The 5th International Forum on the
Decommissioning of
the Fukushima Daiichi Nuclear Power Station

Issues at the TEPCO's Fukushima Daiichi NPS

from the Nuclear Regulator's Perspective

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1. Major Risk Issues

Countermeasures for Risks which would have an effect on the human and the environment

〇Treatment of Stagnant Water in Reactor Buildings etc.

〇Removal and Stabilization of Zeolite Sandbags in basement floors of Process Main Building etc.

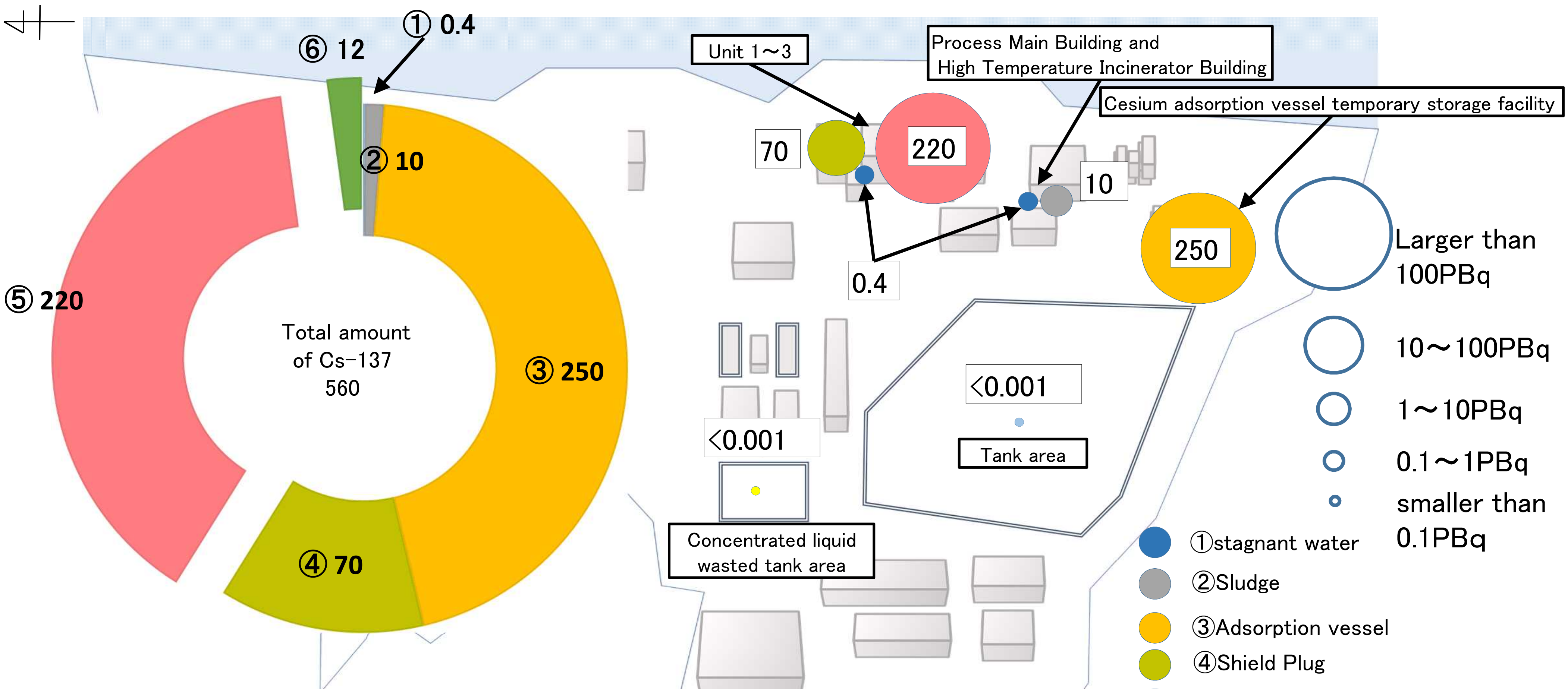
〇Transfer and Stabilization of Sludge from Decontamination Equipment

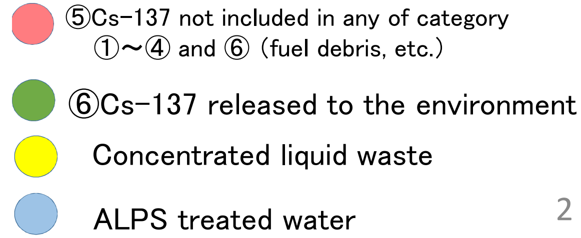
〇Measures to prevent structures from collapsing or being damaged by earthquake, tsunami, etc.

