status

•Very high radiation level in the building

Inspection of contamination status on the defueling floor will be conducted in the future.

Tasks

•Radiation dose reduction measures

•Countermeasures for the dispersion of radioactive materials during engineering work

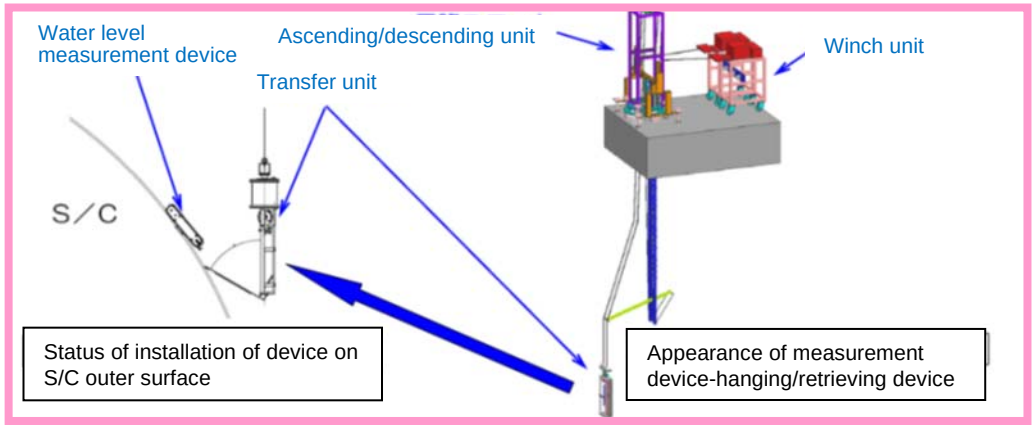
Opened blowout panel

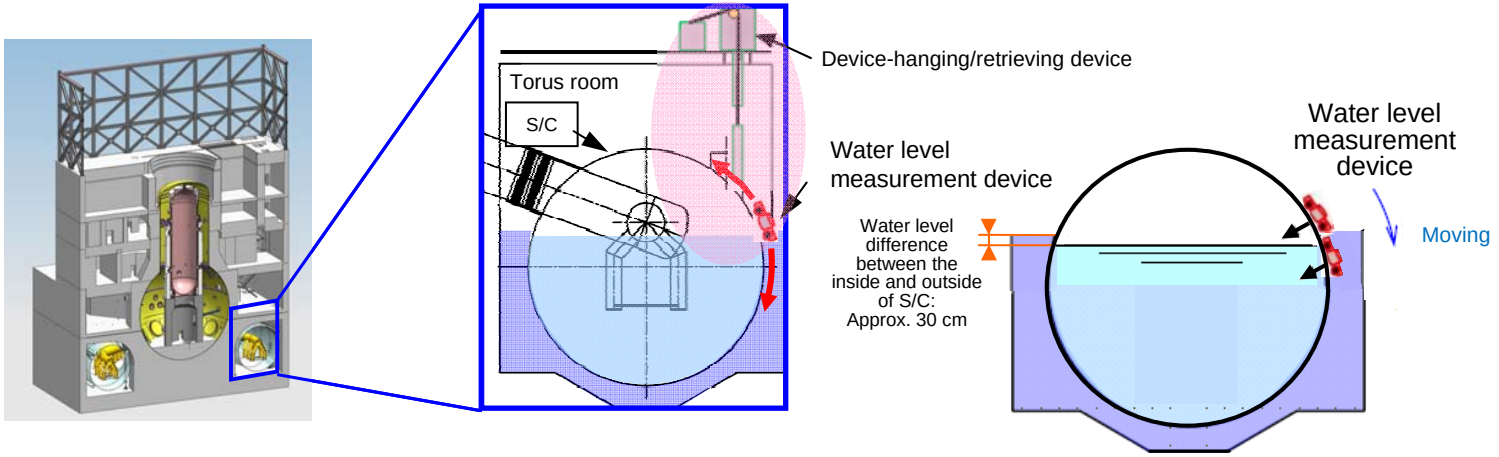
As of Apr. 10, 2011 **Present**

Toward fuel debris removal (Preparation for fuel debris removal)

Measurement of water level in S/C in Unit 2 (Overview)

- To repair (seal the water leak locations of) the PCV in preparation for the fuel debris removal, the water level in the S/C was measured to assume the state of the opening area at leak locations in the PCV.
  (By checking the water level difference between the inside and outside of the S/C, the opening area was assumed, and it will be considered that it is possible whether the water sealing material might flow out of the S/C or not.)





