METI
Ministry of Economy, Trade and Industry

The Update of Fukushima Daiichi NPS

Agency for Natural Resources and Energy, METI

4th, March 2021

Current situation of Fukushima Daiichi NPS

(1) March 2011　Fukushima Daiichi nuclear accident

i) Due to the earthquake and tsunami, electricity to the plant was lost.

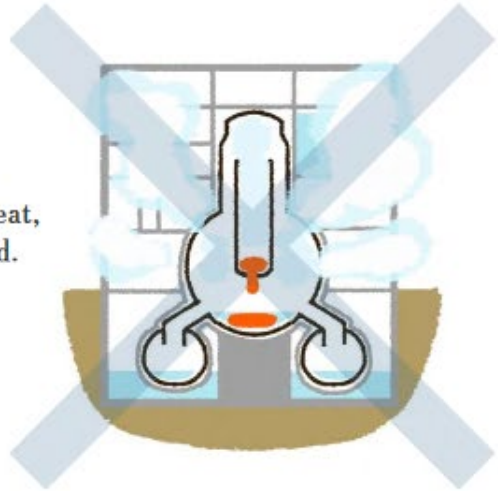
ii) **Core melt (unit 1, 2 and 3)　/ hydrogen explosion (unit 1, 3 and 4)**

(2) NOW　Fukushima Daiichi keeps stable state

i) **Decommissioning** (risk reduction by removing spent fuel, fuel debris. etc)

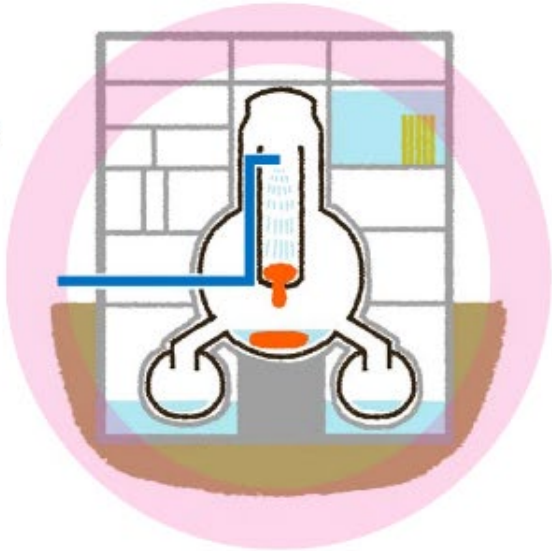
At the time the accident occurred

The accident cut off the water supply to the reactors.
As a result, the fuel generated heat, and hydrogen explosions occurred.



Today

Reactors are being kept stable.

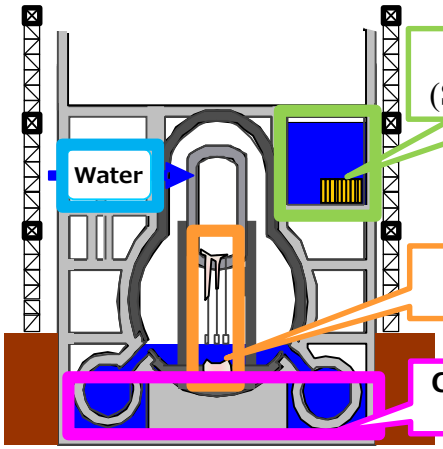


Decommissioning of TEPCO Fukushima Daiichi NPS (FDNPS)

◇ **Fukushima Daiichi Decommissioning is a continuous risk reduction activity** to protect the people and the environment from the risks associated with radioactive substances by:

- ✓ Removing spent fuel and fuel debris from the Reactor Building
- ✓ Reducing the risks associated with contaminated water and radioactive waste

◇ **Safe and steady decommissioning is a prerequisite for reconstruction of Fukushima**



Spent fuel (Spent fuel pool)

Fuel that remains after its usage for power generation.
Continuous cooling is needed to suppress the heat

Fuel Debris

Fuel that has melted and solidified by the accident.
Continuous cooling is needed to suppress the heat

Contaminated Water Management

Radioactive Solid Waste Management

Removing fuel from the Spent Fuel Pool: Units 1 and 2 — Rubble removal → Installation of fuel removal equipment → Fuel removal; Unit 3, Unit 4 — Storage/Transportation