〇Countermeasures for other risks which should pay attention to（Risks which effect on offsite are smaller than the above）
- Stabilization of ALPS slurry
- Stable storage of spent cesium adsorption vessel
- Removal of fuels from SFPs of Unit 1 and 2

1. Major Risk Issues

Location of radioactive materials (Mainly Cs-137) (spent fuels not included)
(unit ; PBq) ＊ : listed up in the ascending order of stability





- Reduction of radioactivity is taken into account assuming that the radiation reduced for 10 years (11th March 2021) from the accident
- Total amount of Cs-137 is estimated using「JAEA-DATA／Code2012-018」considering reduction
- Amount of Cs-137 released to the environment is estimated, referring to「Additional report of the Japanese government to IAEA－about the TEPCO Fukushima Daiichi Nuclear Power Station accident －(the second report)」and considering reduction
- This material shows the location of Cs-137 except for spent fuels. However, besides Cs-137, 36 PBq of Sr-90 (in process main building and concentrated liquid waste tank area)、0.69 PBq of H-3 (in tank area) exist.
- Since fraction is rounded up or down, sum of ①～⑥ doesn't match the total amount.

1. Major Risk Issues

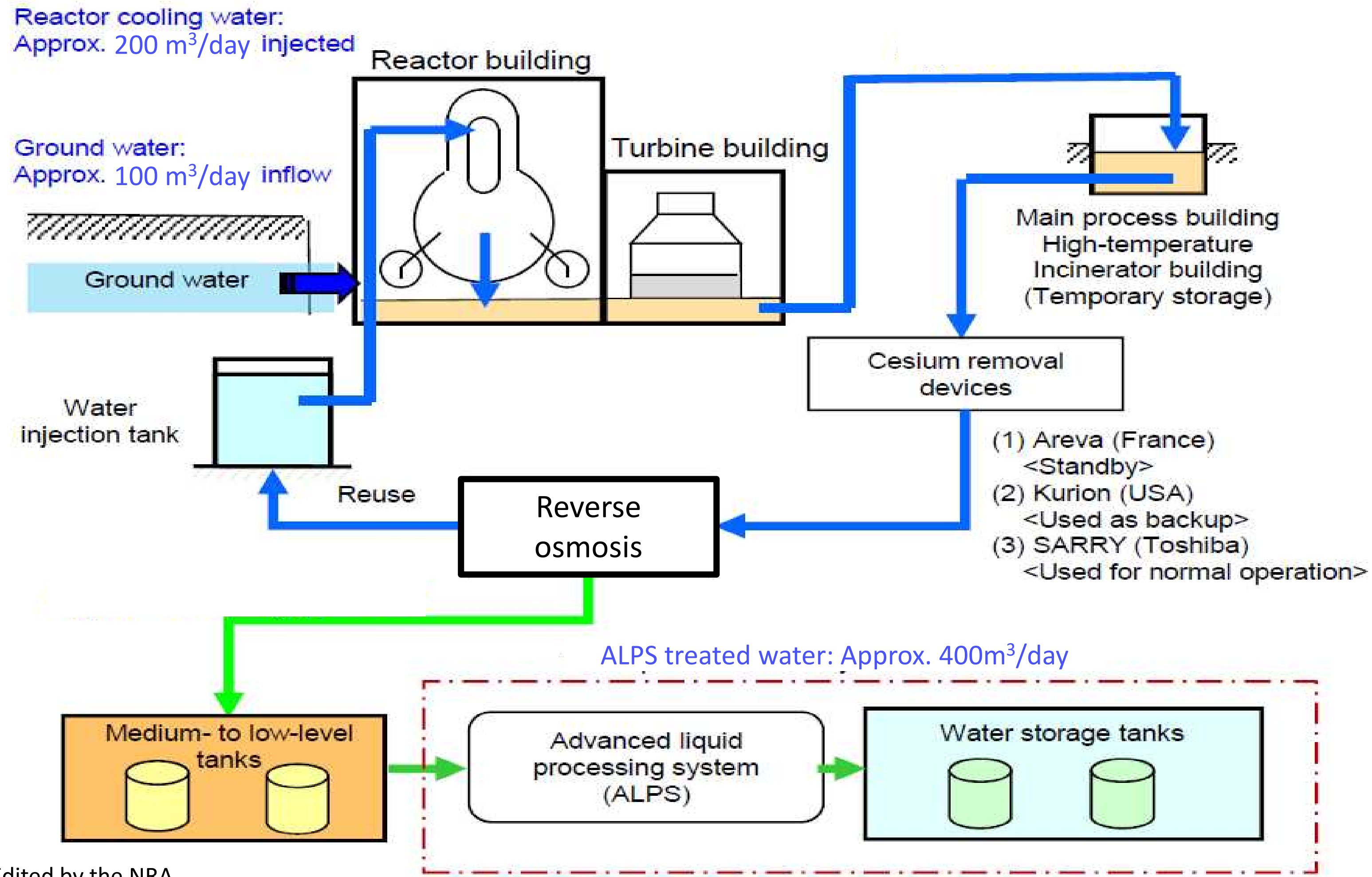
Measures for Mid-term Risk Reduction at TEPCO's Fukushima Daiichi NPS (Main Goals)