Overview on water level measurement in S/C at Unit 2

Measurement by device

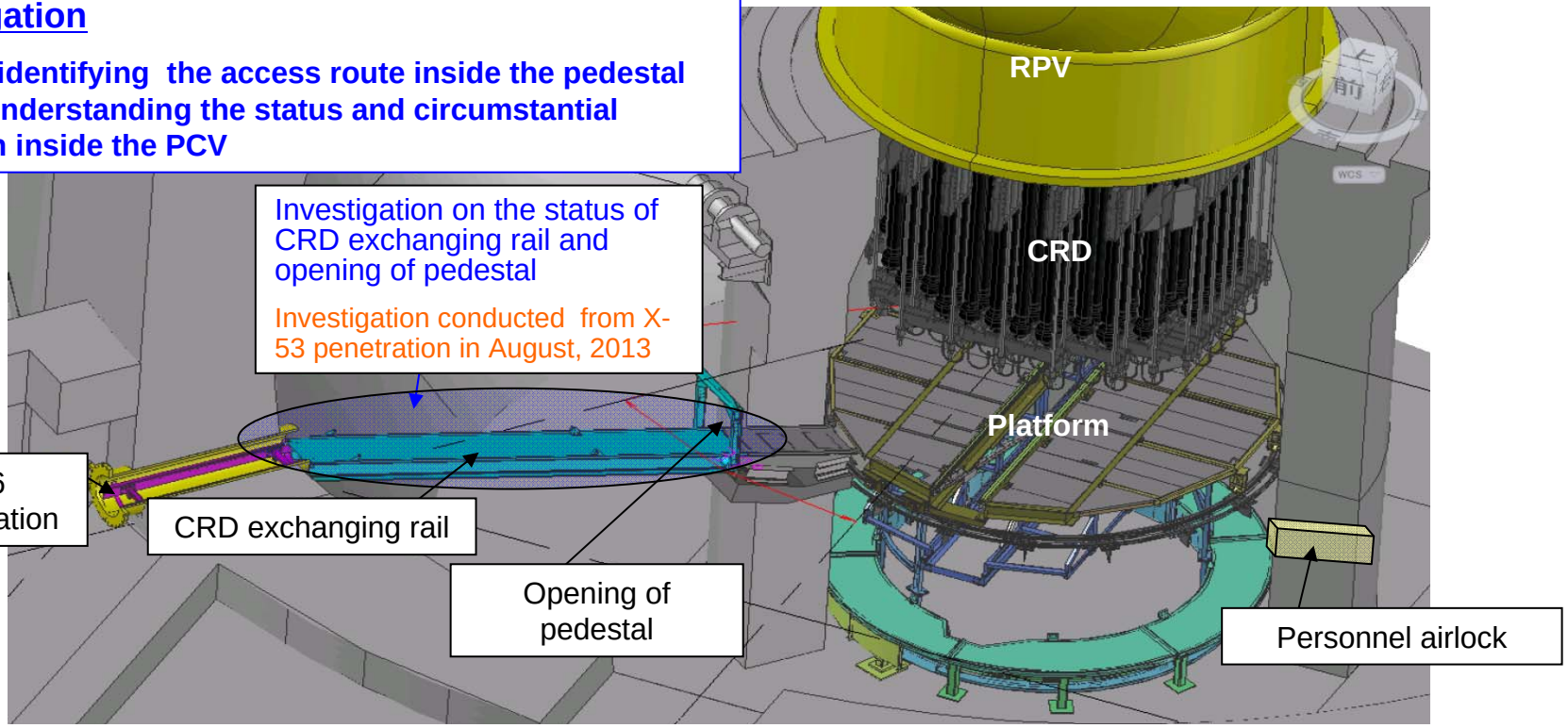
Toward fuel debris removal (Preparation for fuel debris removal)

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



Toward fuel debris removal (Preparation for fuel debris removal)

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

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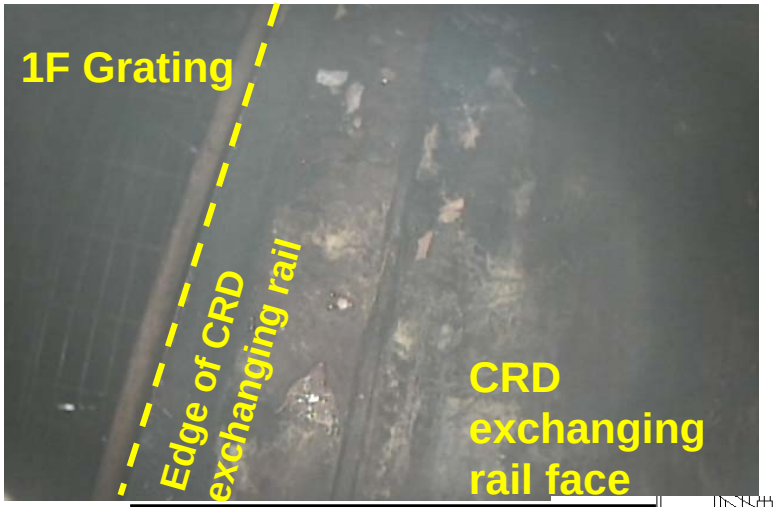