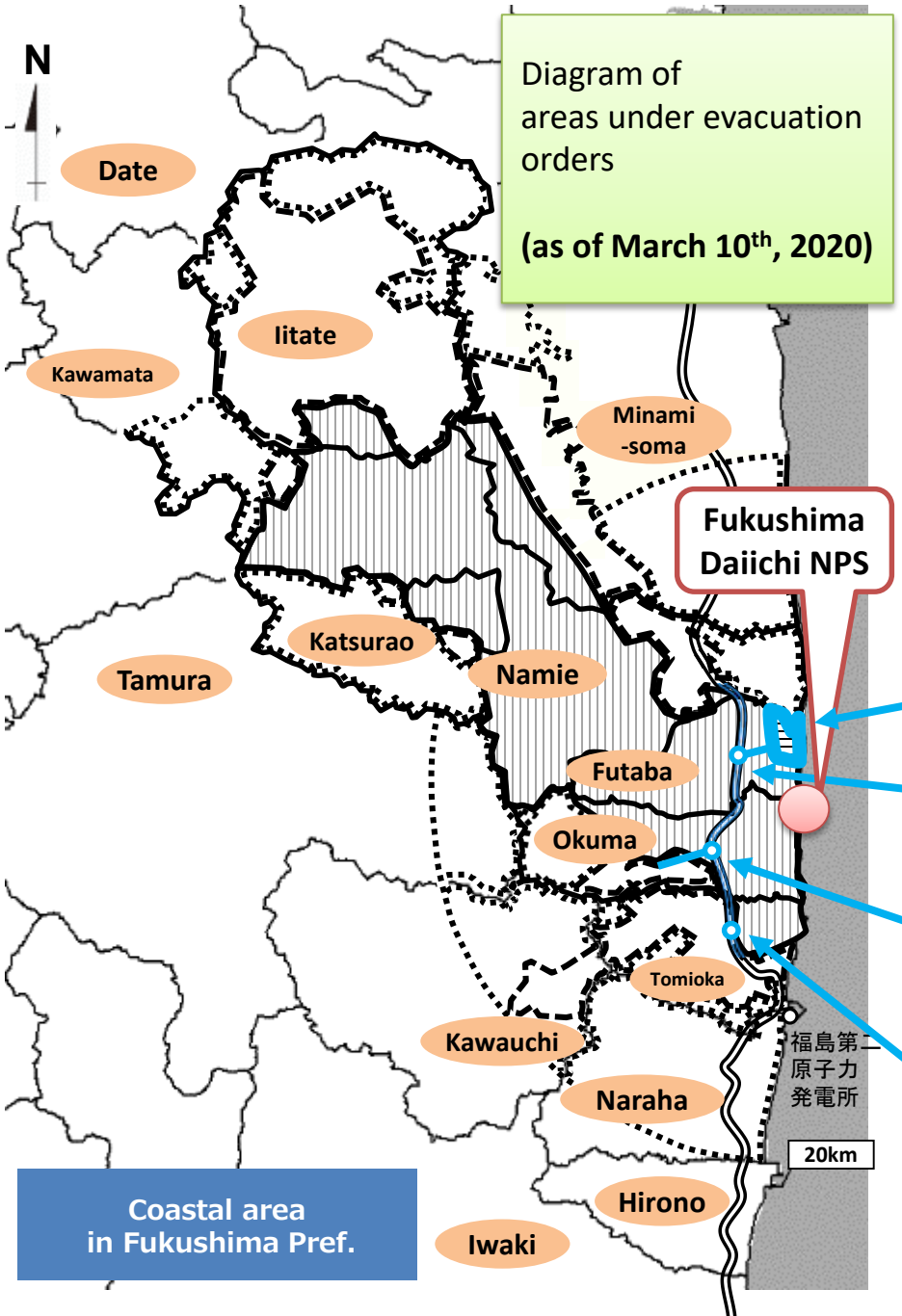
Fuel debris retrieval: Units 1, 3 — Ascertaining of the situation inside the PCV/ consideration of fuel debris retrieval etc; Unit 2 — Fuel debris retrieval → Storage/ Transportation