Issue / Fiscal Year	Liquid Radioactive Material	Spent Fuel	Solid Radioactive Material		Countermeasures for External Events	Important Issues to Progress Decommissioning
2021	Approach toward stopping water injection to reactor Advanced approach to decrease the water level in S/C of Unit 1 and 3	Design of shielding related to fuel removal from Unit 2, etc. Start installation of additional dry storage casks	Install large waste storage facility (Cs adsorption vessel)	Operate analysis facility on full-scale and build up structure for analysis Investigate inside Unit 1 PCV	Block the openings of buildings, etc. 【tsunami】 Widen the paving area around buildings 【rainwater】 (completed in FY2023)	Improve workplace environment continuously Reinforce quality management structure of Decommissioning Project Investigate and grasp the contamination around the shield plugs Remove high-dose SGTS pipes in lower part of exhaust stack of Unit 1 and 2, etc.
2022	Process untreated water in tanks (continues on and after 2023)	Start fuel removal from Unit 6 Provide shielding in Unit2 R/B Operating Floor and suppress dust scattering (completed in FY2023)	Start operating additional incinerator Install ALPS slurry (HIC) stabilization facility	Retrieve fuel debris from Unit 2 experimentally and investigate inside PCV and analyze debris Install volume reduction facility and 10th solid waste storage facility		Dose reduction under high-dose environment Take measures to suppress dust scattering from buildings, etc. Handle the ALPS treated water (e.g. Discharge into the sea)(Timing has not been decided) Consider the effect of the contamination beneath the shield plugs to each decommissioning works
2023	Half the amount and treat stagnant water in R/B (Establish method to remove α nuclides until FY 2021)	Install Unit 1 R/B cover	Start removing Sludge from Decontamination Facility Safety measures for fuel debris retrieval (Timing has not been decided) Start removal of Zeolite etc. in Process Main Building, etc. (decide method until FY 2021)			
Further future goals 2024 ～ 2032	Dry up Process Main Building, etc. Treat all stagnant water in R/B	Start fuel removal from Unit 5 Expand dry storage cask area to install additional dry casks Fuel removal from Unit 1 and 2 Fuel removal from spent fuel pool of all units	Install analysis building No.2 and other fuel debris analysis facility Remove rubble stored outside Control waste in safer and more stable state	Store retrieved fuel debris in stable state	Prevent deterioration and maintain soundness of buildings Seal outer wall of buildings 【groundwater】	

Countermeasures for Risks which would have an effect on the human and the environment

Countermeasures for Risks which effect on offsite is relatively small, but still should pay attention

1. Major Risk Issues : Stagnant Water Processing



Source: TEPCO's material Edited by the NRA

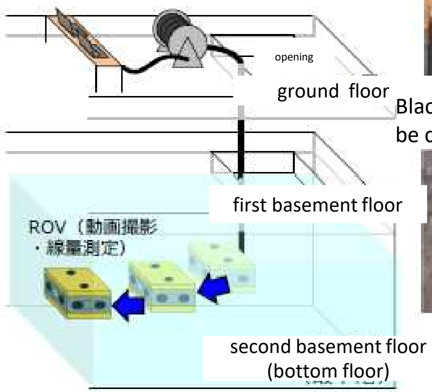
1. Major Risk Issues : Zeolite Sandbags in PMB and HTI

- In Dec. 2018, TEPCO investigated dose rate of the basement floors of PMB and HTI buildings, and detected high dose rate at the bottom then: 2,600mSv/h in PMB, 800mSv/h in HTI.

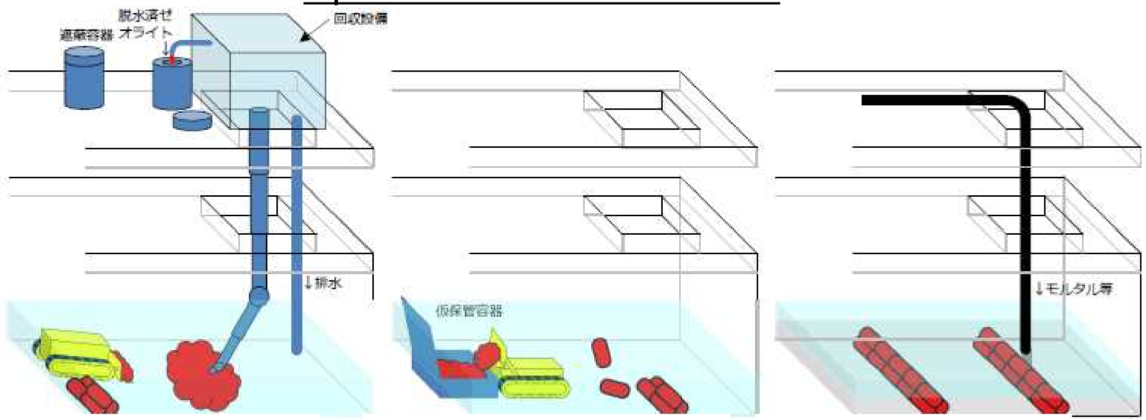
- The cause of high dose rate was sandbags containing zeolite installed right after the accident to decrease concentration of nuclides in contaminated water temporarily stored in PMB and HTI. The highest measured surface dose rate of sandbag was approx. 3000mSv/h in PMB and approx. 4000mSv/h in HTI