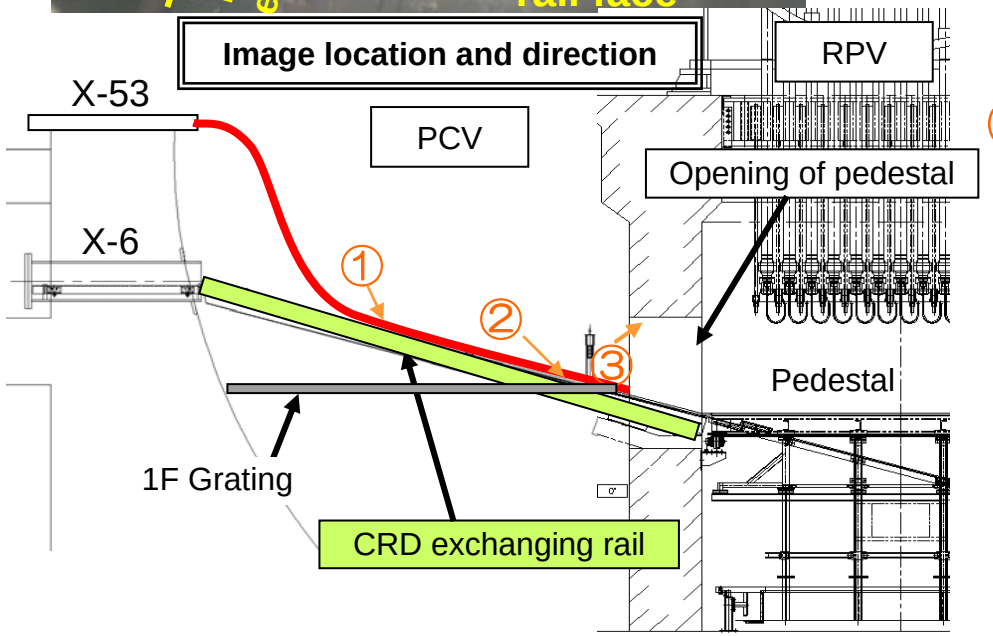

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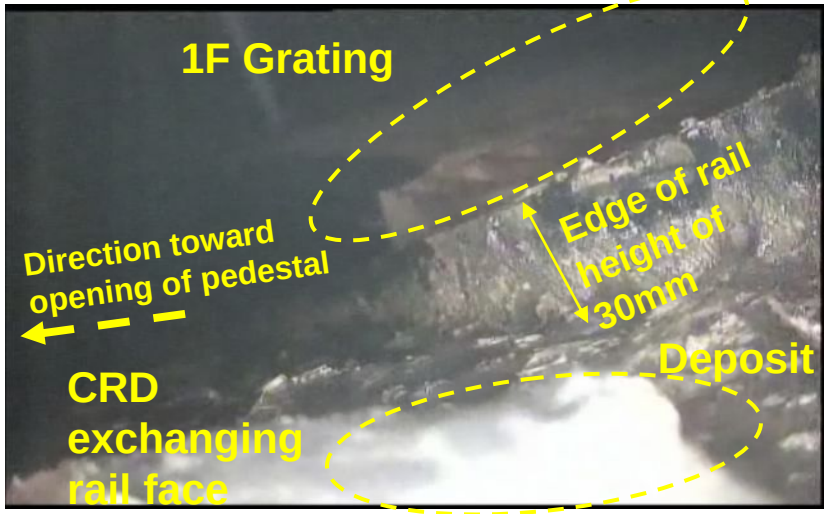

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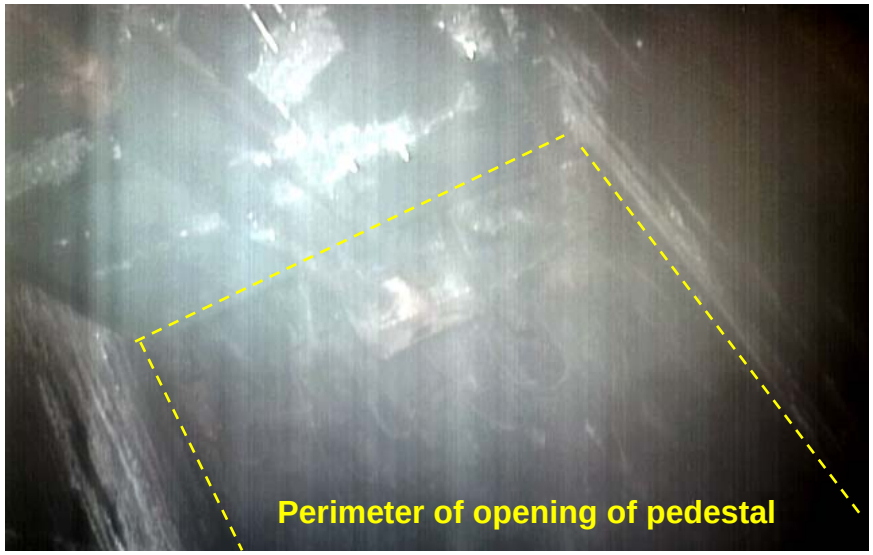
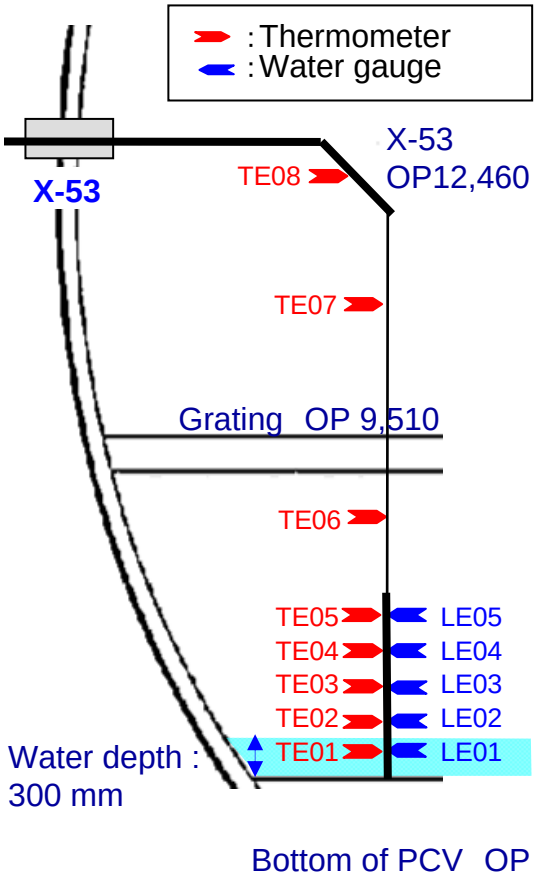
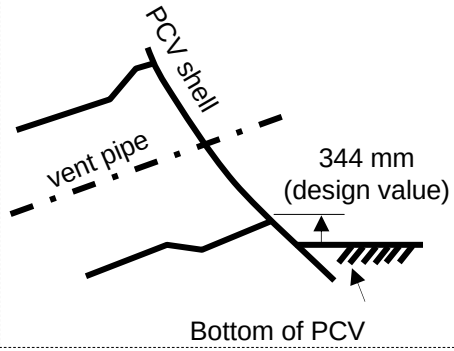


Finding of water levels inside unit 2 Pressure Containment Vessel

- After failing to insert a measurement instrument in March 2012, re-inserting of an instrument was successful in early June 2014.
- Water levels and temperatures inside PCV have since been monitored.



The water level seems to be around over flow height into the vent pipe



Ref: around a vent pipe

［As of 8:00, June 11, 2014］

Monitoring results				Height
Temp.[℃]		Water level		
TE08	33.7	–	–	OP.11,920
TE07	33.7	–	–	OP.10,690
TE06	33.5	–	–	OP.8,100
TE05	33.5	LE05	OFF	OP.6,430
TE04	33.5	LE04	OFF	OP.6,230
TE03	33.6	LE03	OFF	OP.6,030
TE02	35.0	LE02	OFF	OP.5,830 *350 mm from the bottom of PCV
TE01	**35.8**	LE01	**ON**	OP.5,630 * 350 mm from the bottom of PCV

