52th JAIF Annual Conference

Fukushima Daiichi Decontamination and Decommissioning: Current Status and Challenges

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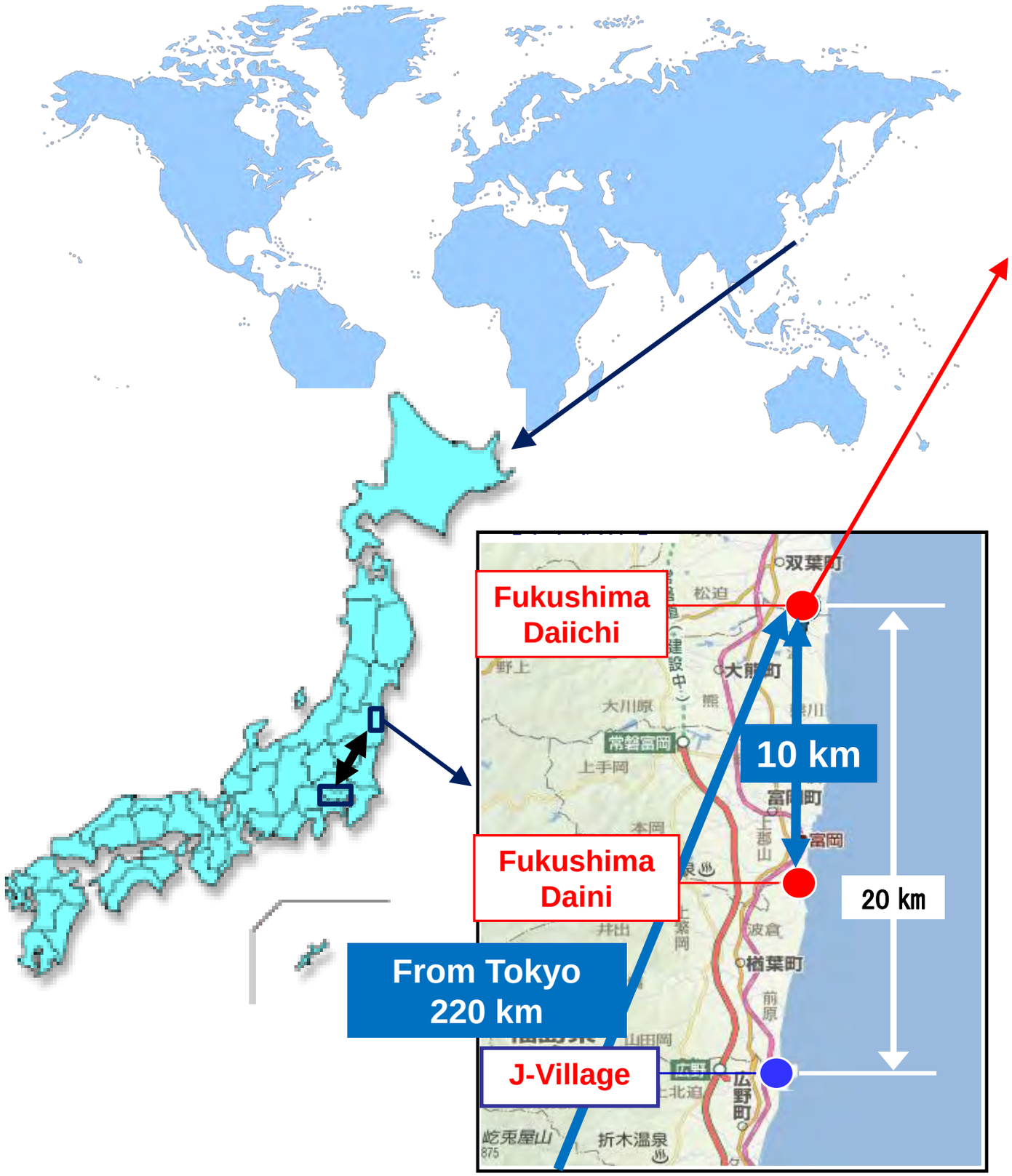
TEPCO

Map of Japan and Location of Fukushima Daiichi NPS (1F)

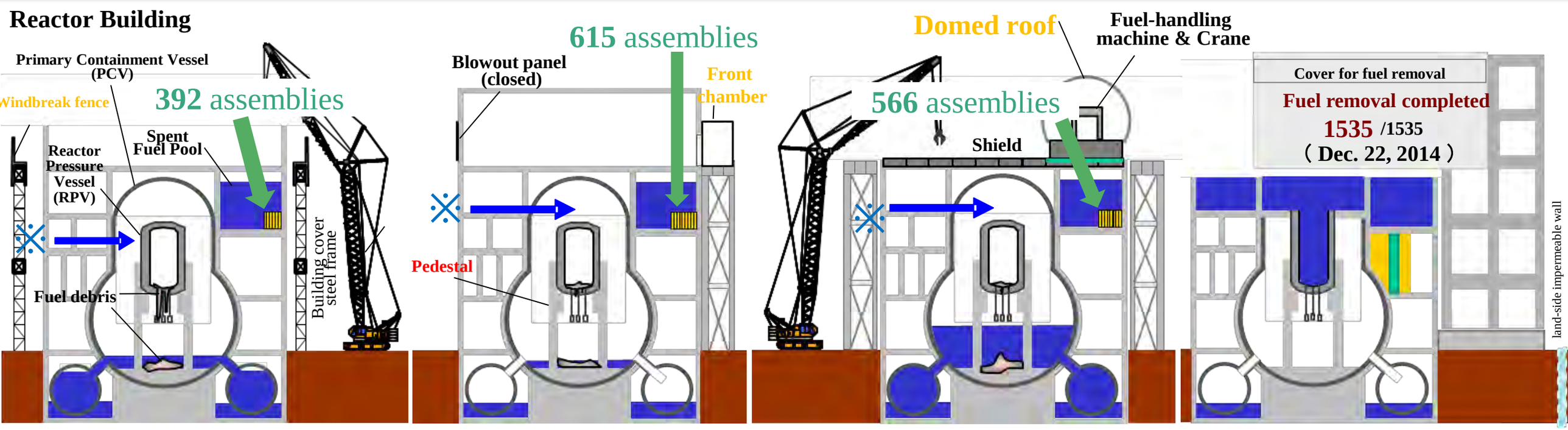


Unit	Start of operation	Reactor Type	Power Output (MWe)	Main Contractor
1	1971	BWR-3	460	GE
2	1974	BWR-4	784	GE / Toshiba
3	1976	BWR-4	784	Toshiba
4	1978	BWR-4	784	Hitachi
5	1978	BWR-4	784	Toshiba
6	1979	BWR-5	1,100	GE / Toshiba

1. **Current Status of Fukushima Daiichi NPS**
2. **Improving Work Environment**
3. **Contaminated Water Management**
4. **Fuel Removal from Spent Fuel Pools**
5. **Toward Fuel Debris Retrieval**
6. **Two-way Communications**

State of Units 1 - 4

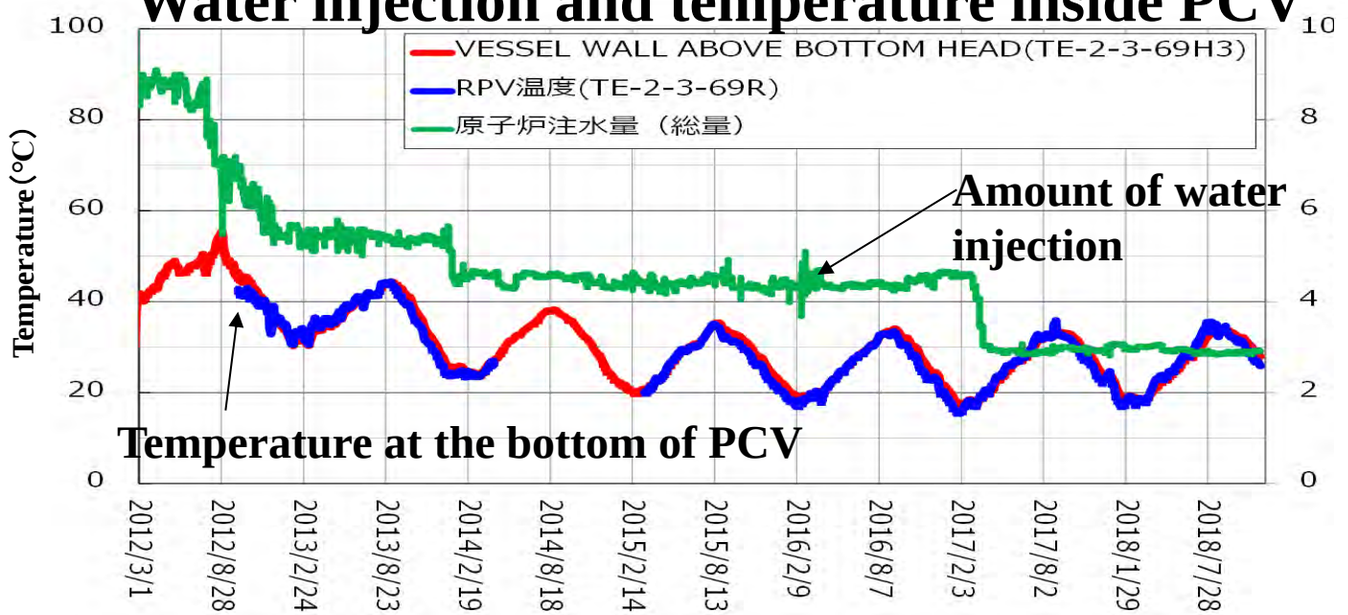
- **All reactors are in cold shutdown condition.**
- **The temperatures of PCV and RPV have been stabilized in spite of decreased water injection.**



Values as of 11:00 am on April 1, 2019

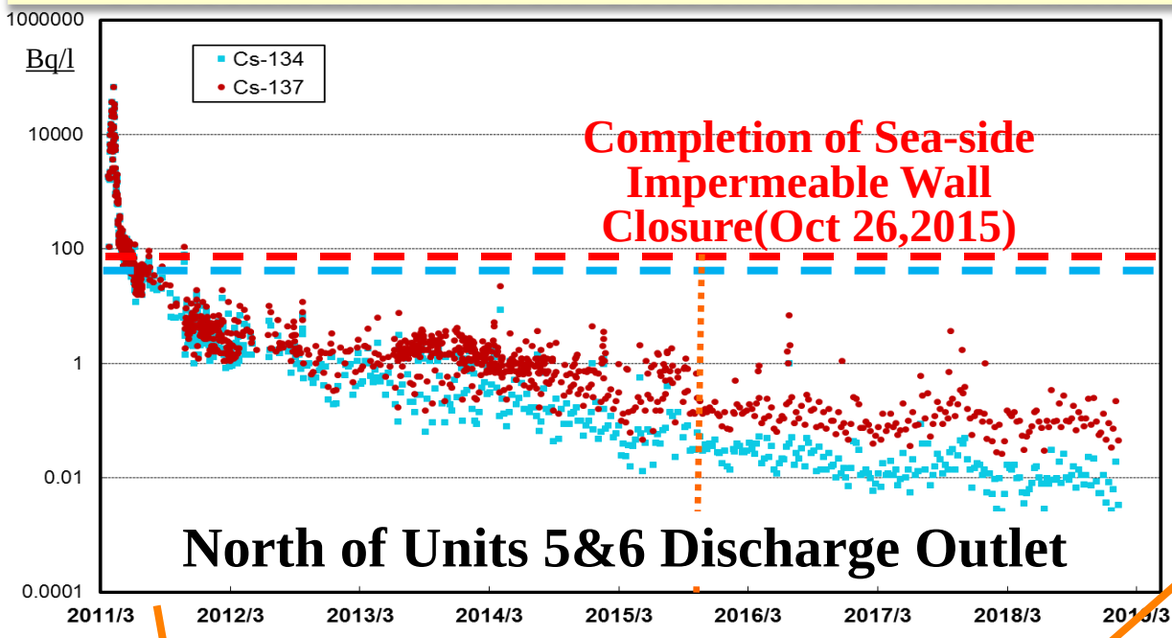
	Temperature at the bottom of the pressure vessel	Temperature inside the containment vessel	Fuel pool temperature
Unit 1	15 ℃	15 ℃	17 ℃
Unit 2	20 ℃	21 ℃	17 ℃
Unit 3	18 ℃	18 ℃	16 ℃

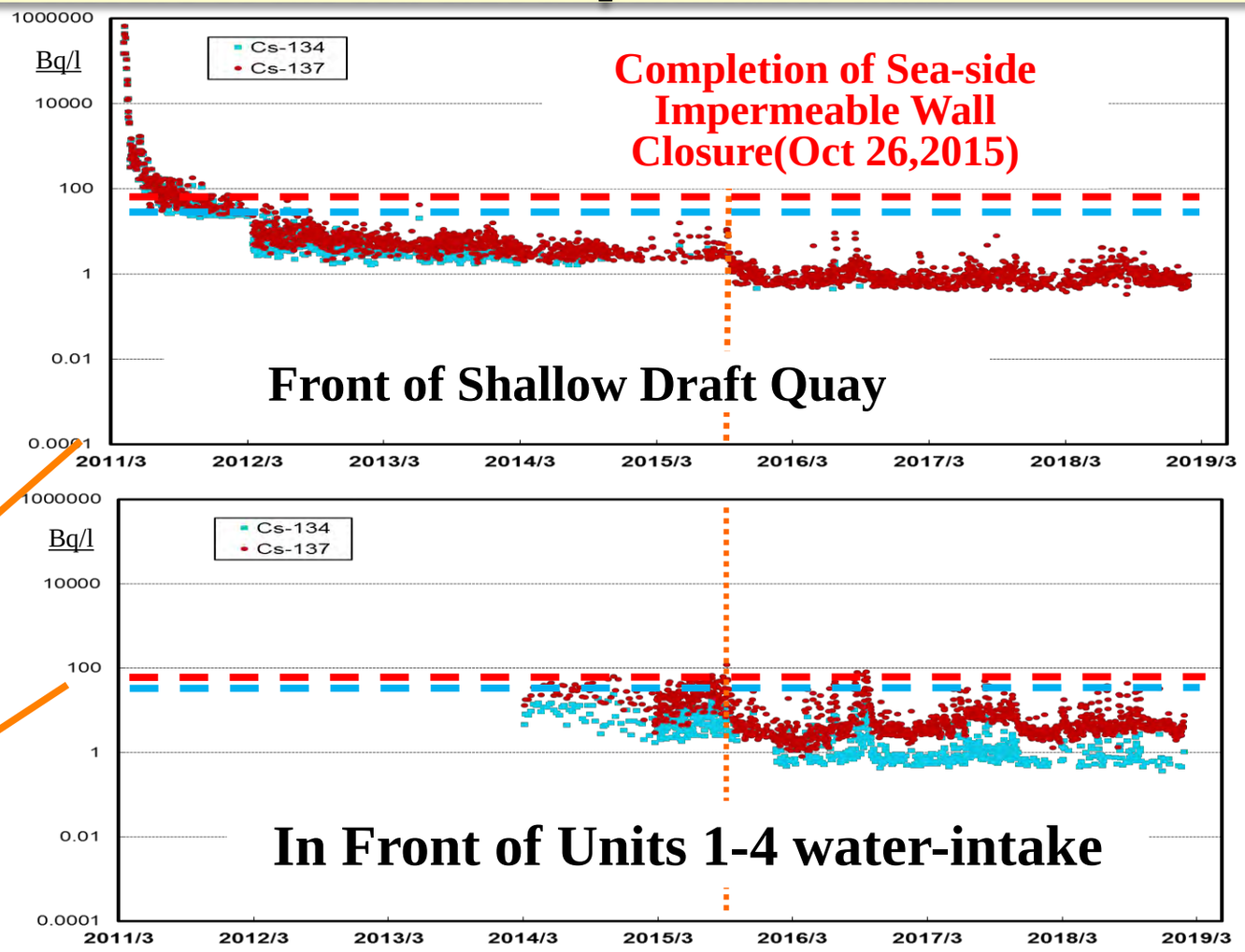
Water injection and temperature inside PCV