- In PMB and HTI stagnant water shields radiation from the sandbags; therefore, to remove stagnant water alternative shields are required with the sandbags exposed to the air.

investigation in HTI



Options to remove or shield

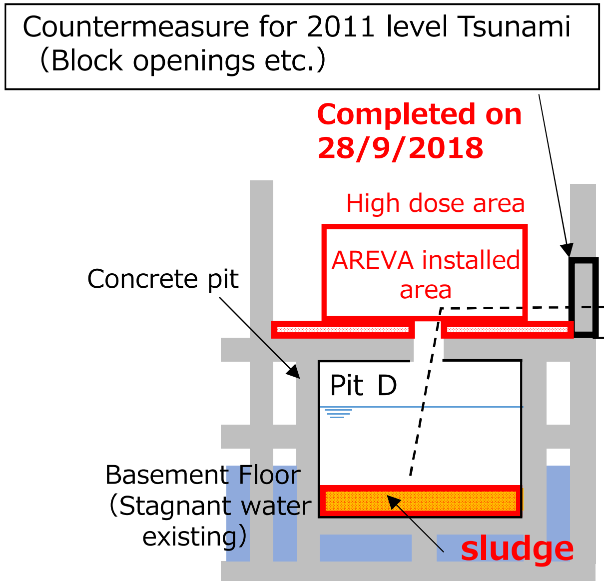


① Remote collection
Advantage
・Able to collect at once
Disadvantage
・Need prepare shielded container and place to store
・Equipment to collect sandbags become high dose

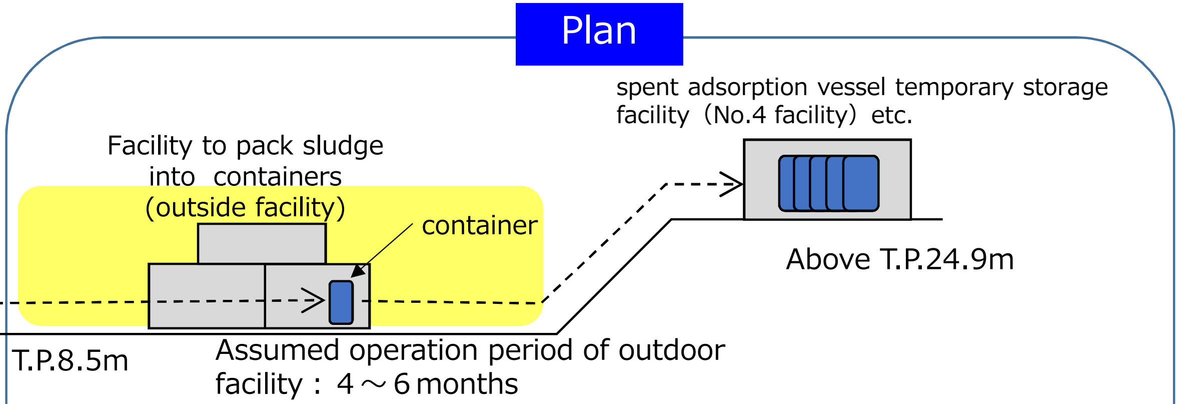
② Remote accumulation to provisional container
Advantage
・Able to secure storage space for the time being
Disadvantage
・Need to collect the container later

③ Solidification
Advantage
・Able to implement early
Disadvantage
・Difficult to collect later
・Sandbags exist in wide range and difficult to fill all the area

1. Major Risk Issues : Treatment of Sludge from AREVA

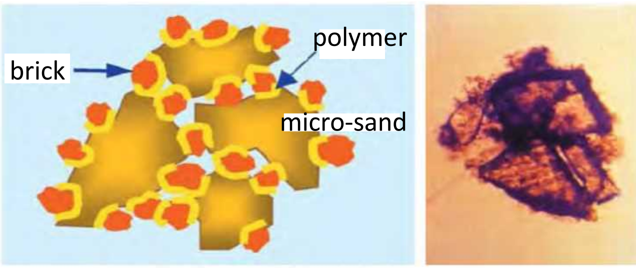


Cross-sectional view of PMB around Pit D



Planning to extract sludge from Pit D, send sludge into containers outside the building where radiation dose is low, and then transfer them to higher ground area whose level is higher than the tsunami height (T.P. 24.9m)

sludge



Example of contaminated precipitate

【Sludge】

Precipitate adsorbed nuclides such as Cs-137 in adsorbent solution.