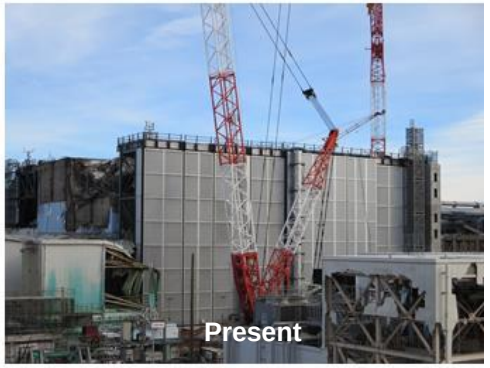
Current Status of Unit 3

Current Status

- Debris removal from the top of the reactor building completed (October 11, 2013)
- Installation of fuel removal cover and fuel handling facility planned
- Steel frame debris dropped into SFP (September, 2012)
- Beginning target of fuel removal activities rescheduled from the perspective of getting safety most prioritized (Changed from the end of December, 2014 to the end of September, 2015)

Tasks

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



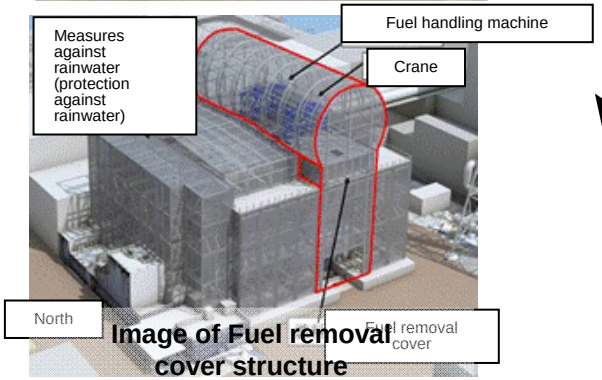
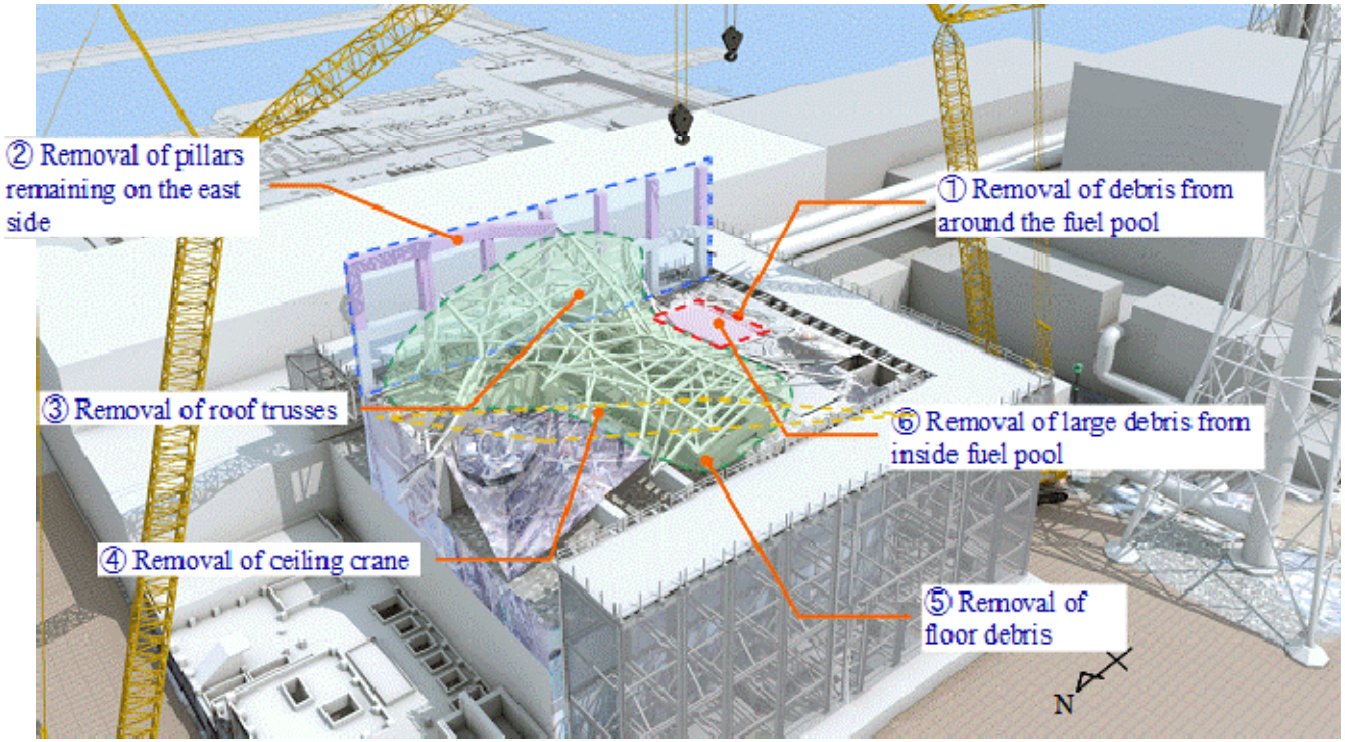


Image of Fuel removal cover structure

Toward fuel debris removal (Fuel removal from SFP)

- With remotely operated heavy machinery, the removing activity of debris from the top floor completed (October 11, 2013)
- Fuel removal from spent fuel pool continuously conducted
- Currently developing/implementing the plan for decontamination and shielding against radiation