▼ Current progress

Disassembly of reactor facility, etc: Consideration of scenario and technologies → Design and construction of equipment → Dismantling and other tasks

Extended to 30-40 years

(Ref.) Lift of evacuation orders



Explanatory notes

- Areas where Returning is Difficult(ARD)
- Preparation Area for lift of Evacuation order
- Area in which evacuation orders were lifted
- JR Joban Line (The entire line is reopened in 14 March, 2020)

< Blue framed area >

Futaba [Lifted on March 4th, 2020]

・Preparation Area for lift of Evacuation order

・Futaba Sta. and streets around the Sta. : ARD

Okuma [Lifted on March 5th, 2020]

・Ono Sta. and streets around the Sta. : ARD

Tomioka [Lifted on March 10th, 2020]

・Yonomori Sta. and streets around the Sta. : ARD

JR Joban Line between Namie Sta. and Tomioka Sta. : ARD

(Ref.) Status of regional economic center

The recovery of the regional economic hub is also making steady progress, with the restoration of infrastructure, the maintenance of shopping malls, and the reopening and improvement of industrial facilities.

The entire JR Joban line is reopened

Futaba Station
(reopened; 2020.3.14)

Maintenance of Michi-no-eki

Michi-no-eki Naraha
(reopened; 2020.6)

Michi-no-eki Namie
(One part for start; 2020.8)

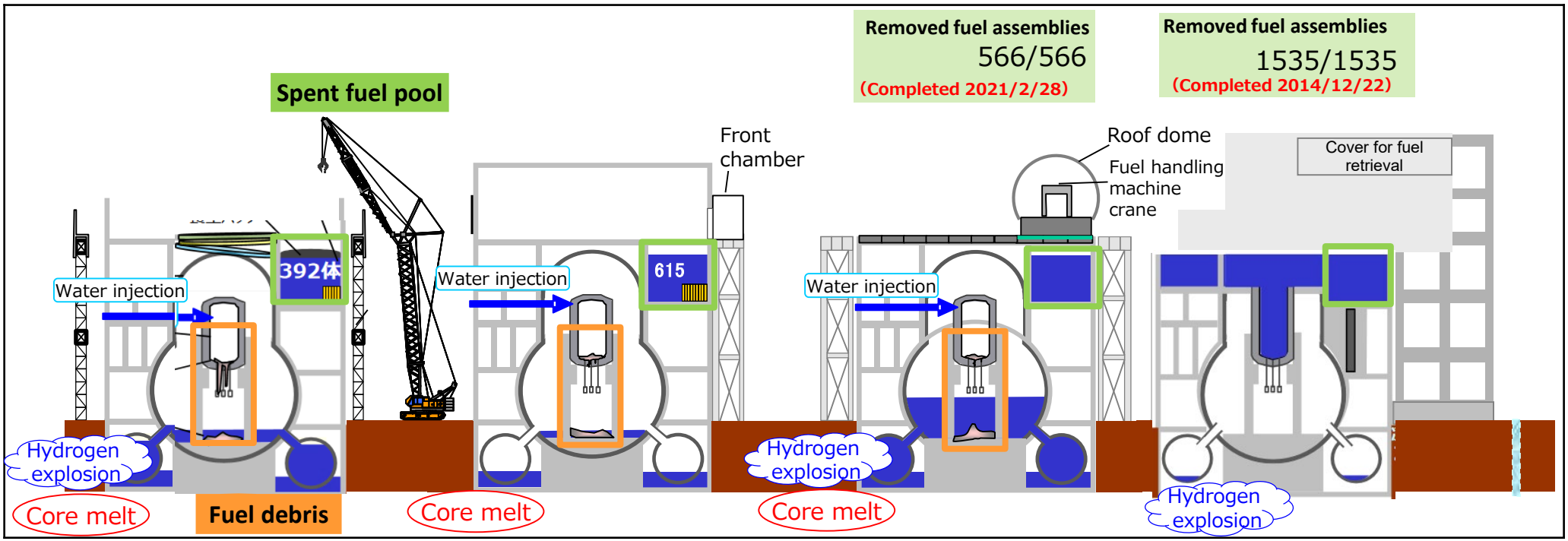
Resumption of fishery industry

Contract fishing port
(The auction reopened after nine years; 2020.4)