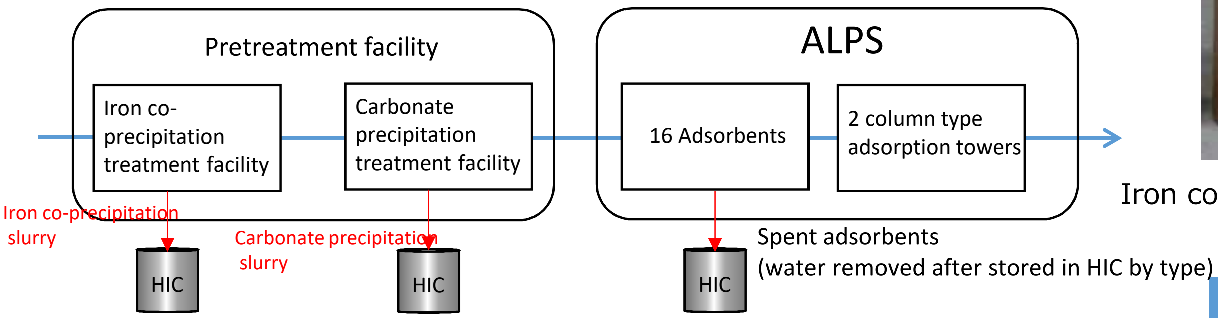
- **Main components : Barium sulfate(66%)**
  Ferrocyanides
- **Major nuclide : ^{90}Sr (Approx. 3×10^{8}Bq/cm^{3})**
- **Water content : Approx. 80%**
- **Amount of sludge : 37m^{3}**

Source:TEPCO,Edited by NRA

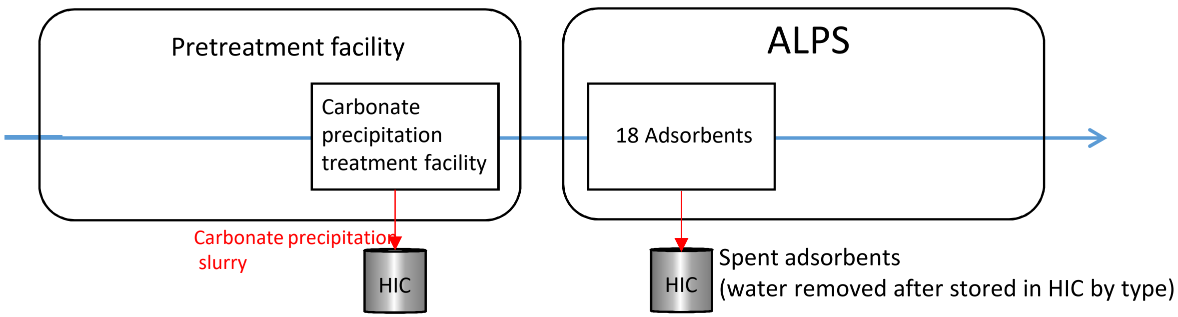
1．Major Risk Issues : Slurry from ALPS

- At ALPS, contaminated water is treated with pretreatment facility and ALPS equipment in sequence, and 62 radioactive substances are removed (except for tritium).

System diagram of ALPS (original)



System diagram of expanded ALPS



Source:TEPCO,Edited by NRA

※1 : High Integrity Container

Iron co-precipitation slurry

Carbonate precipitation slurry

HIC※1 (PE body)

HIC※1 (after attaching stainless reinforcement body)

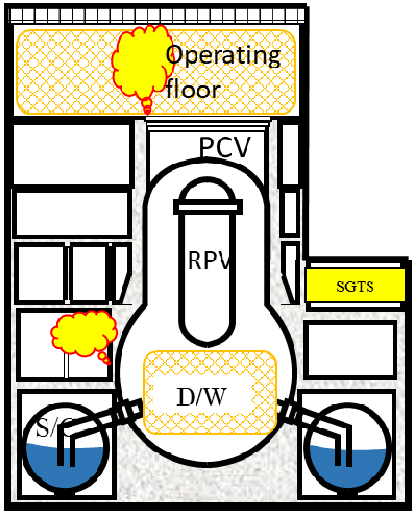
Main component		Concentration of representative nuclide	Amount of Slurry※2
ALPS	Iron co-precipitation slurry: $FeO(OH)\cdot H_2O$(75%)	^{90}Sr: 1×10^{6}Bq/cm^3	HIC:386 1008m^3
ALPS	Carbonate slurry: $CaCO_3$	^{90}Sr: 4×10^{7}Bq/cm^3	HIC:971 2535m^3
expanded ALPS			HIC:1121 2926m^3

※2 : Amount as of 28 May, 2018. The recent number of HICs is 3,632 in total as of 5 Nov. 2020 which store slurry and spent adsorbents.