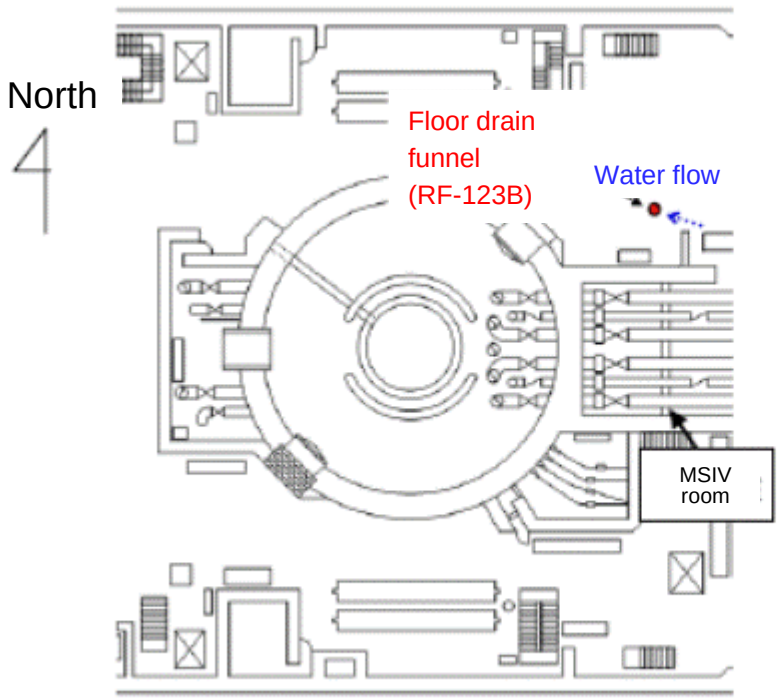


Before large debris removal

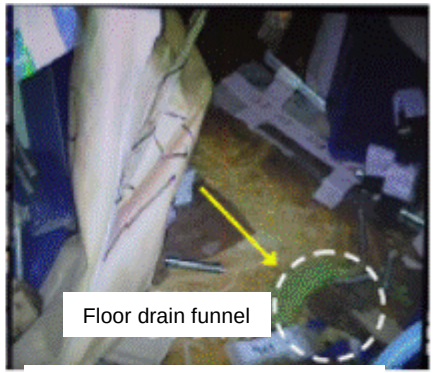
After removal of large debris

Water flow from area near MSIV room to floor drain funnel on 1st floor in R/B at Unit 3

- On January 18, 2014, checking the camera images from the debris removal robot (ASTACO-SoRa) in unit 3, our personnel found that water flowing from the area near the door of the main steam isolation valve (MSIV) room toward the floor drain funnel in the vicinity in the north-eastern area on the 1st floor at Unit 3 R/B.
- On January 21, 2014, it was identified that water injection amount was greatly reduced while the robot was operated for debris removal work.
- No change on plant parameter, etc has been found.



Floor map of 1st floor in R/B at Unit 3



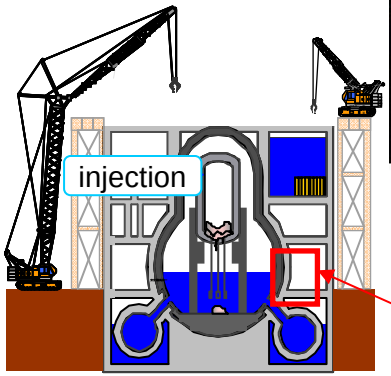
Water flow confirmed (on Jan. 18)

Water flow reduction confirmed (on Jan. 21)

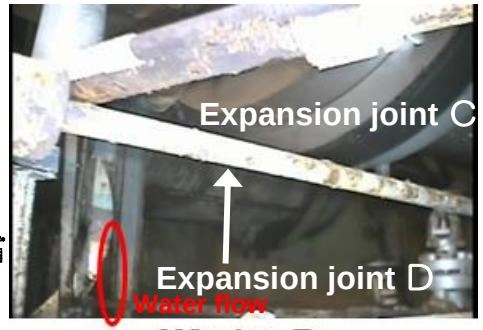
Remote-controlled heavy machinery (ASTACO-SoRa)

Finding of leakage at the Unit 3

- On May 15, by inserting a camera into the Main Steam Isolation Valve (MSIV) room, a leak from around a Main Steam (MS) line was identified. It was the first confirmation of a leak from the Unit 3 PCV.



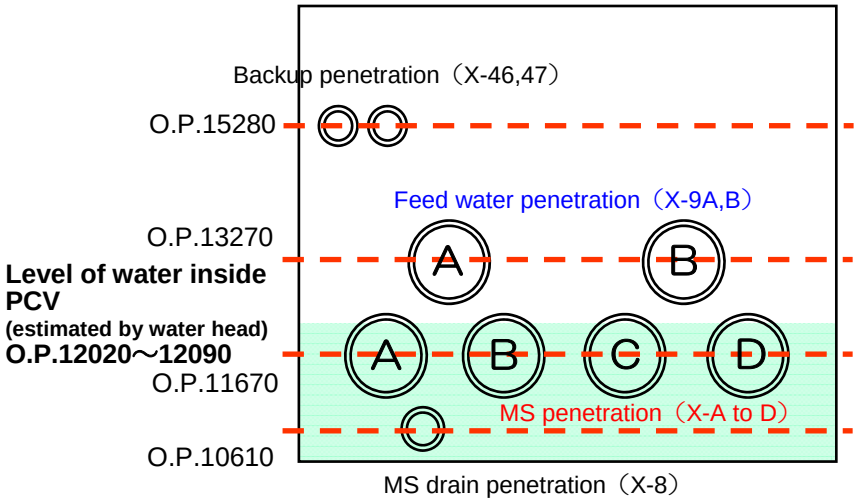
Penetration on PCV by MS pipes



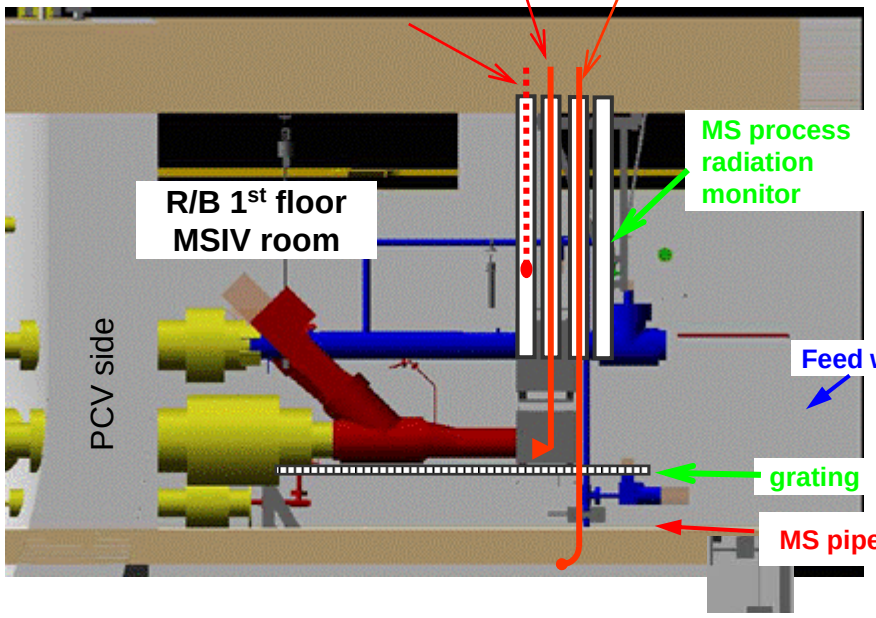
MS pipe D

Pan-tilt camera

Endoscope camera



Penetration on PCV in MSIV room



Cross section of MSIV room

Current Status of Unit 4

Current Status

•Fuel removal from SFP commenced (November 18, 2013, target by the end of year 2014)