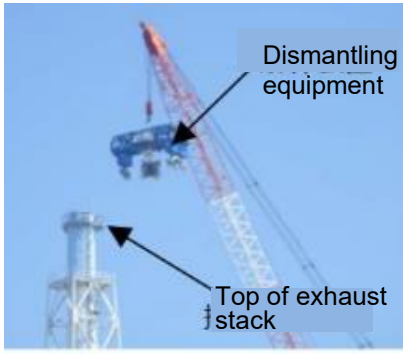
Maintenance of industrial exchange facilities

Futaba Town Industrial Exchange Center
(New open; 2020.10)

(Ref.) Current status of Unit 1-4 of Fukushima Daiichi NPS

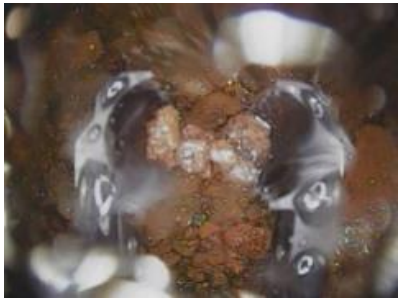


<Dismantling of Unit 1/2 exhaust stack >



Local company joins as a prime contractor.
[Completed in May 2020]

<Fuel debris retrieval>



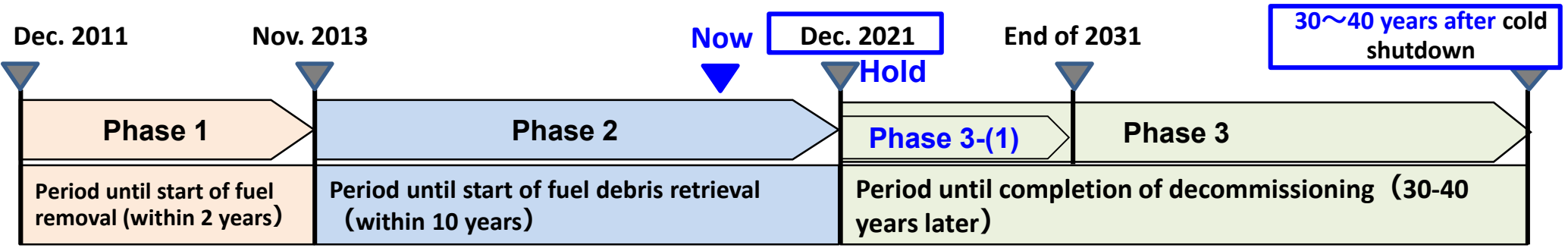
Confirmed that the deposit likely to be the fuel debris was able to be gripped and moved.(Unit 2)
[Feb. 2019]

<Fuel removal>

Lifting the last fuel assembly (2021/2/26)

Completed fuel removal from the spent fuel pool of Unit3 and transfer to the common pool, by remote control. [Apr. 2019-Feb.2021]

Major milestones of Mid-and-Long-Term Roadmap (Dec. 2019)



Major milestones

		Revised Roadmap	
Contaminated water management	Reduce to about 150 m³/day **Reduce to about 100m³/day or less** (Further reduction of generation)	Within 2020 **Within 2025**	achieved **NEW**
Stagnant water removal / treatment	Complete stagnant water removal / treatment in buildings* • Excluding the reactor buildings of Units 1-3, Process Main Buildings, and High Temperature Incineration building. **Reduce the amount of stagnant water in reactor buildings to about a half of that in the end of 2020**	Within 2020(*) **FY2022 - 2024**	achieved **NEW**
Fuel removal	**Complete of fuel removal from Unit 1-6**	**Within 2031**	**NEW**
	Complete of installation of the large cover at Unit 1	**Around FY2023**	**NEW**
	Start fuel removal from Unit 1 (Methods have changed to ensure safety and prevent dust scattering)	**FY2027 – 2028**	**REVISED**
	Start fuel removal from Unit 2	**FY2024 - 2026**	**REVISED**
Fuel debris retrieval	Start fuel debris retrieval from the first Unit (Start from Unit 2, expanding the scale gradually)	Within 2021	*Expected to be delayed by approximately 1 year
Waste management	Technical prospects concerning the processing/disposal policies and their safety	Around FY2021	
	Eliminating temporary storage areas outside for rubble and other waste	**Within FY2028**	**NEW**