2. Issues Recently Identified

Basing on the assumption that Cs-137 concentrates under-surface of the upper shield-plug, analytical calculation was made.

Cause of High-Dose Rate at Operating Floor of Unit 1-3



※1 The shield-plugs had been dis-located (may be the time of Hydrogen Explosion.)

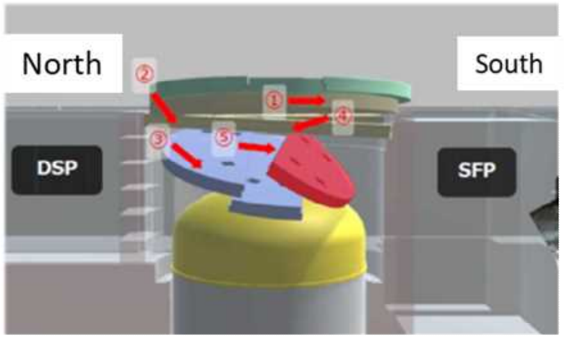
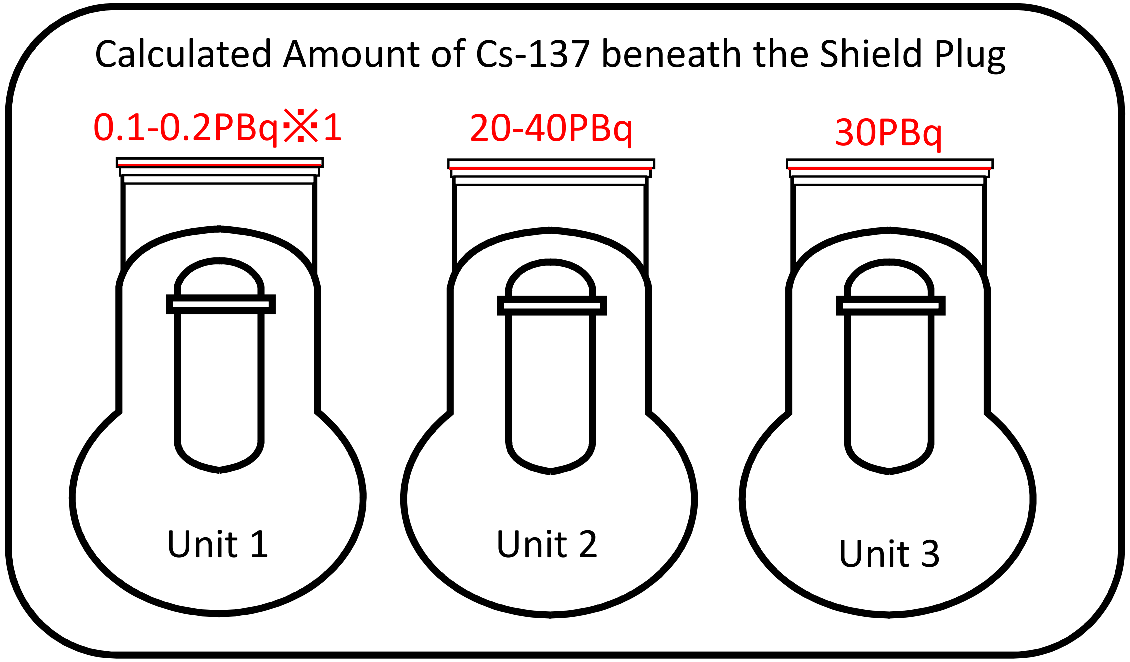