Tasks

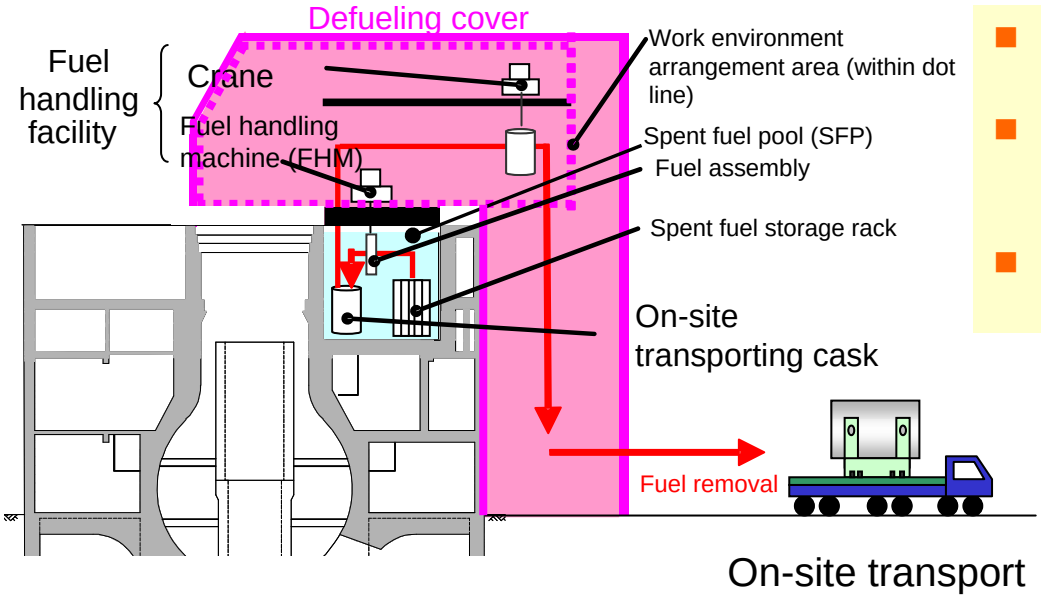
•Continuing work while ensuring safety

•Exploring the methodology for the removal of the fuels with their leaks confirmed

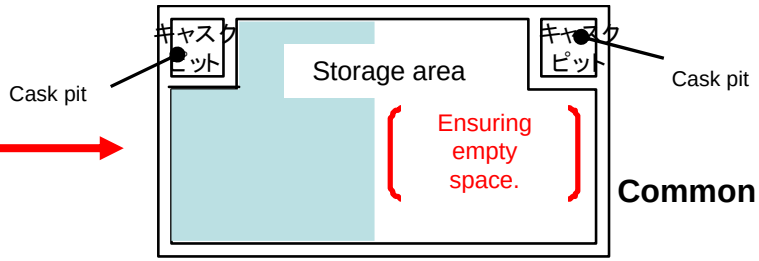
As of Sep. 22, 2011

Fuel Removal Cover Structure Present

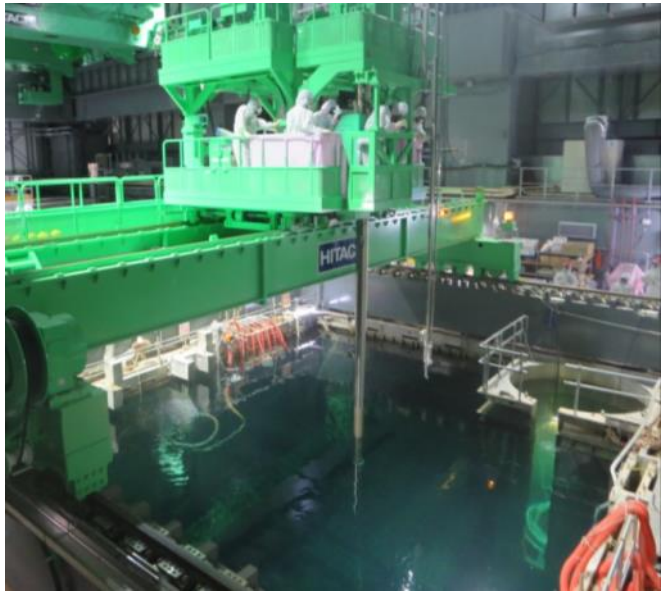
Toward fuel debris removal (Fuel removal from SFPs)



- Fuels have been removed from Spent Fuel Pool (SFP) in Unit 4 since November 18, 2013.
- 1533 fuels was stored inside SFP at the time of starting fuel removal. They are scheduled to be completely removed by the end of year 2014.
- 1188 fuels have been already removed and transported to common fuel pool on site as of June 30, 2014.