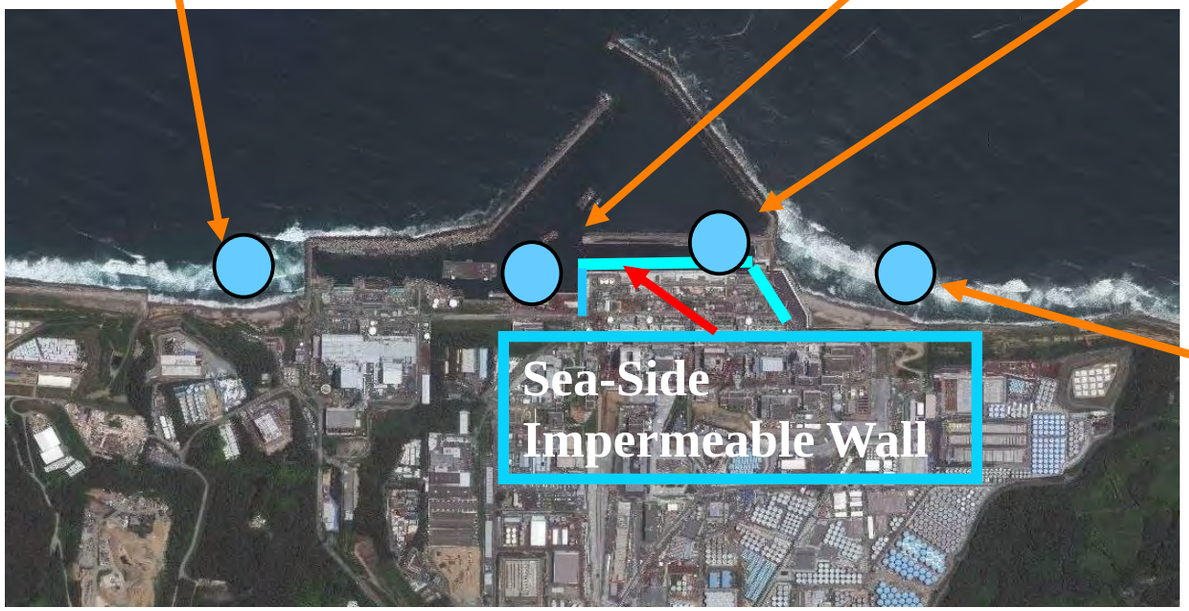
Monitoring Level in the Sea

- **Compared to the situation just after the accident, the current level of radioactivity has been lowered to less than parts per million at the lowest.**
- **The concentrations outside the port are substantially below the Japanese regulation limits.**
- **Concentration levels decreased further after the closure of the sea-side impermeable wall.**





Japanese Regulation Limit
- Cesium 137: 90Bq/L
- Cesium 134: 60Bq/L



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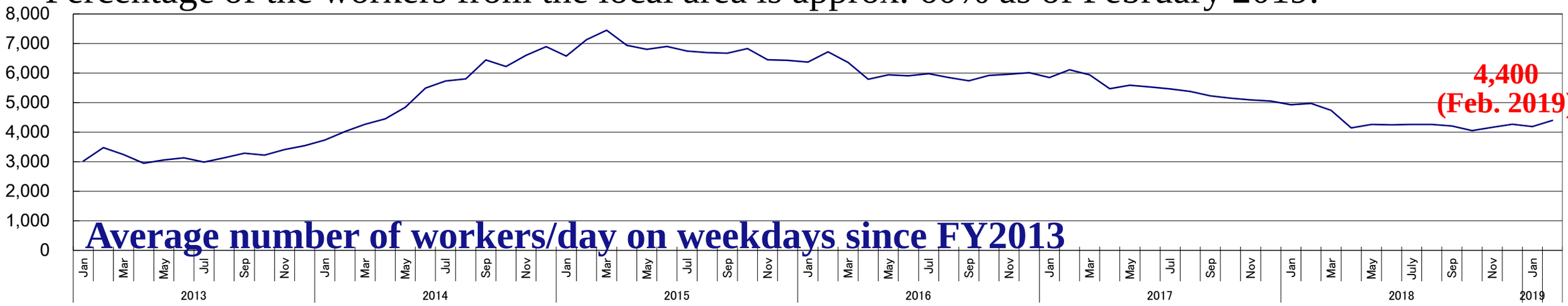
Number of Site Workers and Change in Exposure Dose Level

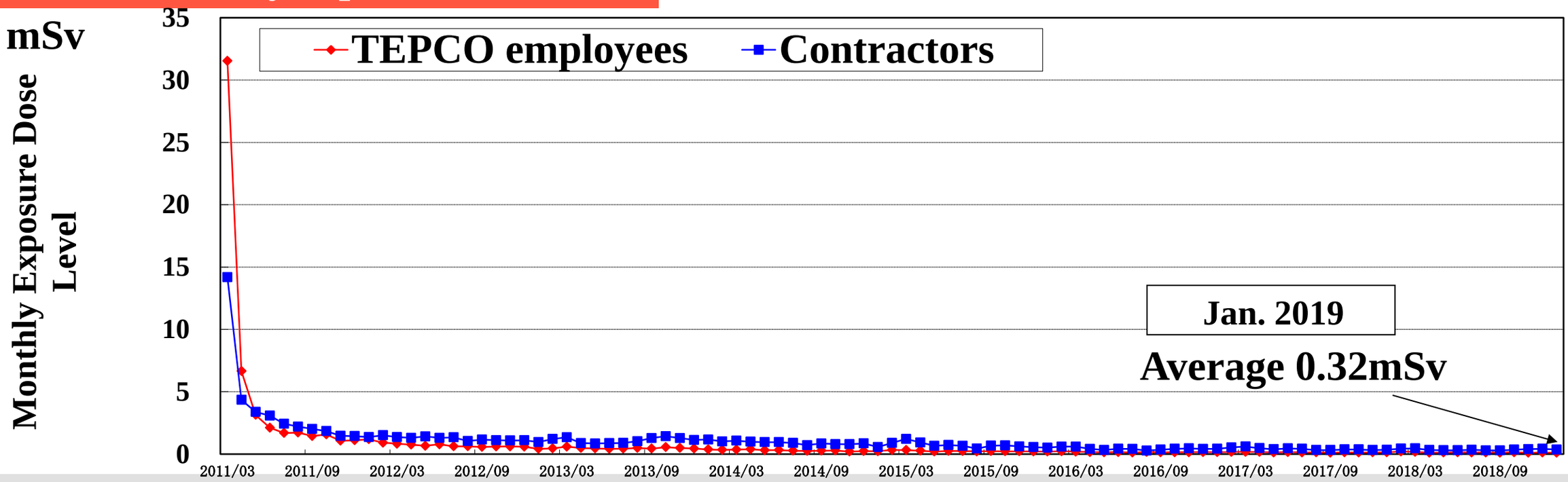
- **Currently about 4,000 people／day are working on weekdays.**
- **The exposure dose climbed to 21.59mSv/m in March 2011 but it has plunged to around 0.3mSv/m in recent months.**

Changes in number of workers (TEPCO & Contractors)

- Average number of workers engaged in the work on weekdays is 4,400 as of February 2019.
- Percentage of the workers from the local area is approx. 60% as of February 2019.



Trend of monthly exposure dose rate

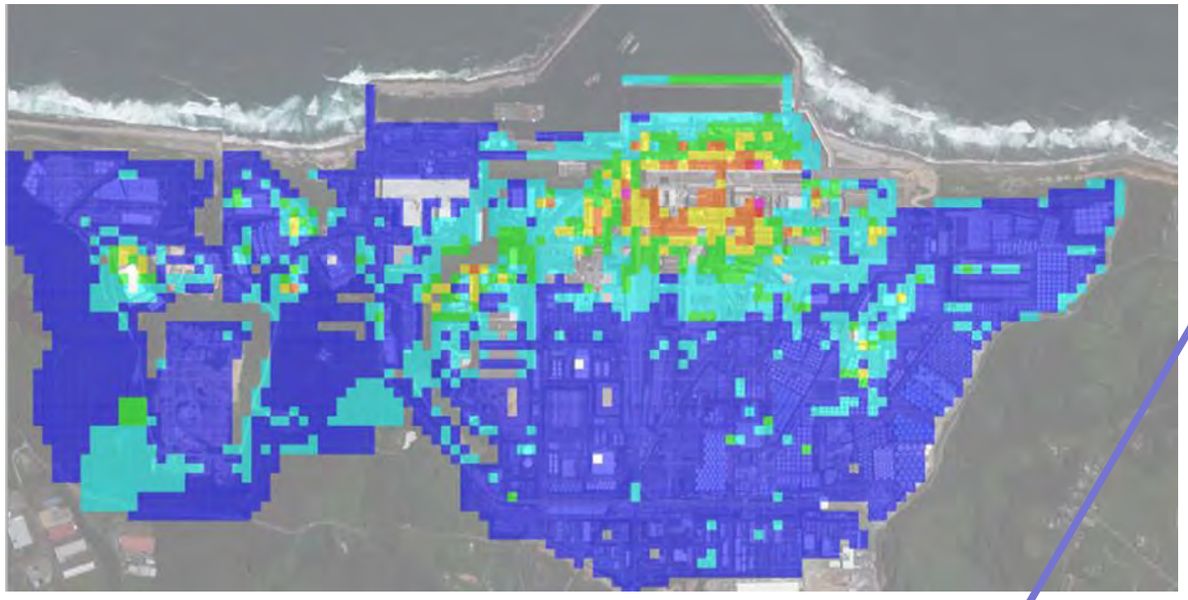


Decreased Site Radiation Dose

- **As a result of radiation reduction measure, workers don't have to wear full-face respirators or half-face respirators anymore in most parts of the site.**

Distribution of dose level

: Area below 5μSv/h (Feb. 2018)



Zoning on the site（May 2018)

Area where people should work in protective gears

Area where people can work in general uniforms

【96% of the site】

Site touring by cabinet members (Dec. 2018）

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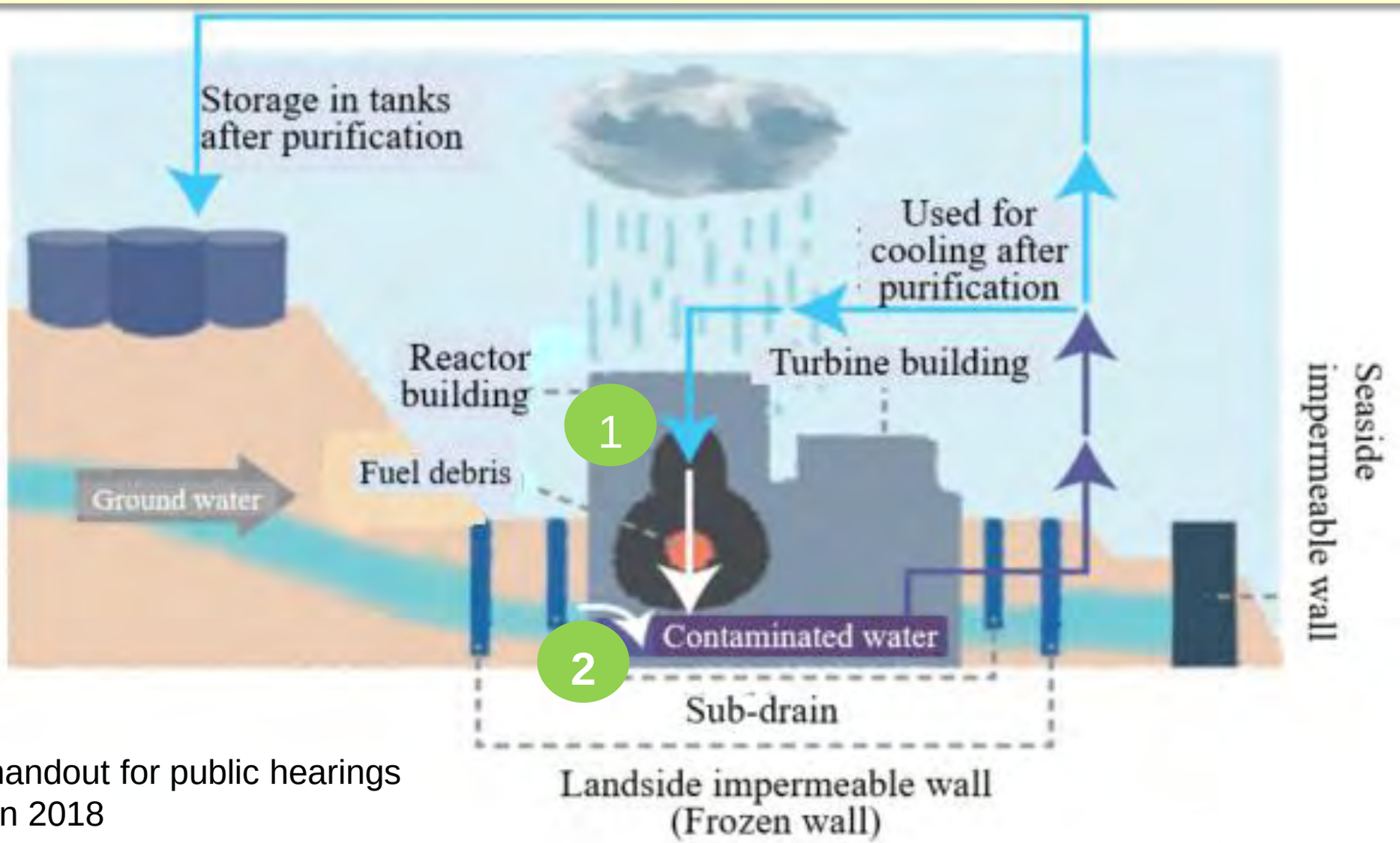
Generation, Purification and Storage of Contaminated Water

- In the reactor, cooling of fuel debris by water injection is continuing. (①)
- In order to prevent flow out of the reactor building, the water level of the contaminated water is maintained lower than the groundwater level outside of the building.
- As a result, groundwater flows into the building and mixes with contaminated water, and additional contaminated water is generated inside of the buildings. (②)
- After processing by purification equipment such as ALPS, the water is stored in tanks. However, tritium cannot be removed by the purification equipment.