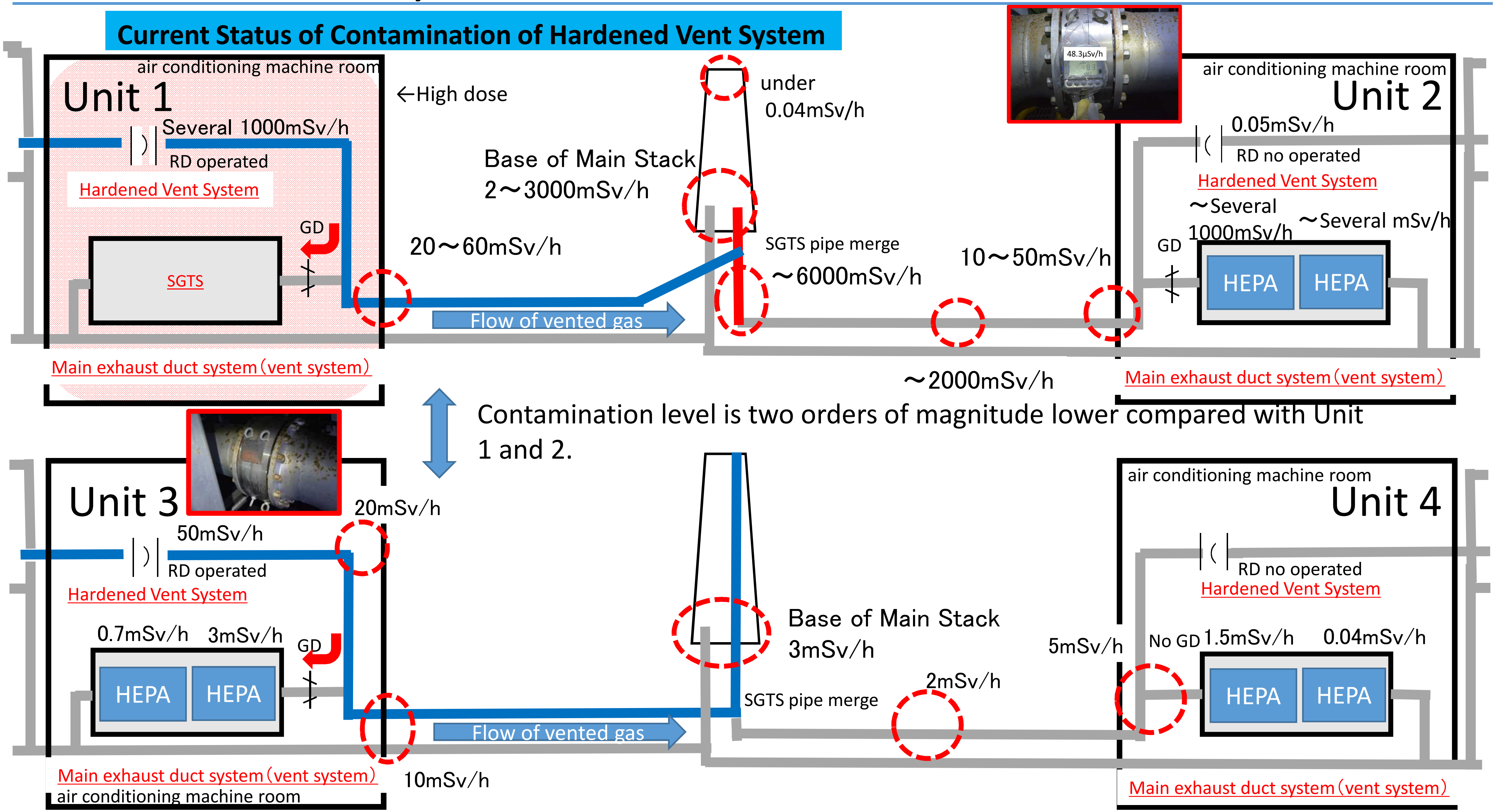
Image of Unit 1 Shield Plug (from west-side)



※Analytical calculation ; NRAJ, “Investigation and analysis of the TEPCO's Fukushima Daiichi NPS Accidents”, Appendix 7-1, p.185, (2021.3.5)
https://www.nsr.go.jp/data/000345595.pdf