<Loading the cask on transporting vehicle>



<Fuel removal activity>

Improvement on work environment

Workers：approximately 5,000 persons per day (As of June, 2014)

◇ Efforts to reduce the area where full-face mask should be worn and to reduce radiation dose for site workers

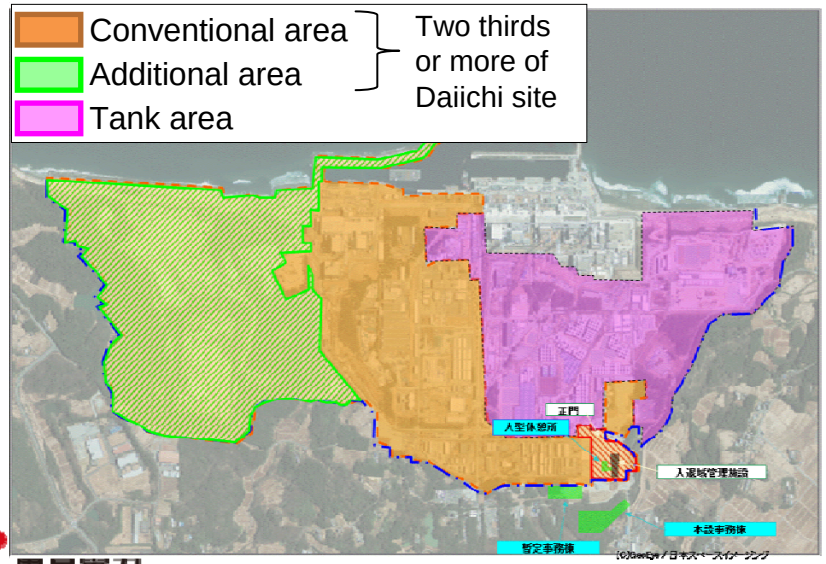
◇ Welfare facilities

- ✓ Mobile rest facility by modifying large bus (operated since January, 2014)
- ✓ Large rest facility (with 8 story building, can accommodate approx. 1200 persons, will be operated by the end of December, 2014.)
- ✓ Cafeteria (will be constructed in Okuma-town by the end of March, 2015, can supply 3000 meals)

◇ improvement on environment of work place

- ✓ Temporary administrative building (can accommodate 1,000 TEPCO employees, operated in order from July, 2014)
- ✓ Permanent administrative building (will accommodate TEPCO employees plus contractors, will be constructed by the end of March, 2016)
- ✓ Damaged vehicles at the sea side of T/B with high radiation have been removed as rubbles.