Source: Based on the handout for public hearings held by METI in 2018

Three Principles for Measures to Counter Contaminated Water

Principle 1: Removing source of contamination

① Purification of contaminated water using Multi-nuclide Removal Equipment (ALPS)

② Removal of Contaminated water from trenches

Principle 2: Isolating fresh water from contaminated areas

③ Pumping up groundwater using groundwater bypass system

④ Pumping up groundwater using subdrain wells

⑤ Installation of Landside Impermeable Wall (Ice Wall)

⑥ Pavement to prevent rain water from penetrating into the ground

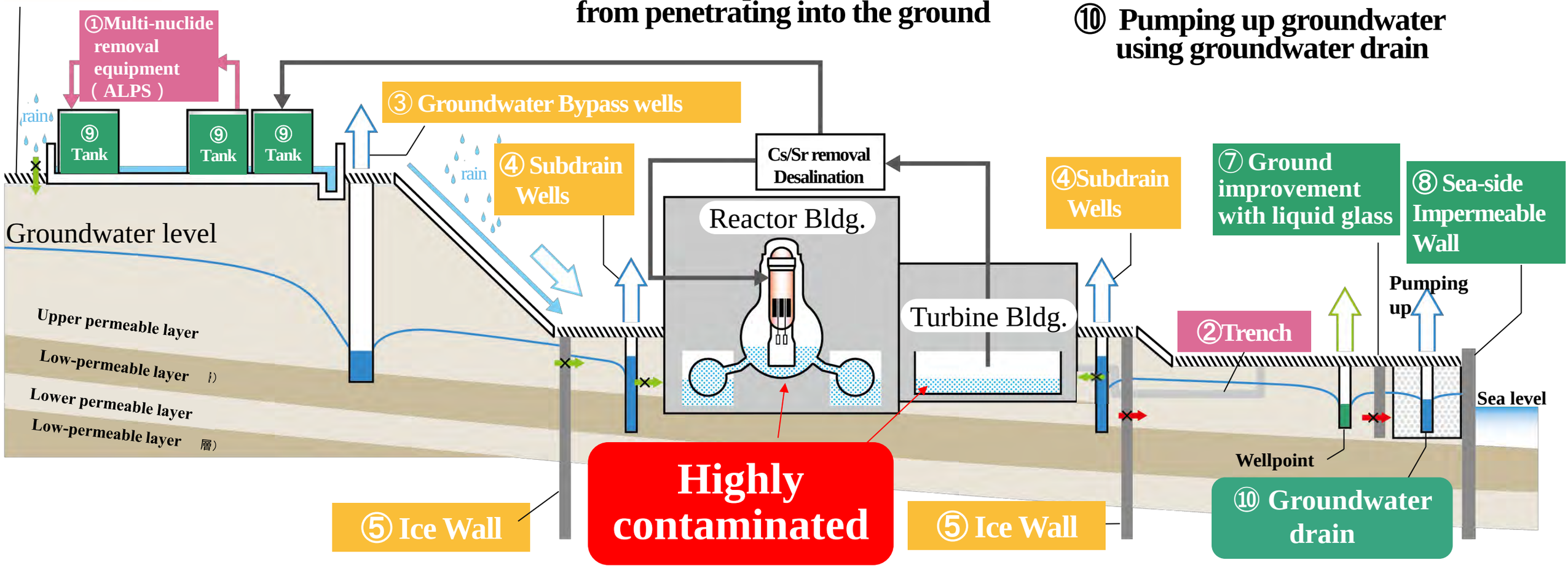
Principle 3: Preventing leakage of contaminated water

⑦ Ground improvement with liquid glass

⑧ Installation of Sea-side Impermeable Wall

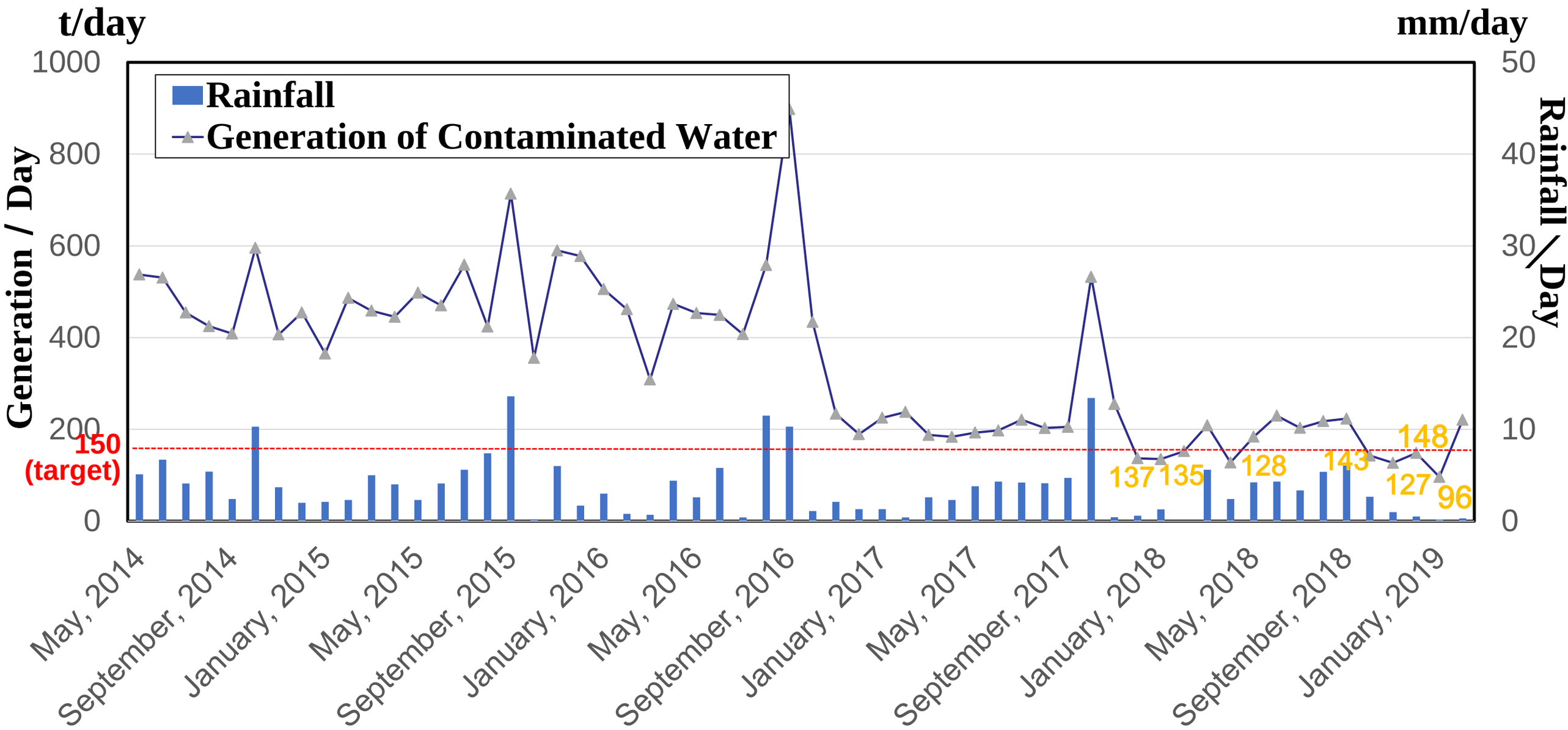
⑨ Augmentation of tanks (Replacement with more reliable welded tanks)

⑩ Pumping up groundwater using groundwater drain



Reduction of Contaminated Water Generation

- **Generation of the contaminated water decreased to 180m³/Day (average value from Apr. 2018 to Feb. 2019) from 470m³/Day (average value in FY2014) as a result of multilayered measures taken.**
- **Will continue to take additional measures against the inflow of rainwater etc., and aim to reduce the generation to 150m³/day on an annual basis within FY2020.**



Storage of ALPS Treated Water

- **Currently, tanks continue to increase. The installation area of the tanks occupy much of the southern half of the site.**
- **The current tank capacity per the construction plan is 1.37 million tons. The available site area for building new tanks is approaching the limit.**

ref. northern half of the site is planned to be the solid radioactive waste storage facilities area)

【ALPS treated water tanks spreading at Fukushima Daiichi site】

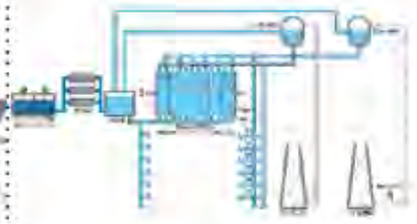
Status of ALPS treated water	
Volume of water stored in tanks	About 1.12 million ton (as of January 2019)
Projected tank volume	About 1.37 million ton (end of 2020)
Generation rate of ALPS treated water	About 50,000-80,000 ton/year

Source: Based on the handout for public hearings held by METI in 2018

Discussion at Task Force and Subcommittee

- **METI's "The Tritiated Water Task Force" assessed the regulatory feasibility, technical feasibility (including monitoring to ensure safety), treatment period and cost of 5 disposal methods ; (1) geosphere injection, (2) offshore release, (3) vapor release, (4) hydrogen release, and (5) underground burial.**
- **All cases are examined on the premise that there is no scientific impact on the human habitant.**
- **The treatment of ALPS treated water has been discussed in "the subcommittee on handling ALPS treated water" as reputational damage can have a societal impact. For the purpose of listening to the concerns on disposal methods and disposal itself from the public widely, public hearings were held in Fukushima and in Tokyo in August, 2018.**

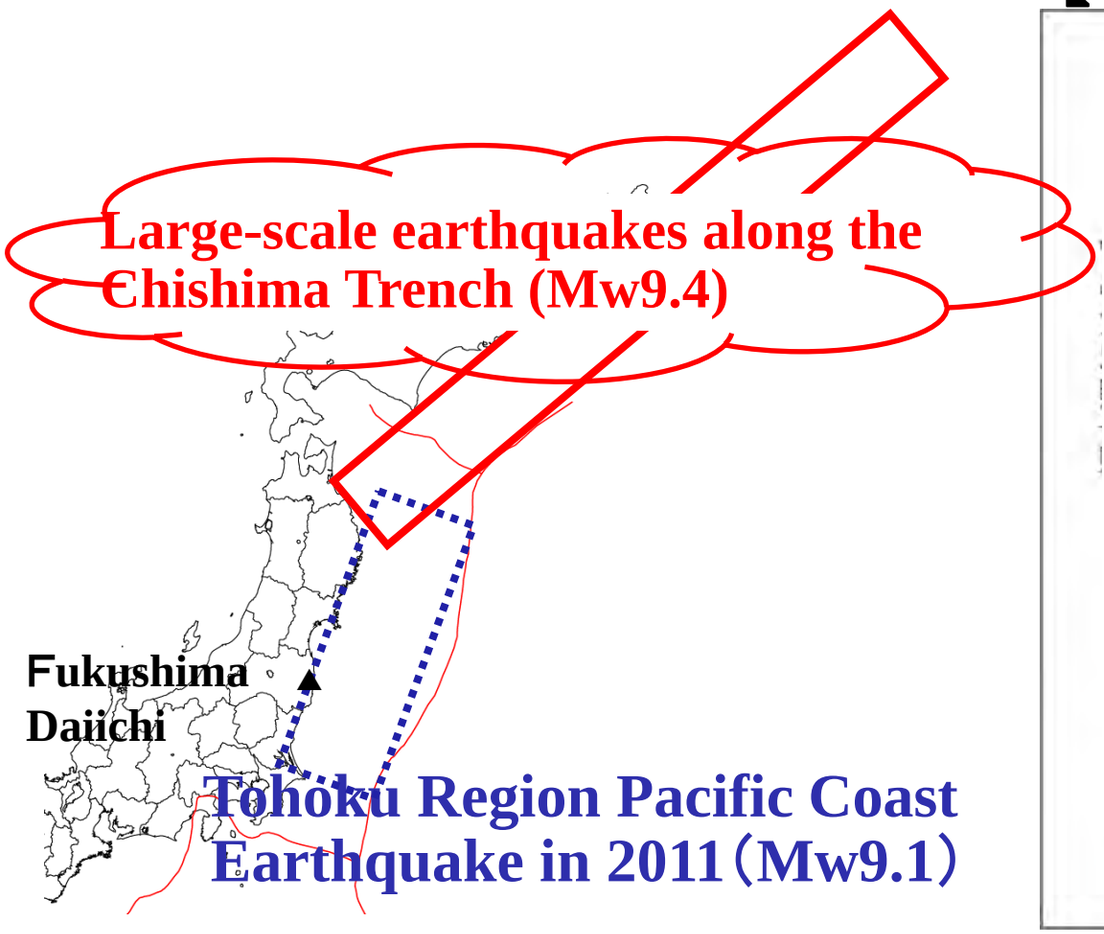
Table. Results of assessment of Tritiated water task force

Method of disposal	(1) geosphere injection	(2) offshore release	(3) vapor release	(4) hydrogen release	(5) underground burial
Image					
Regulatory feasibility	It is necessary to formulate new regulations and standards related to disposal concentration	Feasible (Precedent exists)	Feasible	Feasible	New standards might require to be formulated. (Similar examples exist)
Technical feasibility	Proper stratum is necessary	Feasible (Precedent exists)	Feasible (Precedent exists)	Research and development is necessary for pre-treatment and scale expansion	Feasible

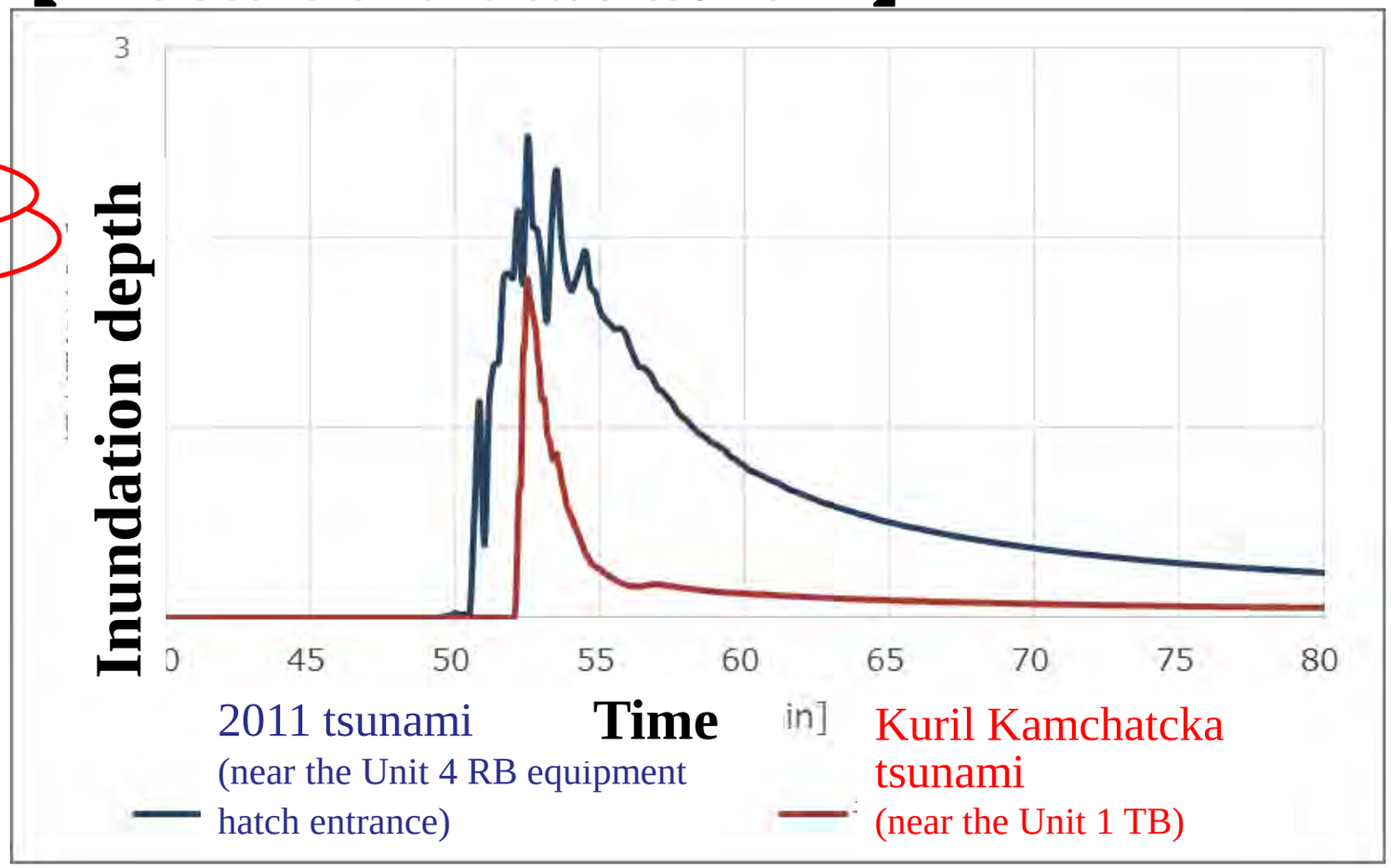
Source: Based on the handout for public hearings held by METI in 2018