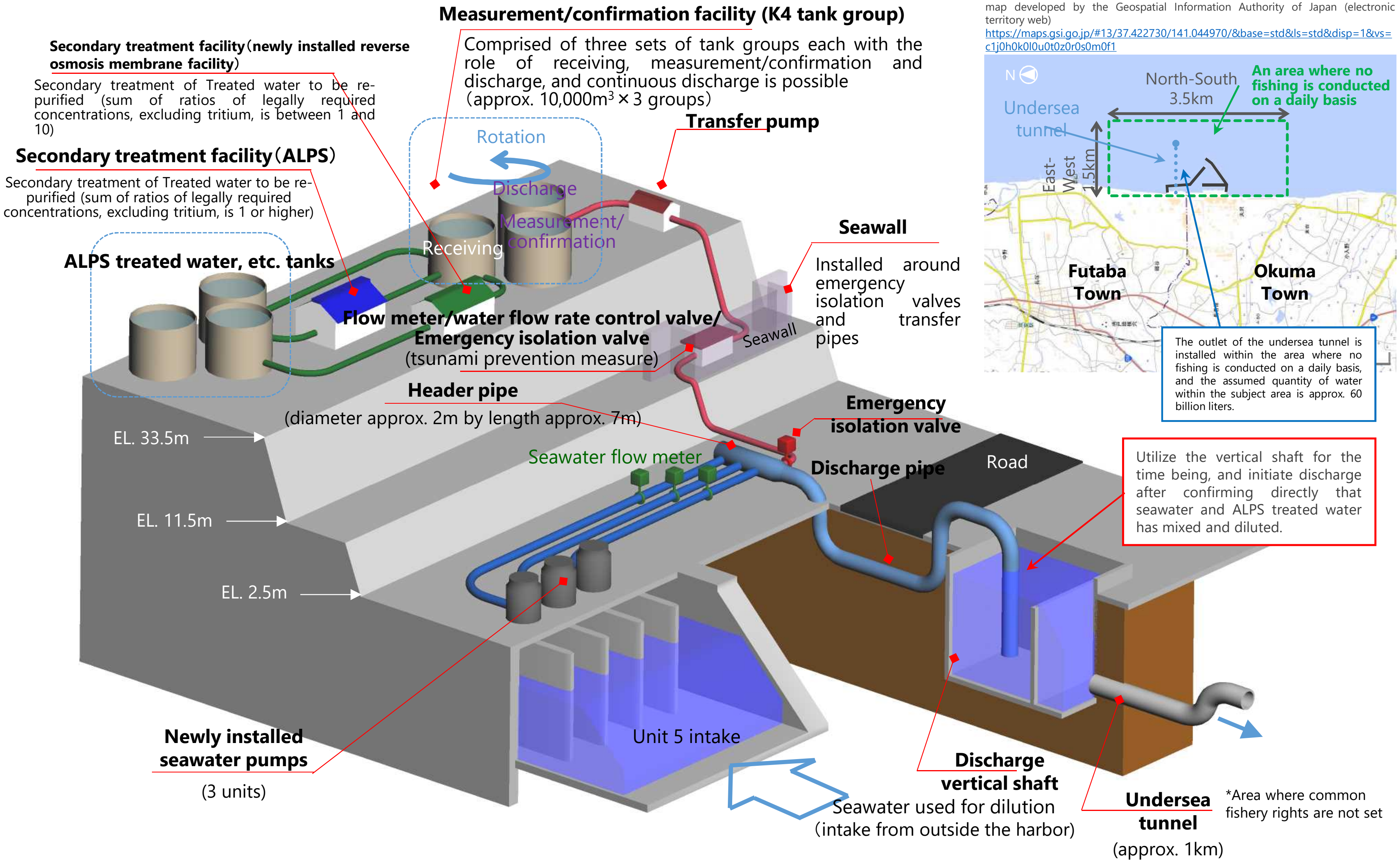
2. Issues Recently Identified

Current Status of Contamination of Hardened Vent System



3. Coming Decommissioning Issue : Release of ALPS-treated Water

Source: Developed by Tokyo Electric Power Company Holdings, Inc. based on the map developed by the Geospatial Information Authority of Japan (electronic territory web)
https://maps.gsi.go.jp/#13/37.422730/141.044970/&base=std&ls=std&disp=1&vs=c1j0h0k0l0u0t0z0r0s0m0f1



Source: TEPCO

3. Coming Decommissioning Issue : Release of ALPS-treated Water

- ***NRA's Review for TEPCO Fukushima Daiichi NPS***

Viewpoints of the NRA's review for ALPS treated water discharge equipment (Tentative)

Review based on the Reactor Regulation Act

The NRA will review the TEPCO's implementation plan whether it conforms to the regulatory requirements* including the following (* "Items required for Measures which should be taken at Tokyo Electric Power Co., Inc.'s Fukushima Daiichi Nuclear Power Station in line with the Designation as the Specified Nuclear Facility"):

- II.9 Treatment, storage, and management of radioactive liquid waste
- II.11 Radiation protection, etc. in the area surrounding the site by restricting release of radioactive materials, etc.
- II.14 Design considerations

Confirmation along with the government basic policy

The NRA will confirm whether the TEPCO's implementation plan is in line with the government basic policy.

4. Concerns on Future Decommissioning Progress

Waste Generations at 1F Site

- Stagnant Water
- Water from Underground
- Rain Water

  - ✓ Identify human and environmental impact
  - ✓ Control water intake and treated water quality

  → **Requires constant analysis of water characteristics**

- Secondary Waste from Water Treatment
- Contaminated Rubbles
- Fuel Debris and Reactor Structures

  - ✓ Identify radiological/chemical status
  - ✓ Consideration on handling methodology
  - ✓ Consideration on approaches to tackle core structures

  → **Large increase of analysis needs anticipated**

☐ **Capacity of human resource and facility/equipment has to be expanded.**

- Number of professional staff - recruitment
- Capability of skilled staff - training

- On-site facility, JAEA (several facilities), and private corporations are continuously available; in addition, two facility plans are on going at 1F site.
- Adequate deployment of facilities with analyzing capacity is required.