Area reduction where full-face mask should be worn



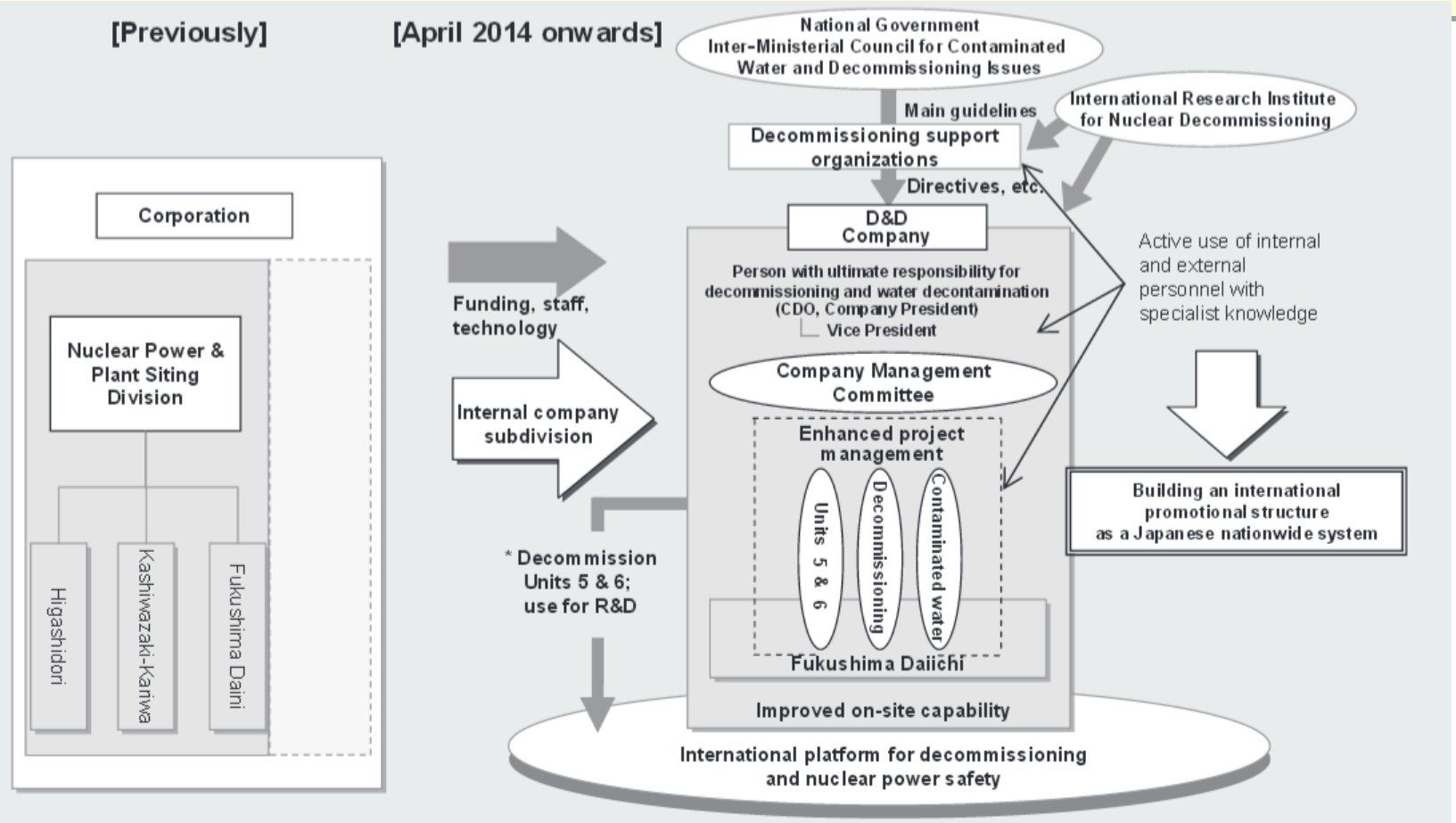
Removal of damaged vehicle rubbles

（Before ）

（After ）

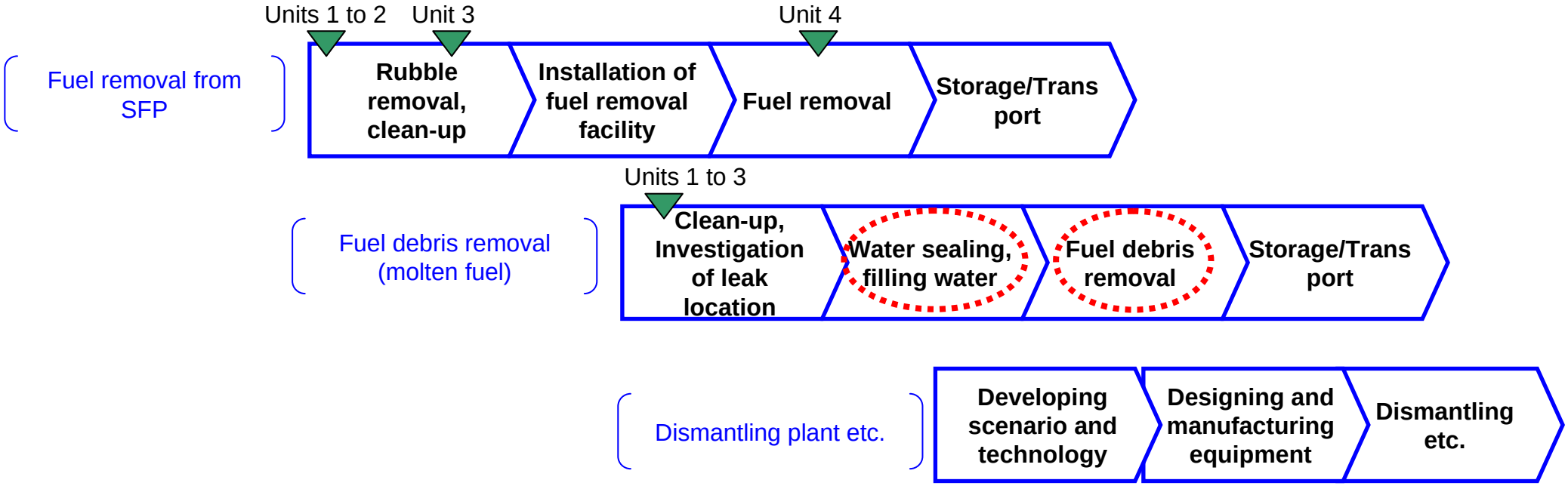
Promotion of decommissioning works at Fukushima Daiichi NPS

- Fukushima Daiichi Decontamination and Decommissioning Engineering Company (FDEC) was established to control the entire decommissioning-related divisions. Decommissioning and measures against contaminated water issue will be expedited as a Japanese government project by collecting the wisdom from experts inside and outside of Japan.



Expectation to IRID (1/2)

- To go ahead with Fukushima Daiichi decommissioning works safely and steadily, R&D is essential, such as development of remote-controlled device etc.
  - As for decontamination device and device for identifying PCV leak locations with remote control, desired results are gradually being obtained with verification testing.
- R&D is imperative for water sealing in S/C, inside investigation, filling water, fuel debris removal in PCV to achieve fuel debris removal in the future.



Expectation to IRID (2/2)

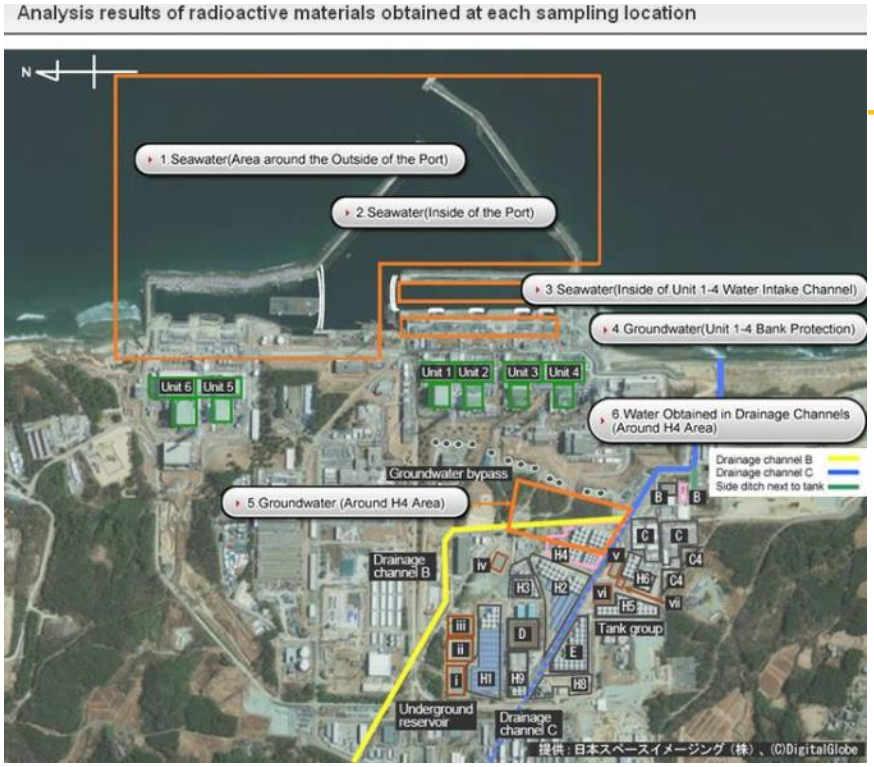
- Collecting knowledge and experience inside and outside of Japan based on needs and challenges in terms of decommissioning of Fukushima Daiichi nuclear power station, screening and giving an expert opinion on technologies
  - Collecting prospective technologies in request for proposals of alternative fuel debris removal
  - Developing element technologies with an eye on using flexibly in the future decommissioning work

- Developing technologies and equipment in considering the reality of the situation and the time frame requirement
  - The element technologies closely relevant to the site can be applied to the site, such as the suction and blast decontamination equipment used inside buildings

- Through close information exchange and cooperation with IRID, Fukushima Daiichi D&D company strive to resolve the challenges faced at the site

For more information

- Updated information regarding decommissioning is shared on TEPCO website.
  http://www.tepco.co.jp/en/decommision/index-e.html



<Result of radioactive analysis around Fukushima Daiichi NPS map imaging>

<Photo and video library>