Response to New Knowledge regarding a Large-scale Quake along the Chishima Trench (1)

- **A new government study shows that a massive earthquake (similar to what occurred in the 17th century, Mw9 and above) is likely to occur along Chishima Trench off Hokkaido soon.**



【The scale of the two tsunami】



The duration and inundation depth

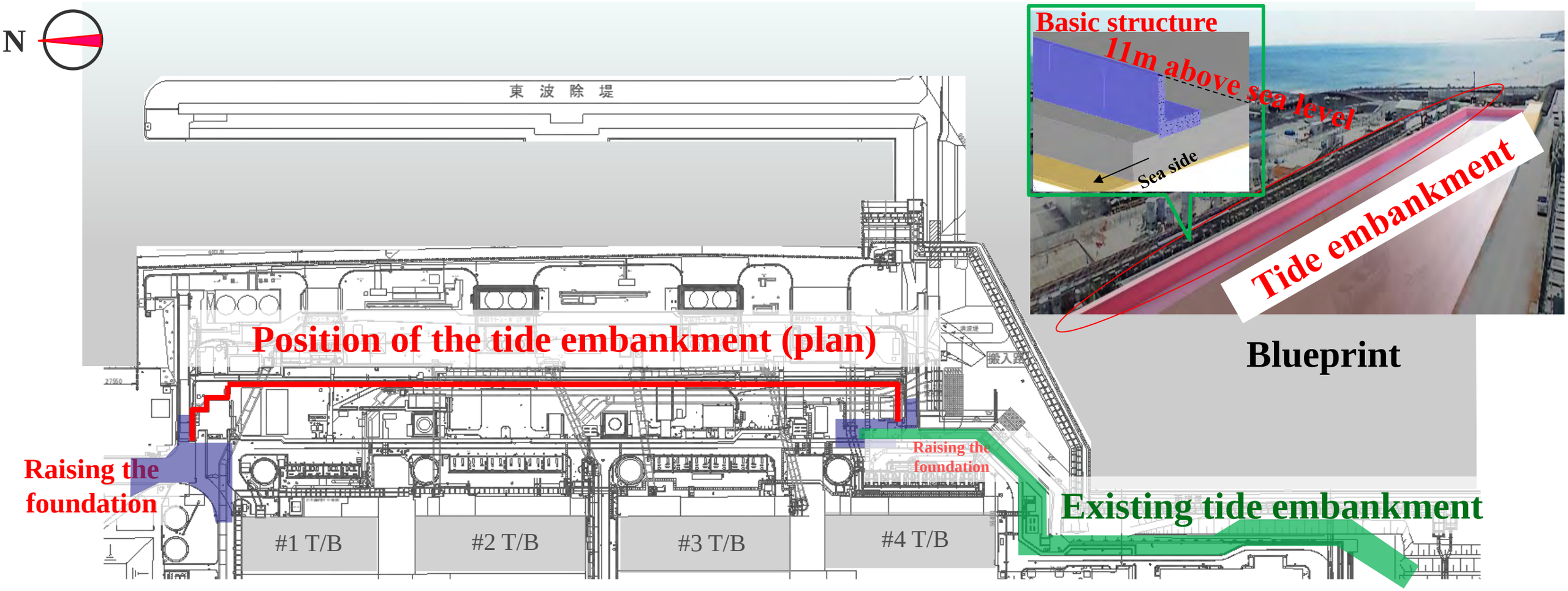
2011 tsunami > Kuril Kamchatka tsunami (expected)

Response to New knowledge regarding a Large-scale Quake along the Chishima Trench (2)

Installment of a tide embankment

①Mitigate the inundation of the ground area, and prevent the outflow of and increase in the contaminated water with the inflow of the tsunami into the buildings.

②Reduce the risk of the decommissioning work becoming delayed by reducing the tsunami damage to the important equipment on the ground area.



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Overview of Fuel Removal from the Spent Fuel Pools

- **After the completion of removal at Unit 4 in December 2014, preparation at Units 1 through 3 is underway**

Units 1 & 2		Unit 3	Unit 4
Removal of rubble & decontamination	Installation of fuel removal facility	Fuel removal	Storage & transportation

Unit 1

- Removal of rubble started (Jan. 2018)

Unit 2

- The opening formed in the front chamber (Jun. 2018)
- Preparatory work on the refueling floor (Since Jul. 2018)

Unit 3

- Installation of the domed roof was completed (Feb. 2018)
- Final stage for starting removal (As of early Apr. 2019)

Toward Fuel Removal from Spent Fuel Pool (Unit 1)

■Removing layers of rubble on the south side is a big challenge.

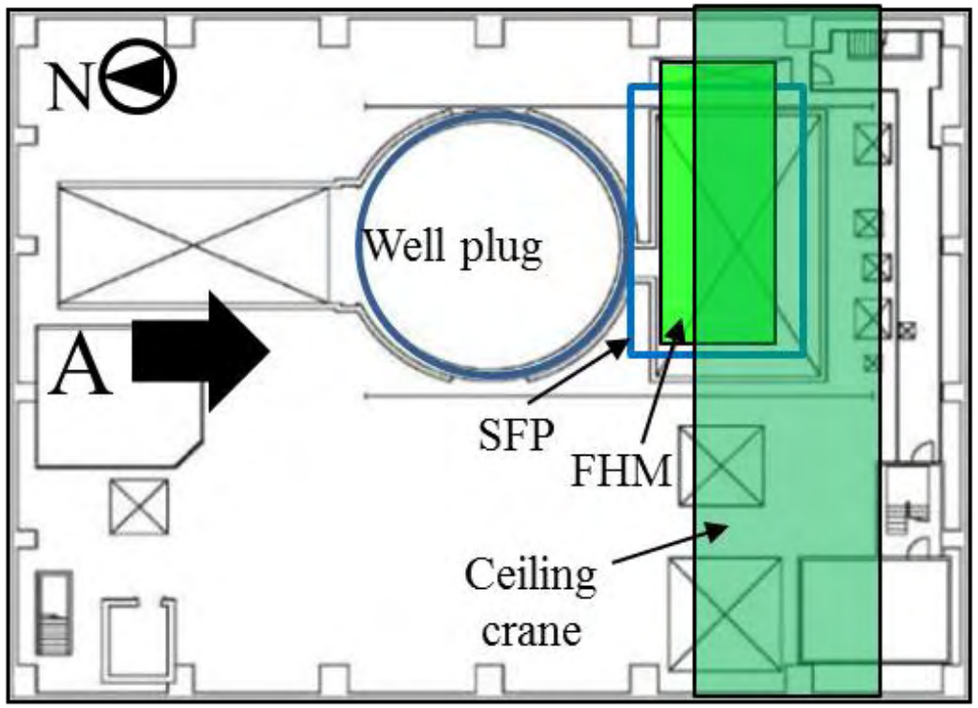


Figure 1 Refueling floor layout plan

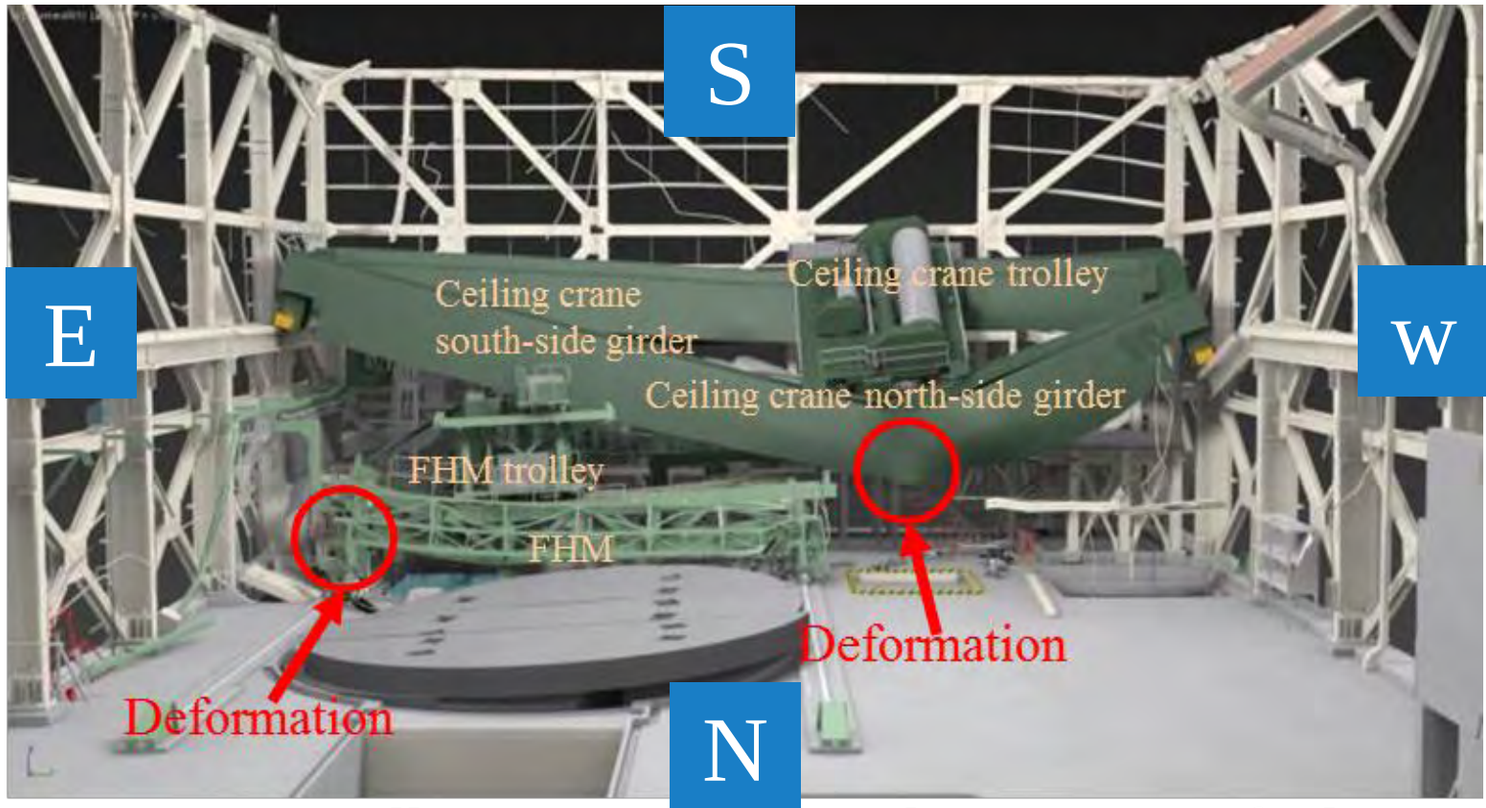
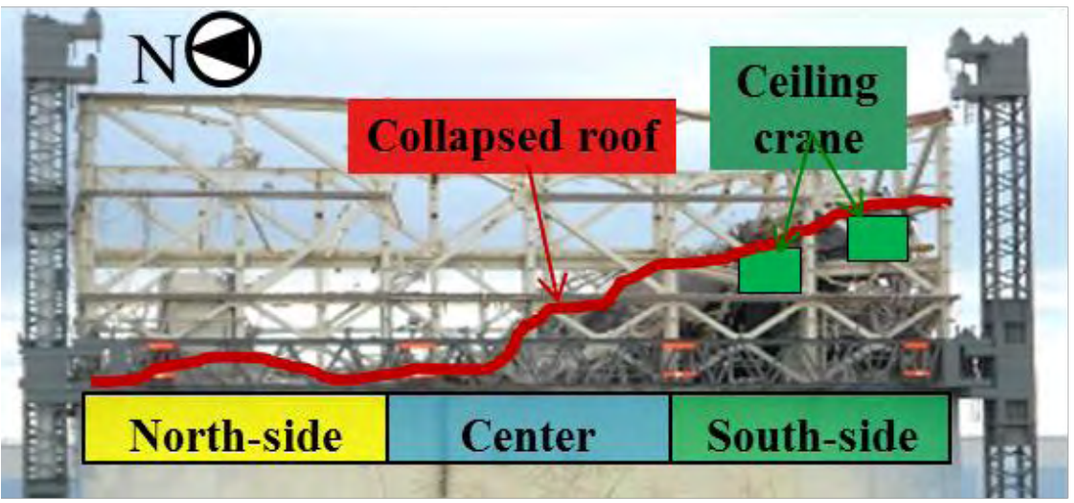


Figure 2 Illustration of the ceiling crane & fuel handling machine (from A)

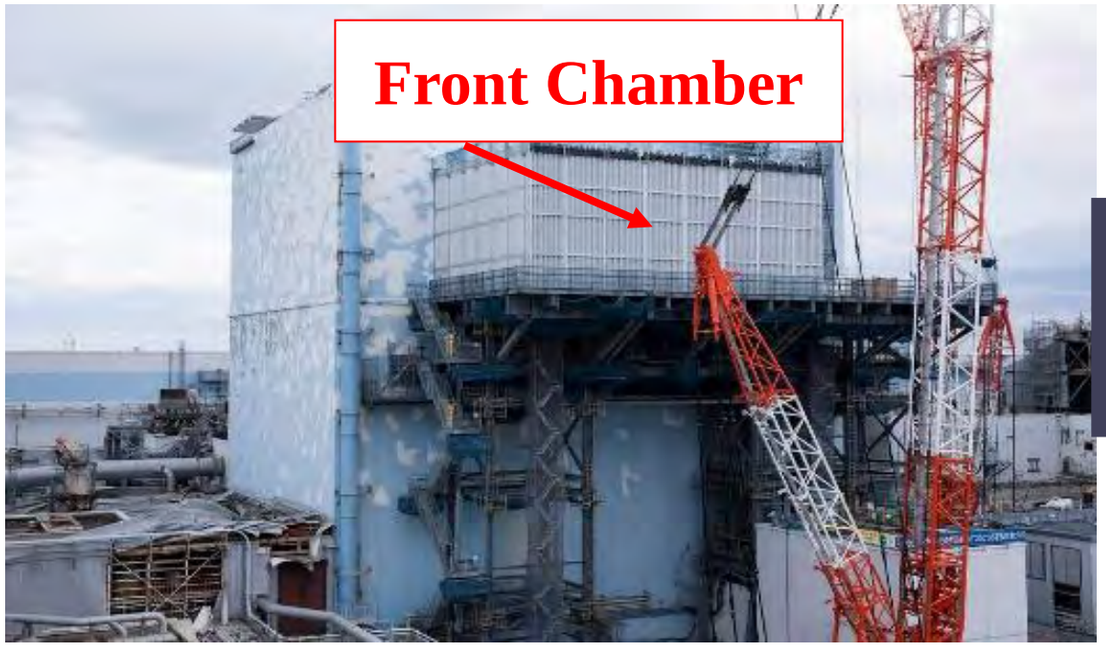


Condition of the collapsed roof

South-side collapsed roof (A)

Toward Fuel Removal from the Spent Fuel Pool (Unit 2)

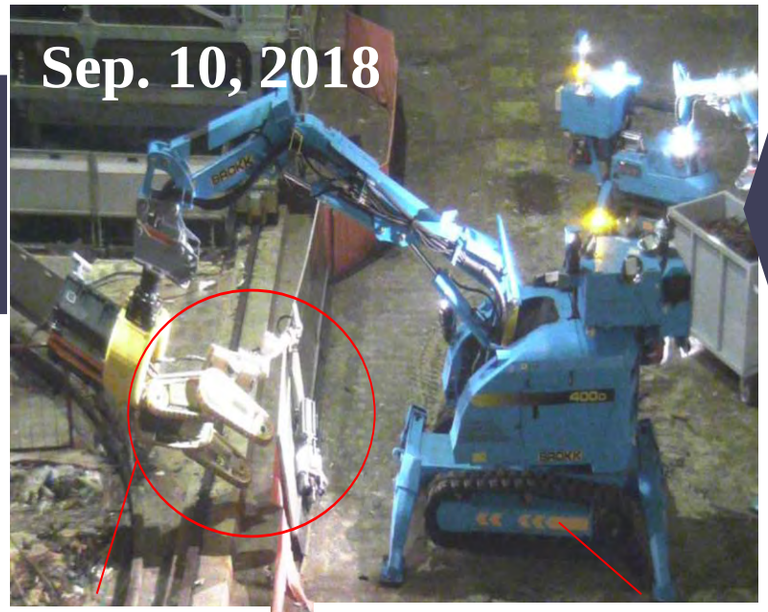
Installation of Front Chamber (2017)



Formation of Opening (Jun. 2018)

Survey on Refueling Floor (Jul. 2018)

Clearing remaining objects (from Aug. to Nov. 2018)



Survey on refueling floor (from Nov. 2018 to Feb. 2019)

Planning for future task

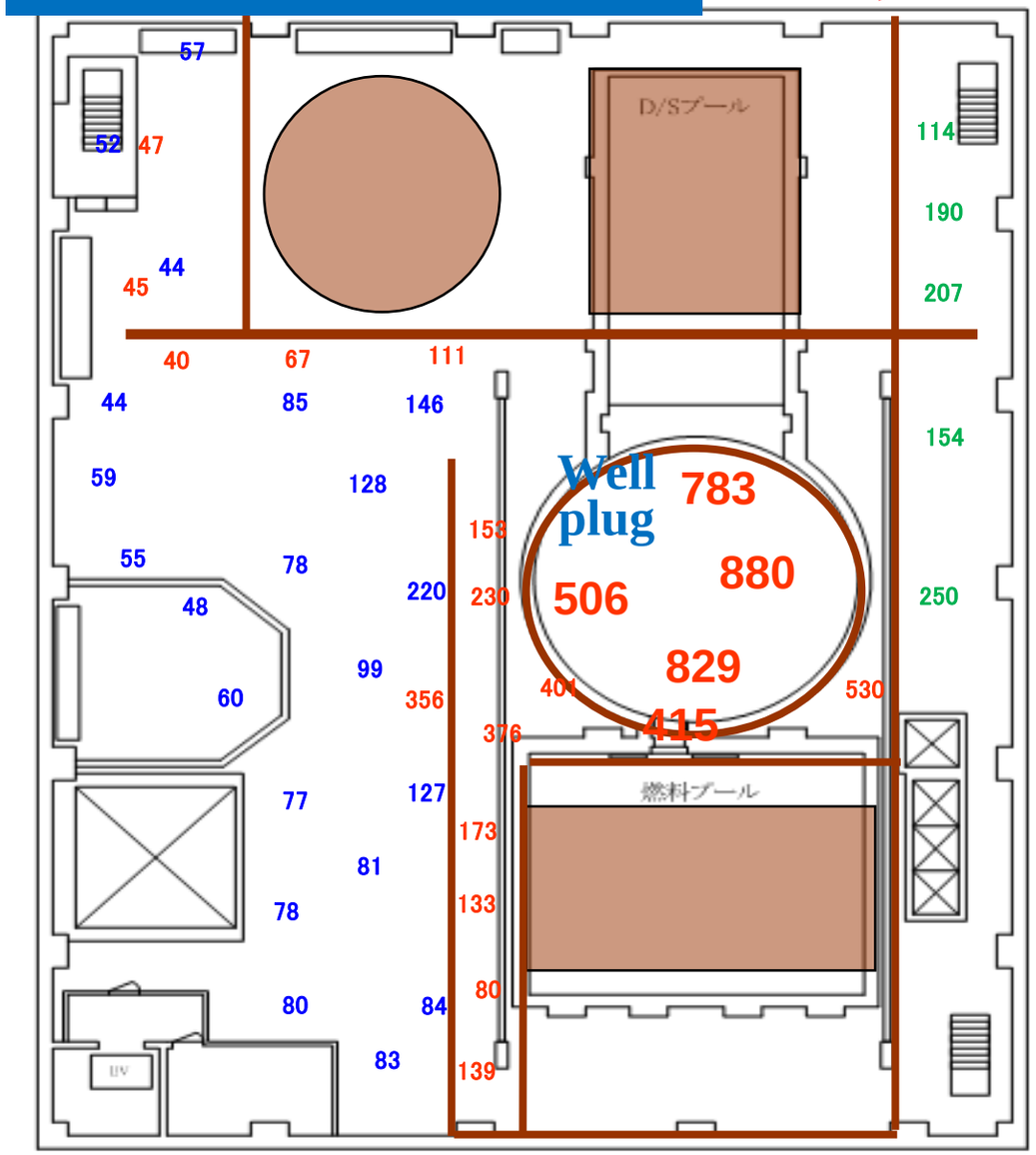
Results of Dose Rate Measurement at Unit 2 Refueling Floor

- **The source of radioactivity is assumed to be the well plug, because the dose rates decrease with increasing distance from the well plug.**
- **The dose rates are much smaller than those in 2011 and 2012.**

＜Previous investigation＞

On the well plug：
About 400～800mSv/h

Nov. 2, 2011 (G)
Feb. 27, 2012 (B)
Jun. 13, 2012 (R)



Measurement height：1.1m

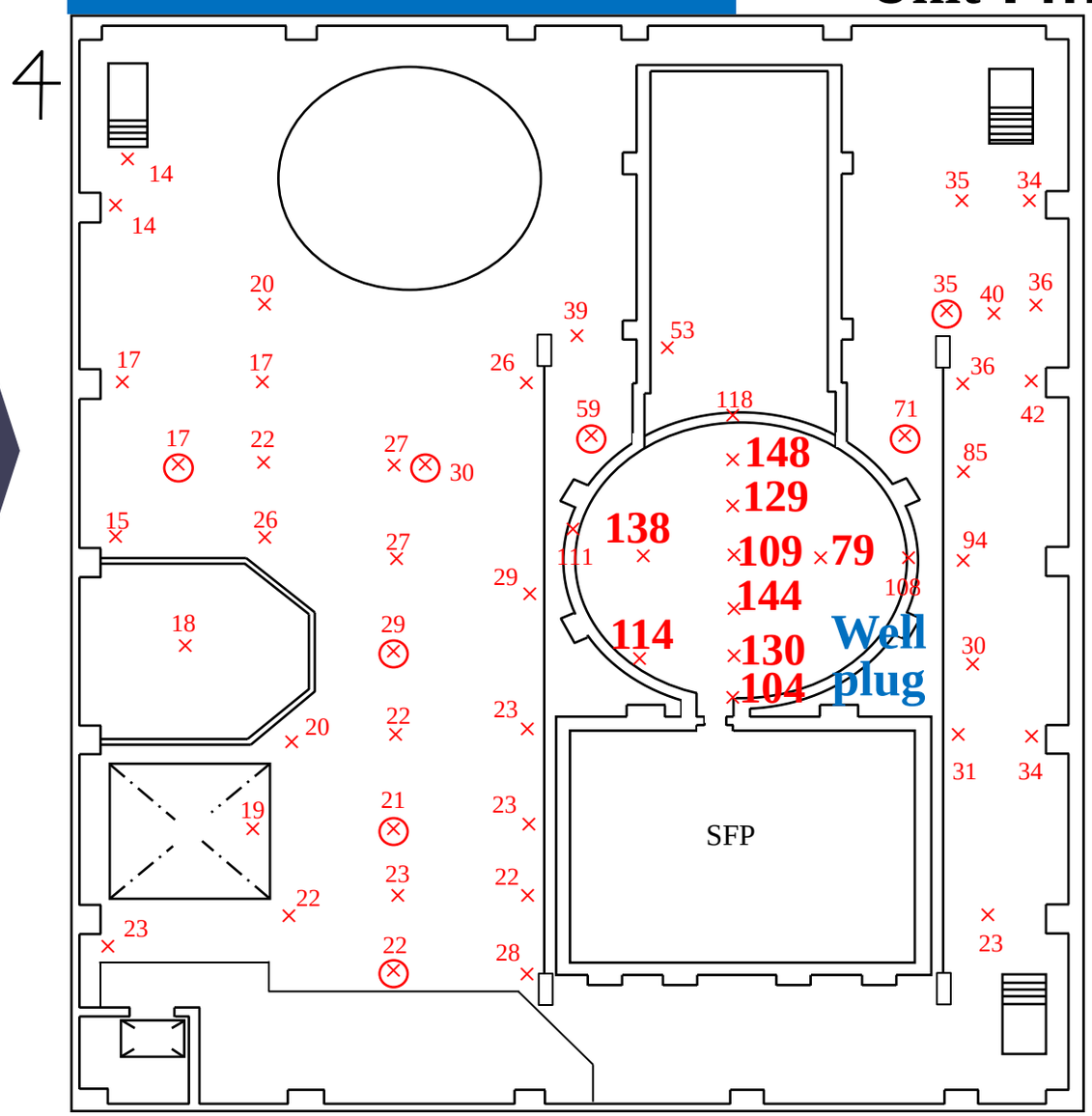
※1cm dose equivalent

＜The latest investigation＞

On the well plug：
About 100～150mSv/h

From Nov. to Dec. 2018 (R)

Unit：mSv/h

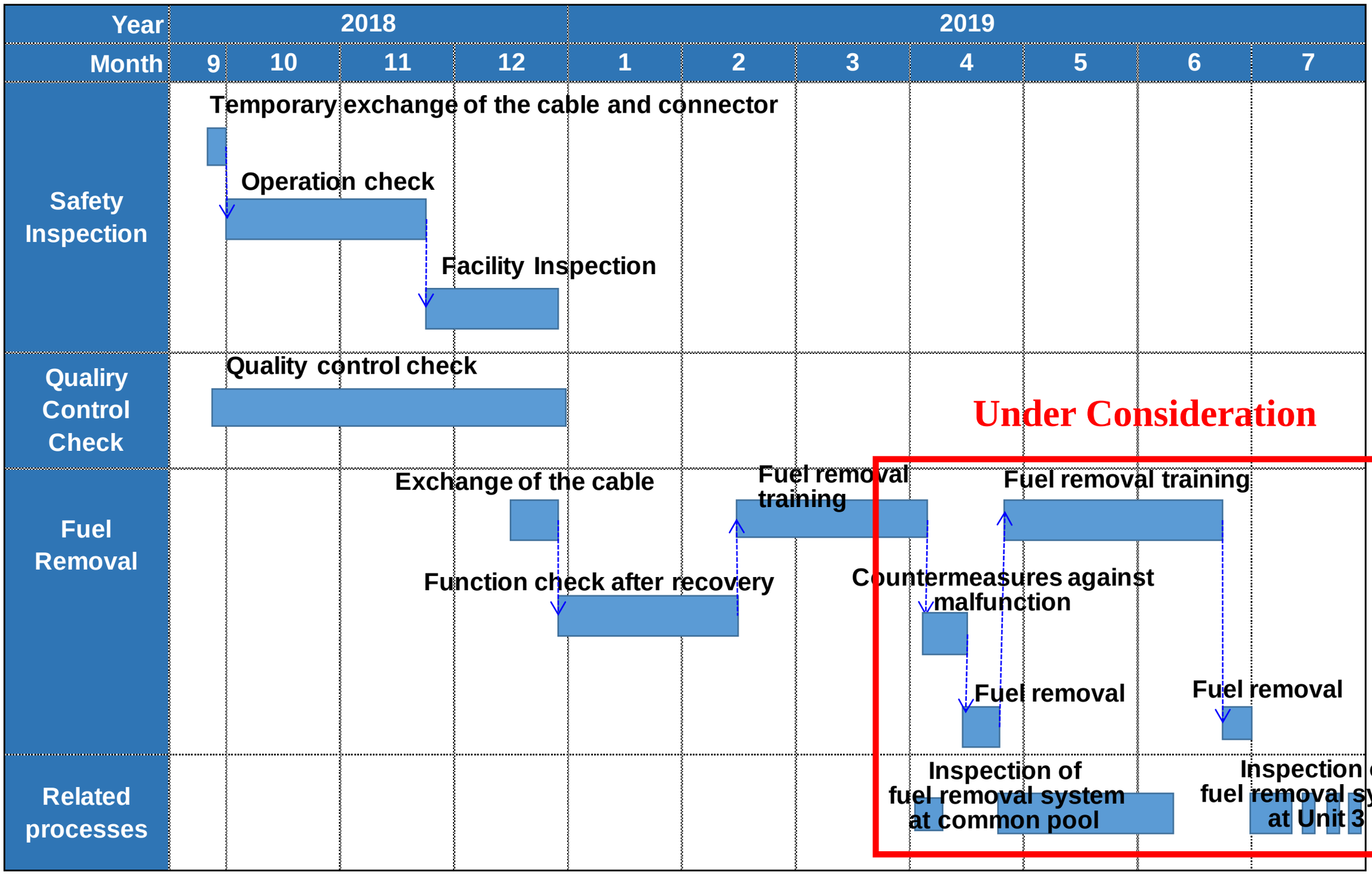


Measurement height：1.5m

※1cm dose equivalent

Fuel Removal at Unit 3

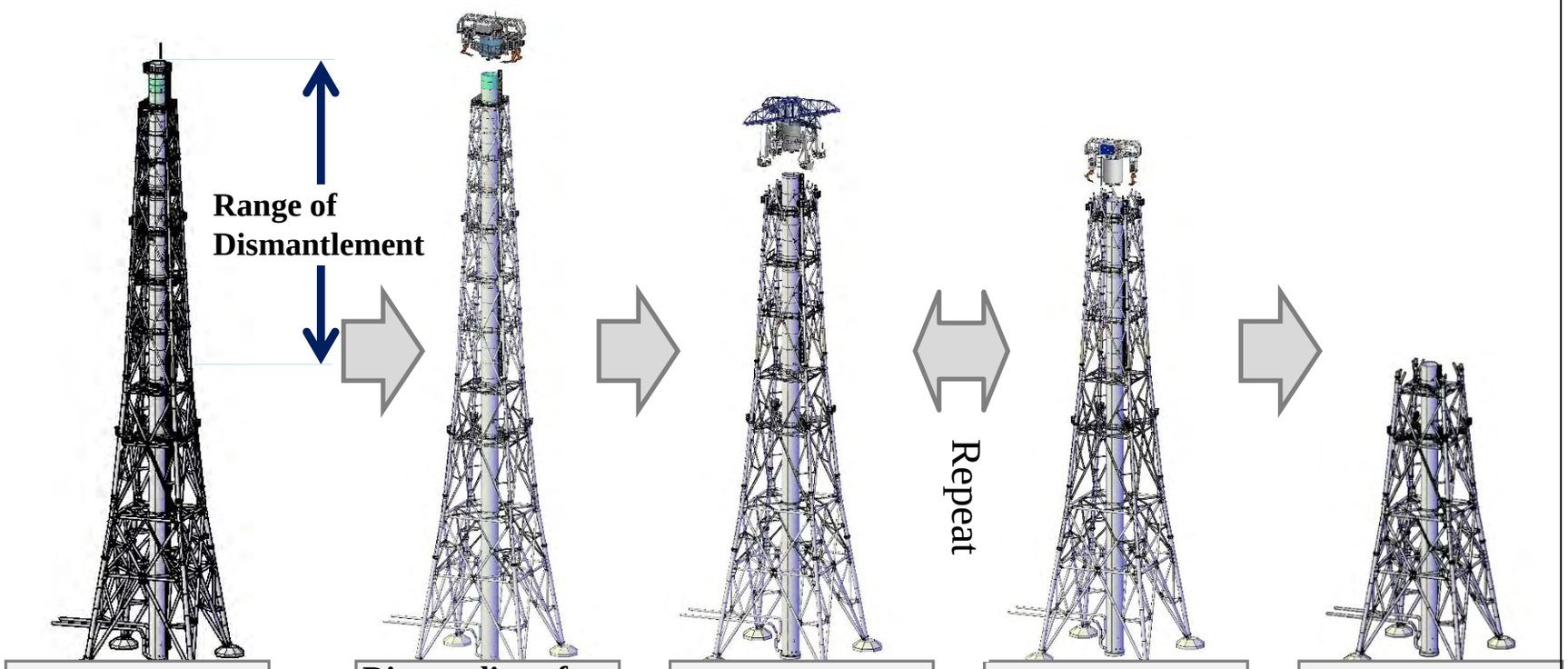
- **The fuel removal is starting within this April.**
- **We aim to finish the work within FY2020 following the revised roadmap.**



Dismantlement of the Exhaust Stack of Units 1 and 2

- **The upper part of the exhaust stack of Units 1 and 2 to be dismantled prior to the fuel removal at Units 1 and 2 for further risk reduction.**
- **The dismantlement is starting in mid May and will be completed in the third quarter.**

Plan for the dismantlement



Preparation
- Installation of crane
- Installation of dismantling equipment

Dismantling of cylinder
- Steps to prevent scattering
- Cylinder grip
- Cylinder Cutting
- Lowering

Dismantling of steel tower
- Steel tower grip
- Steel tower cutting
- Lowering

Dismantling of cylinder
- Steps to prevent scattering
- Cylinder grip
- Cylinder Cutting
- Lowering

Dismantling complete
- Installation of lid on the top part

Mock-up test

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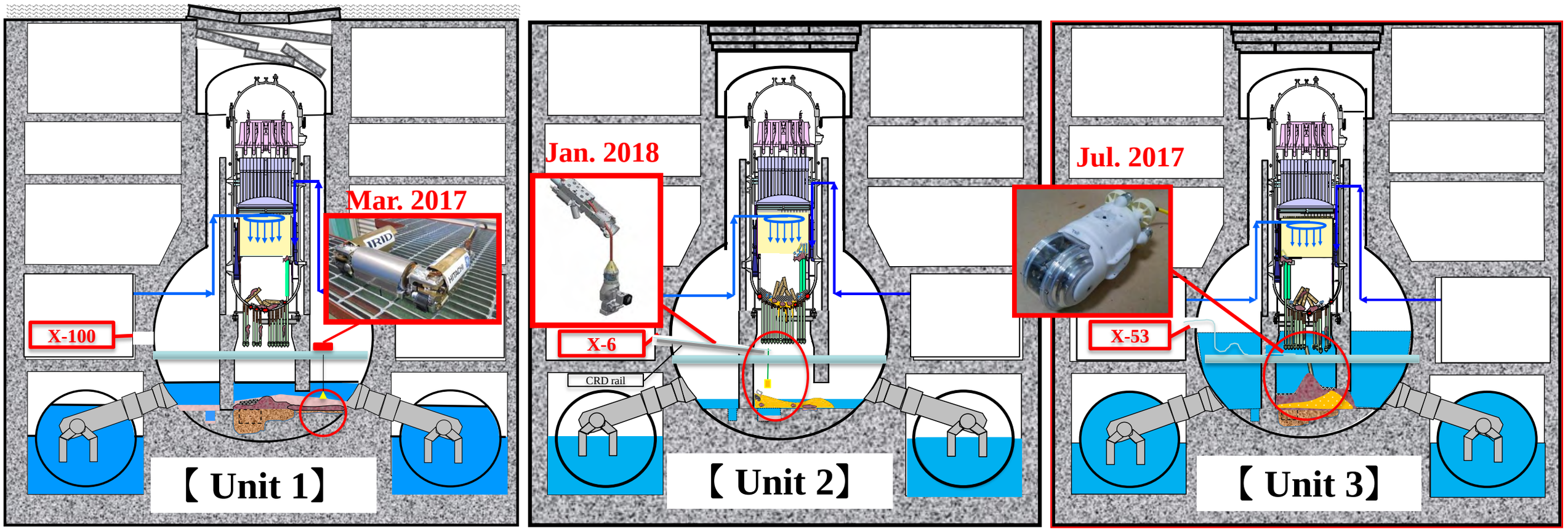
Assumed Distribution of Fuel Debris

- **Investigations suggest that almost all of the fuel in Unit 1 melted and dropped to the bottom of the PCV and most of it is no longer in the reactor's core.**
- **As for Unit 2, it is assumed that some of the molten fuel dropped to the bottom of the RPV or to the lower portion of the PCV, while some still remain within the core.**
- **As for Unit 3, it is thought that most of the molten fuel dropped to the bottom of the PCV, but some is also present at the bottom of the RPV.**



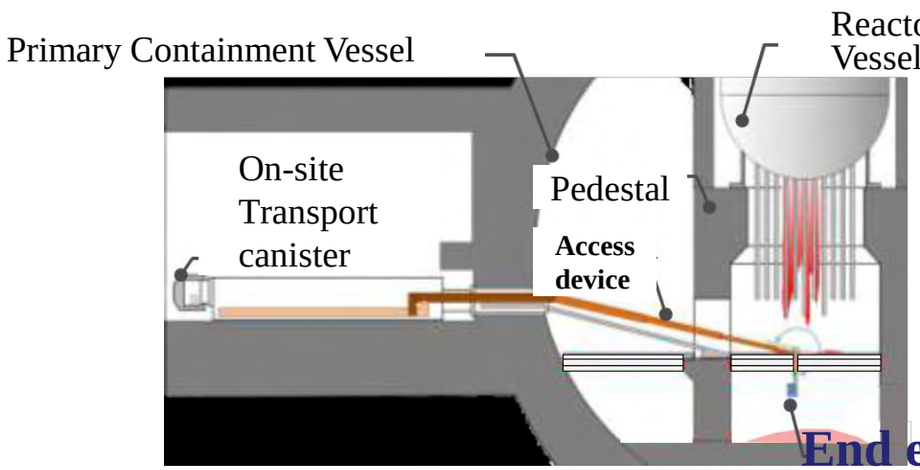
※Periods shown above indicate when the internal investigation took place between 2017 and 2018 (photos：courtesy of IRID)

Toward Fuel Debris Retrieval

- **In the Mid-and-Long-Term Roadmap revised by the government in September 2017, "Policy on fuel debris retrieval" was determined.**
  - **Approach focused on partial submersion method, Prioritizing fuel debris retrieval by access to the bottom of the PCV from the side**
  - **Step-by-step approach**
- **In the near future, investigation inside the PCVs (including small amount sampling) will be continued.**

Environmental Arrangement → **Internal investigation・Small amount sampling** → **Fuel debris retrieval**

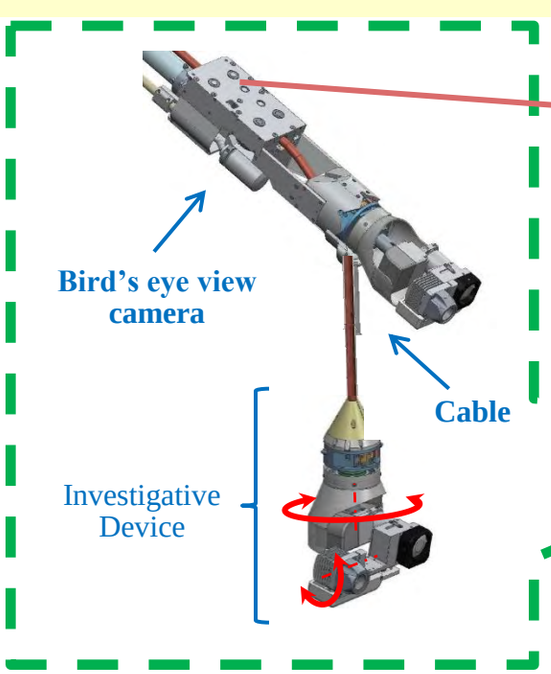
Even though we prioritize access to the bottom of the PCVs, we will consider implementing "top entry method" as well, taking into account that fuel debris is assumed to exist both at the bottom of the PCVs and inside the RPVs.



Conceptual diagram of fuel debris retrieval by access to the bottom of the PCV from the side (small scale retrieval)

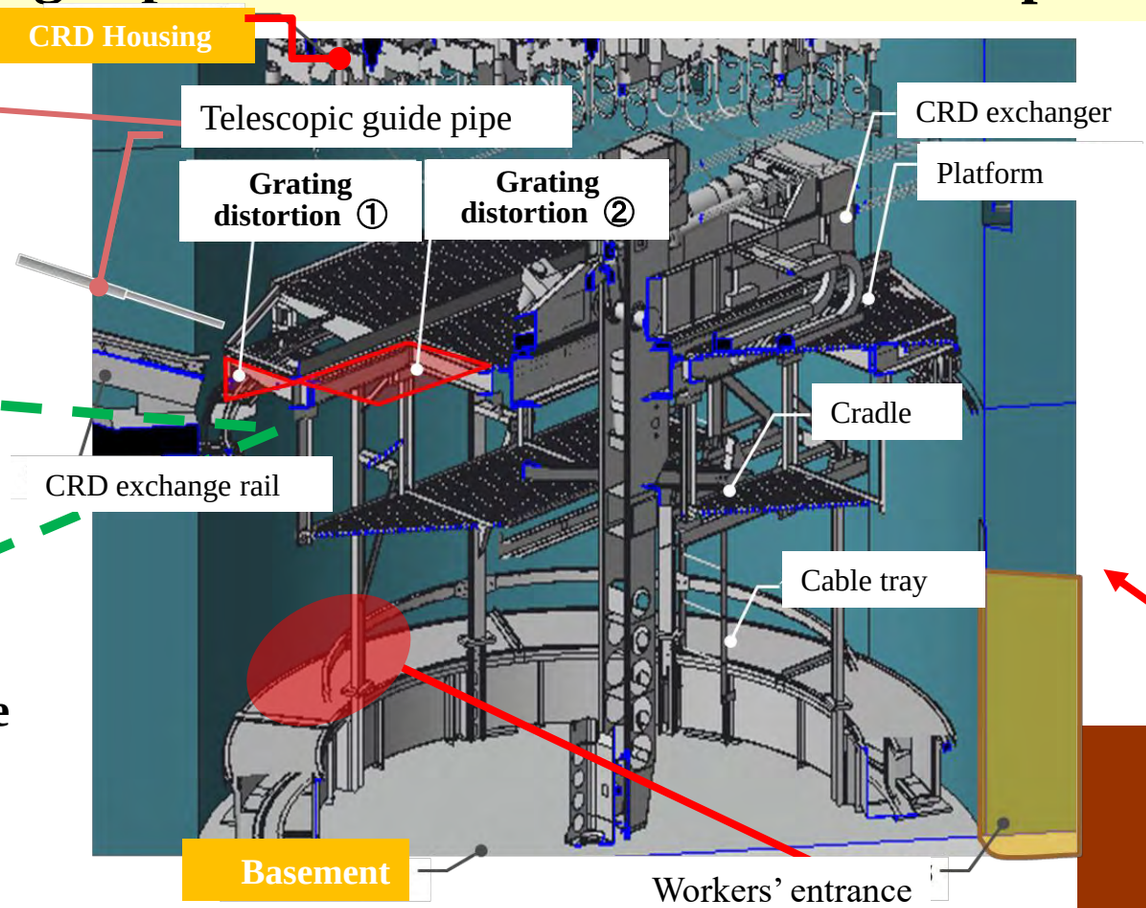
Internal Investigation of Unit 2 PCV (Jan. 2018)

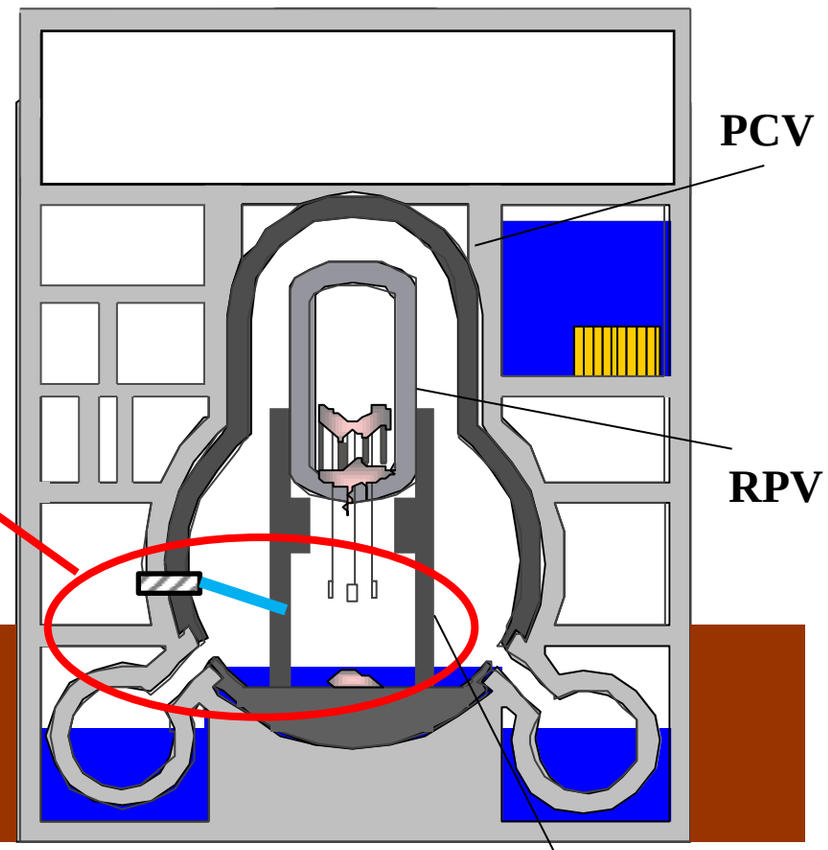
- **An investigative device was lowered through distortion of the grating to the bottom of the PCV inside the pedestal.**
- **Deposits thought to include fuel debris were found. In addition, multiple parts higher than the surrounding deposits were also detected. →Multiple routes of fuel debris falling**



Overview of the investigative device

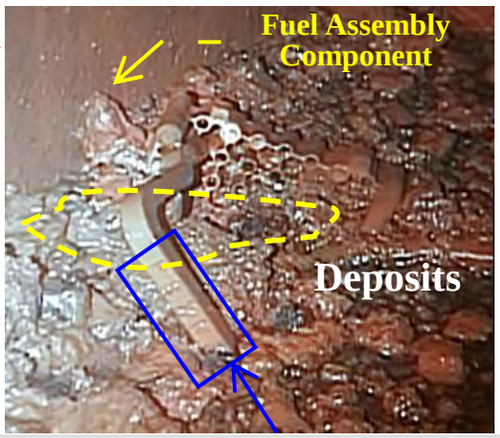
SOURCE: IRID





CRD Housing
(above the grating distortion)

Basement



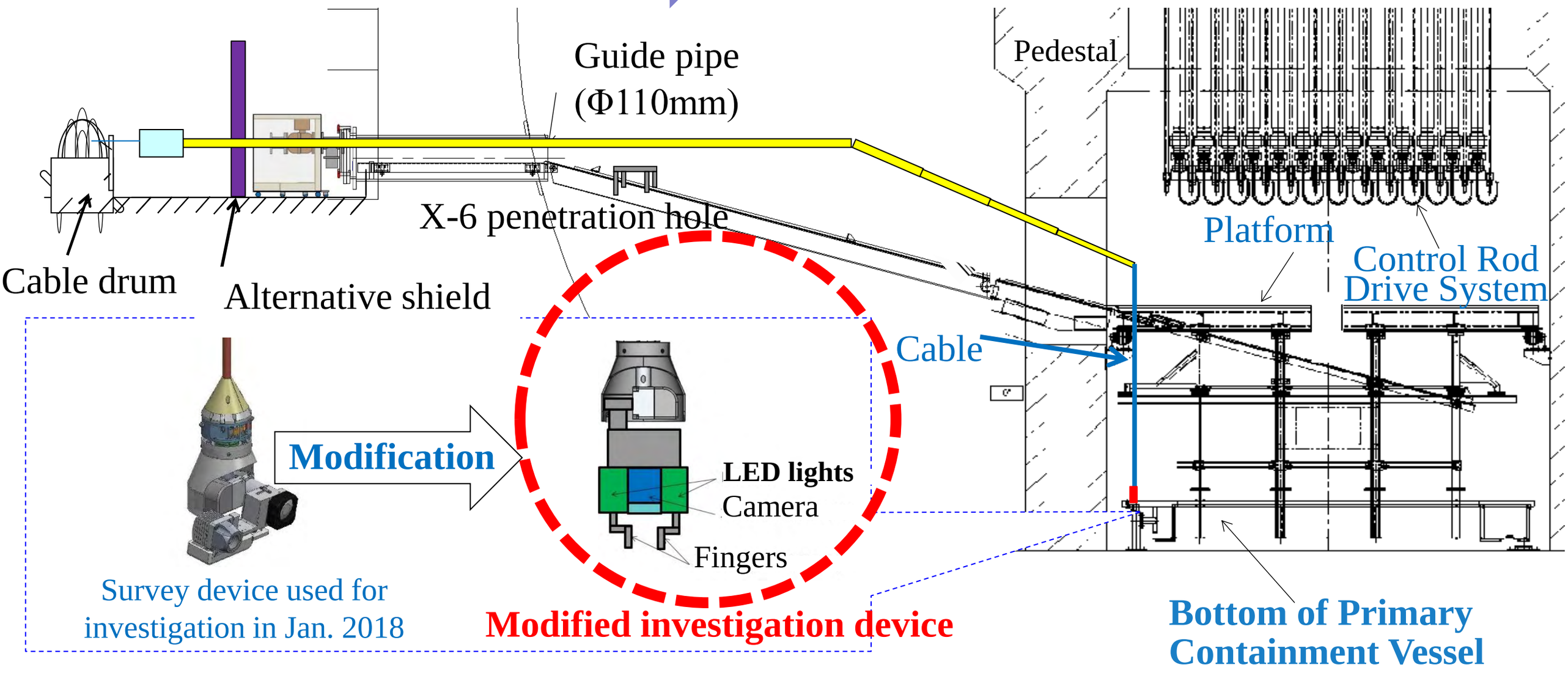
Source:IRID

Investigation of Unit 2 PCV Using a Modified Guide Pipe (Feb. 2019)

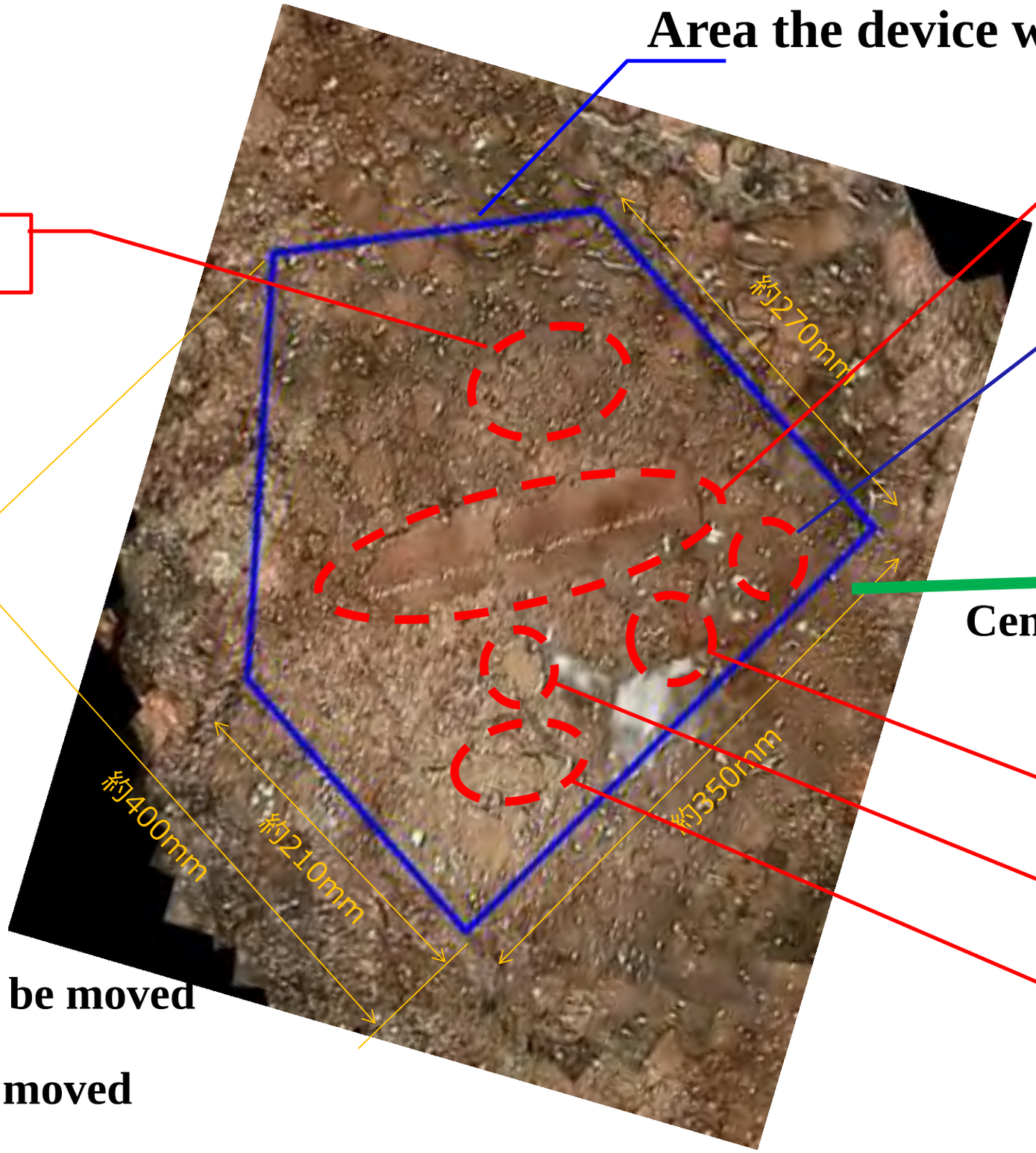
- **In order to understand the mobility of deposits found at the bottom of the pedestal, a new guide pipe modified from the existing one was used.**
- **We found that five out of six investigated locations have deposits that can be moved.**

Primary Containment Vessel in the reactor bldg.

inside



The touched places at the bottom of Unit 2 (Feb. 2019)

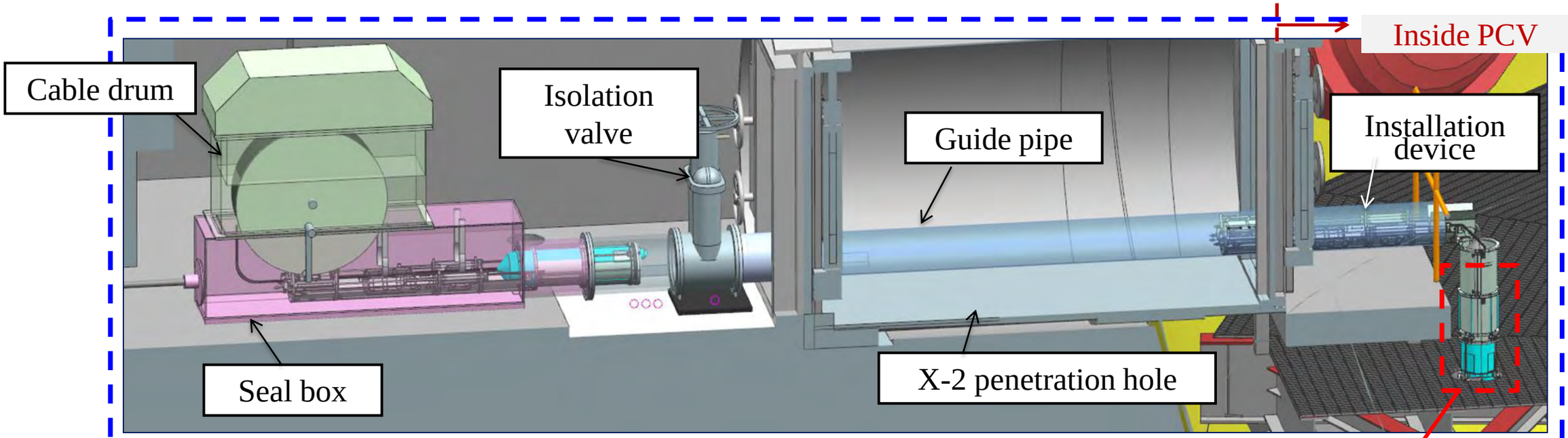


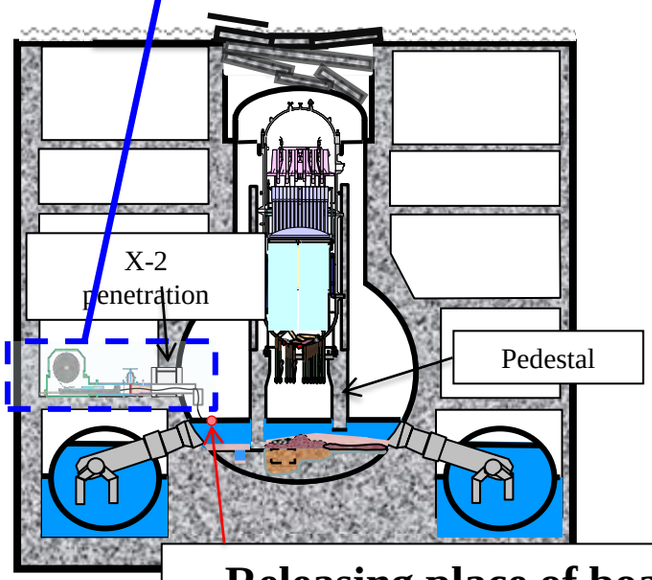
: Cannot be moved

: Can be moved

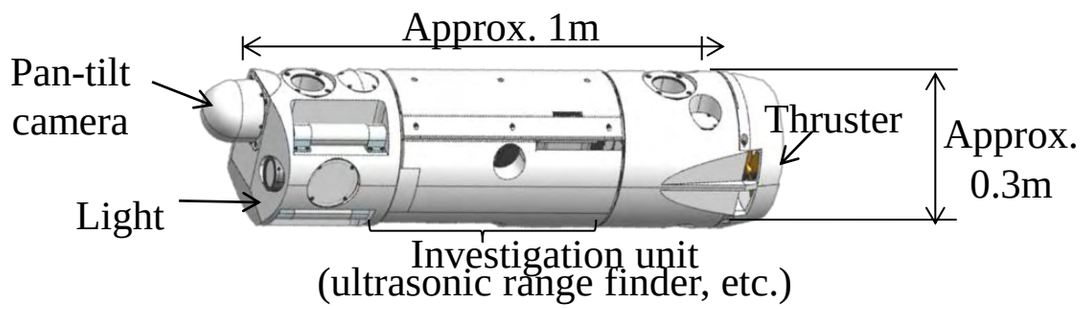
Internal investigation at Unit 1（the first half of FY2019）

- We aim to understand the distribution of deposits outside the pedestal.
- As the deposits lie underwater, a boat-type investigation device is being developed. X-2 penetration hole will be used as a access route.
- Small amount sampling of the deposits is also planned.





Releasing place of boat-type access and investigation device

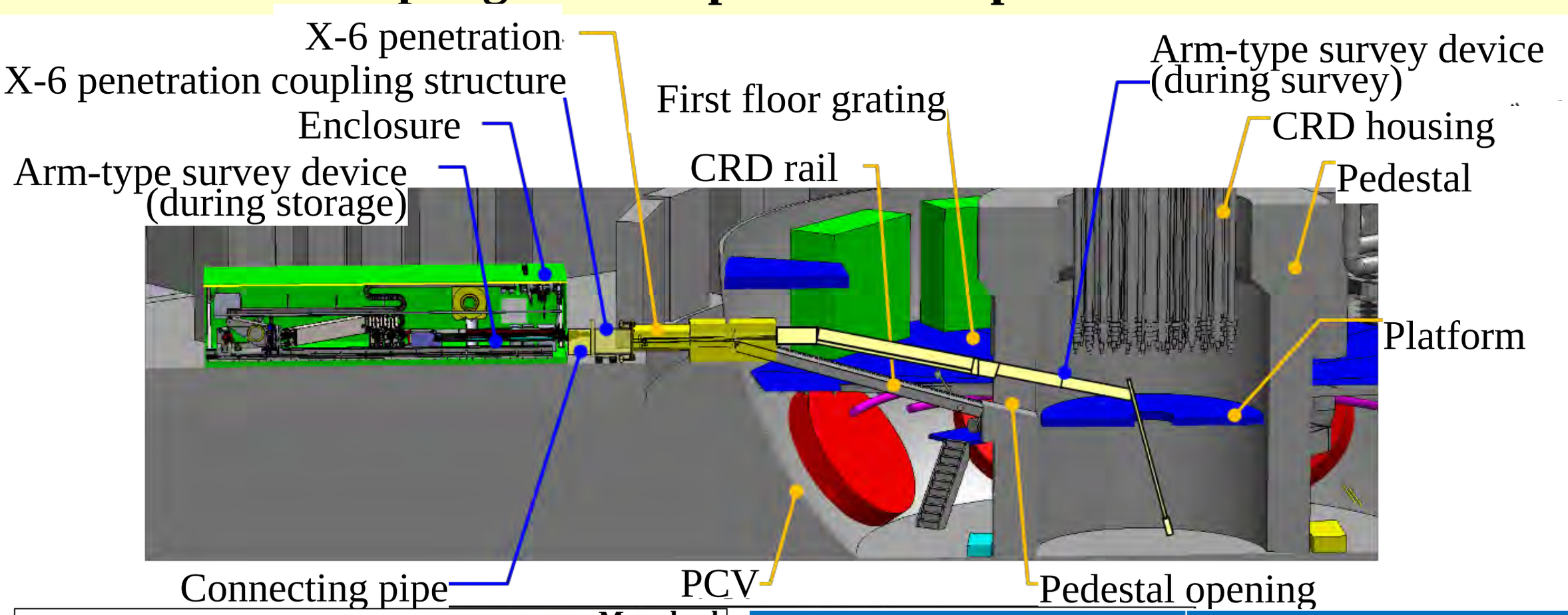


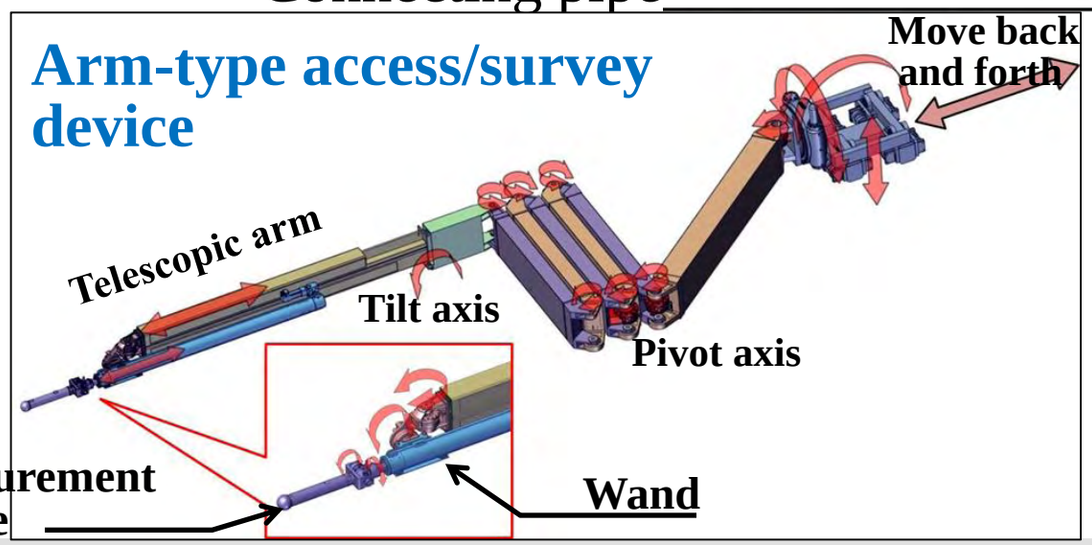
Boat-type investigation device

Courtesy of IRID

Internal investigation at Unit 2 (the second half of FY2019)

- **An arm-type survey device is being developed to understand the distribution of deposits inside the pedestal.**
- **Small amount sampling of the deposits is also planned.**





Investigation Item	Measuring equipment to be mounted
Detailed visual investigation	Pan-tilt camera
3D rendering	Airborne laser scanning equipment
Dose rate	Gamma camera

1. Current Status of Fukushima Daiichi NPS
2. Improving Work Environment
3. Contaminated Water Management
4. Fuel Removal from Spent Fuel Pools
5. Toward Fuel Debris Retrieval
6. Two-way Communications

Two-way Communications with Local Residents

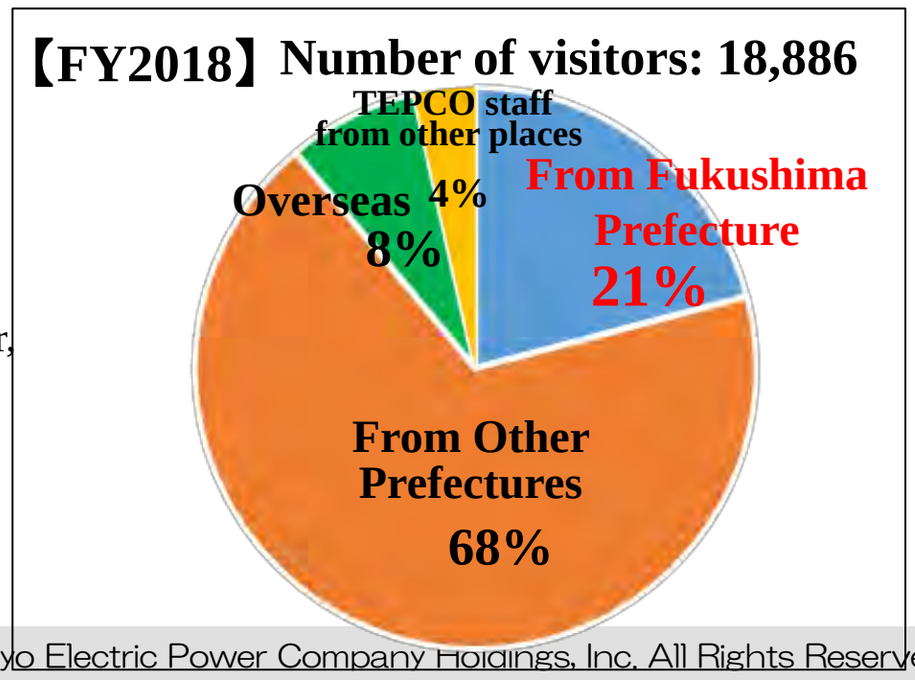
Explanation at public meeting

- Status Updates regarding decommissioning are given to the public at the regular public meetings hosted by Fukushima Prefecture.
- Opinions to TEPCO have been reflected to decommissioning measures.

Center left : Ohkura, Representative of the Fukushima Revitalization Headquarters
Center right：Ono, Chief Decommissioning Officer, President of Fukushima Daiichi Decontamination and Decommissioning Engineering Company

Invitation to Site Tours

- Aims to increase the total number of site tours to 20,000/y by Tokyo Olympics.
- Examples of comments received
  - "I was able to understand the on-site environment has greatly improved"
  - "I want TEPCO to continue this activity which helps to dispel harmful rumors"
  - "I was surprised to learn that the decommissioning work has steadily progressed."



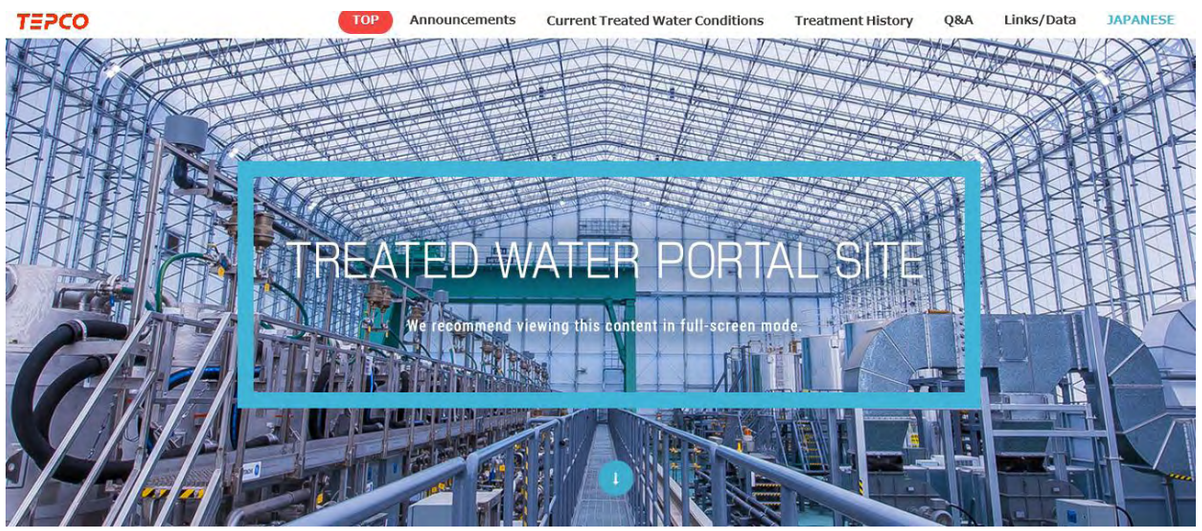
Attendance at 3rd Decommissioning Forum (Aug. 2018)

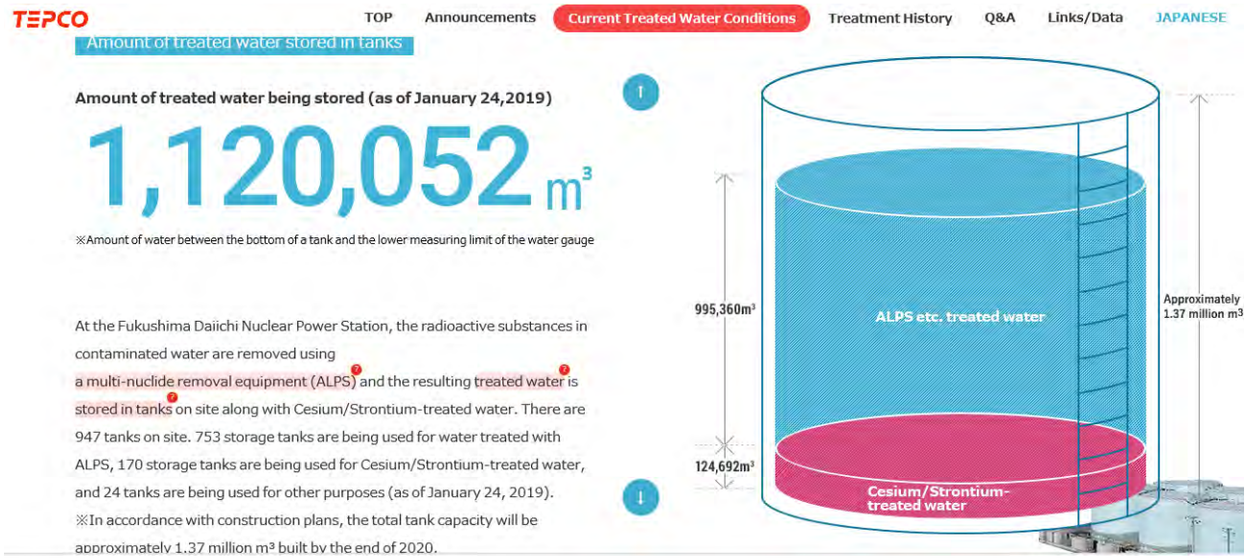
- Providing answers to what the local residents want to know about decommissioning of Fukushima Daiichi.
- The challenges of information sharing on Fukushima Daiichi and how the decommissioning work can help reconstruct the local community were discussed
- The importance of dialogue was recognized.

【Held in Naraha Town, Fukushima Prefecture by NDF】

Information Sharing through Contents on TEPCO's Website

"TREATED WATER PORTAL SITE"





Please use this QR code

http://www.tepco.co.jp/decommission/progress/watertreatment/

INSIDE Fukushima Daiichi [Virtual touring of the site]

Please use this QR code

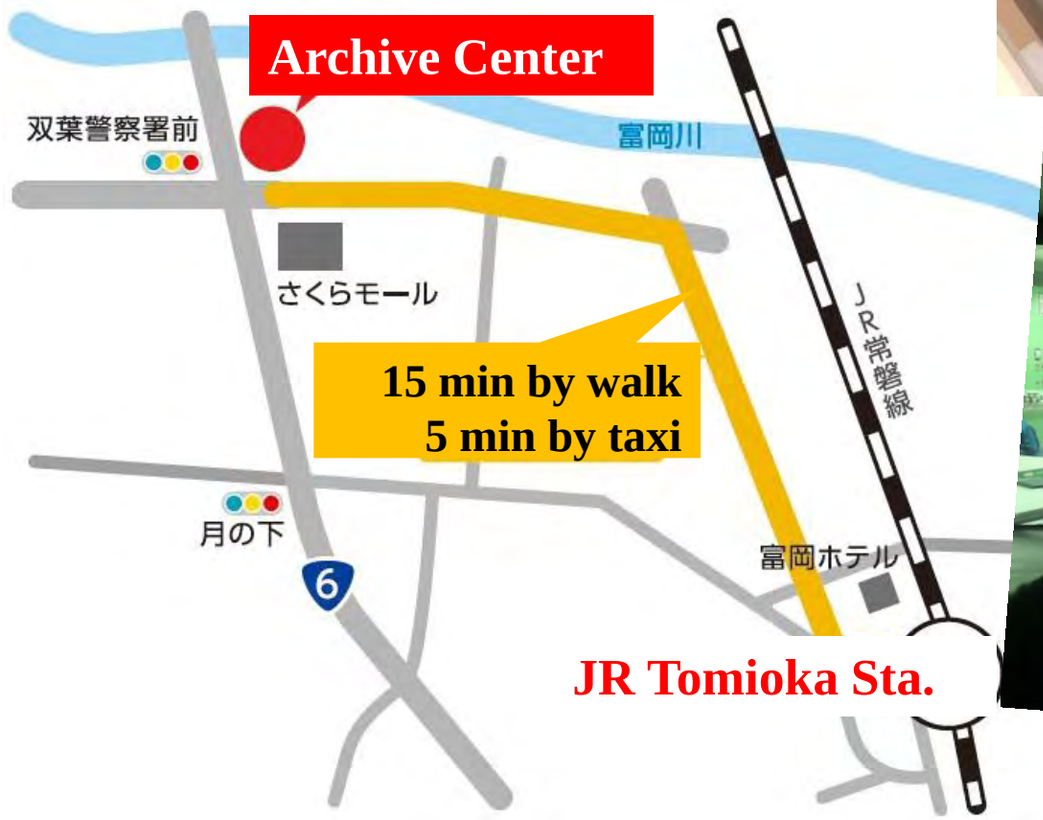
http://www.tepco.co.jp/en/insidefukushimadaiichi/index-e.h

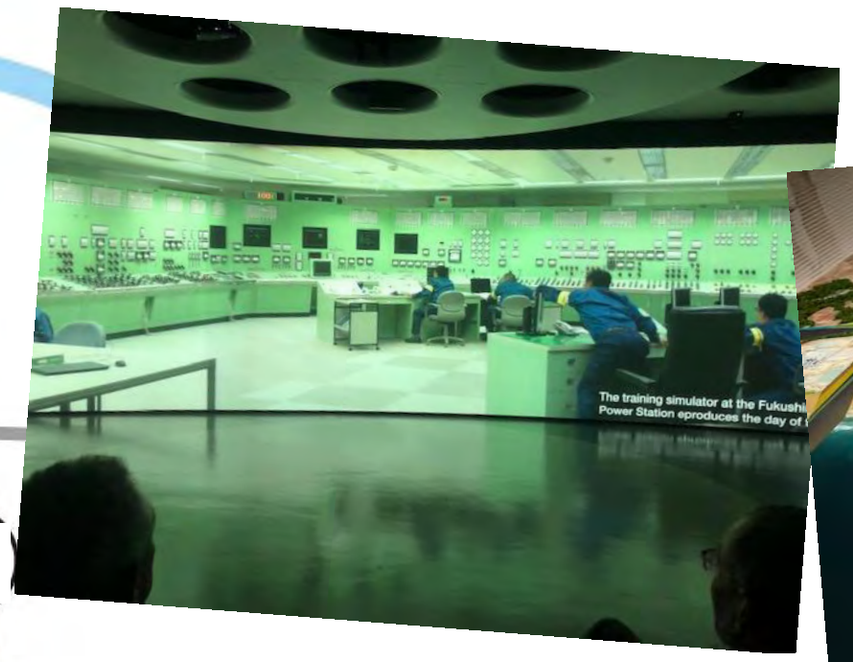
"The current situation at Fukushima Daiichi NPS" -From 3.11 toward the future-

Please use this QR code

http://www.tepco.co.jp/en/news/library/archive-e.html?video_uuid=r0viqse1&catid=61795&fbclid=IwAR1KVTt6RCPFTqa3pZ3J6IONS-9IPyr__w_PtjODGi0h__lIv48Bncvy6M

Archive Center Opened in Tomioka Town（Nov. 2018)





To the Next Stage

Long-term decommissioning work with safety, steadiness and swiftness

Current Status

Engaged in the work looking to the future in a planned manner

Engaged in an emergency crisis mode to reduce the short-term high risk

- **Contaminated Water Management**
- **Radioactivity Reduction**

Thank you for your kind attention