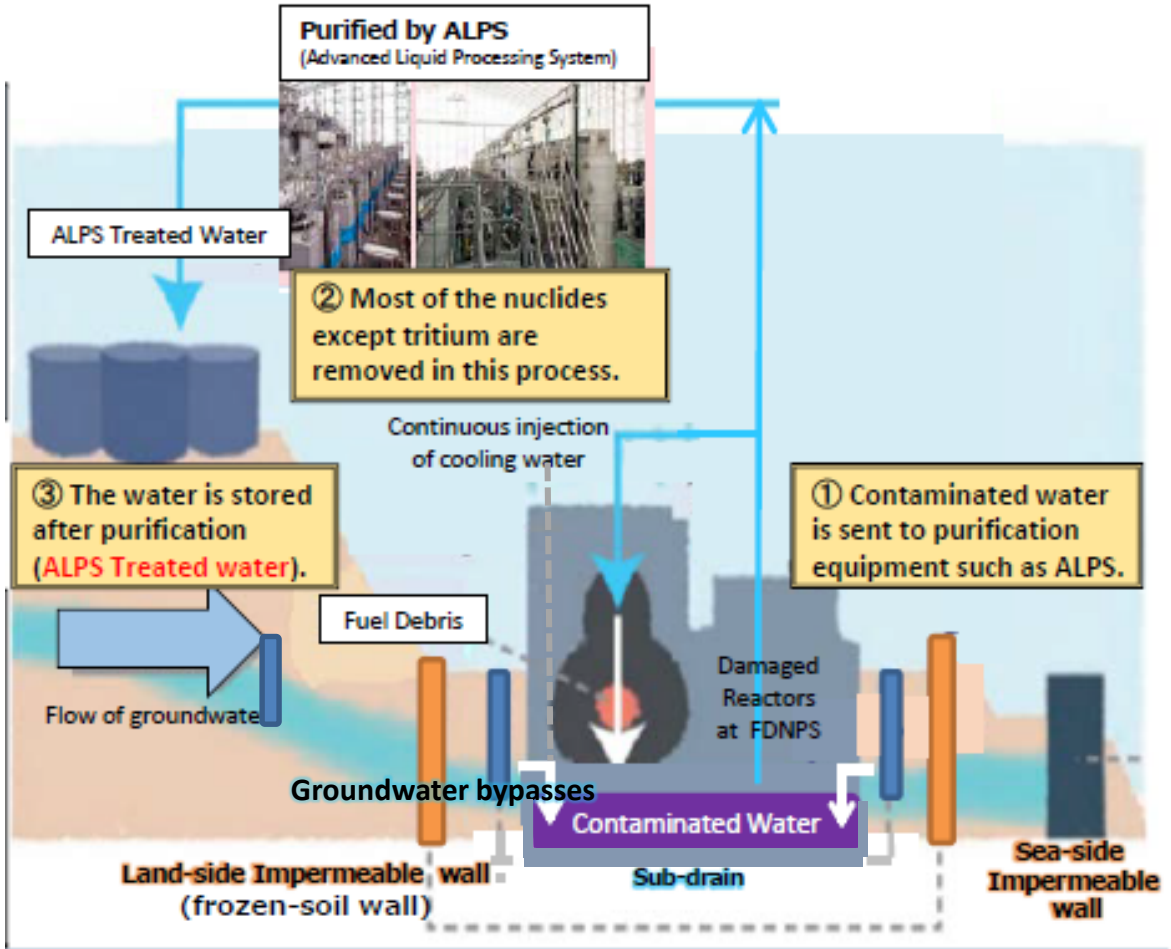
What is “contaminated water” and “treated water” ?

i) “Contaminated water” contains a large amount of radioactive materials, and have been generated in buildings every day since the accident.

ii) “Treated water” is water in which most of radionuclides are removed by purification.

→ *However, “**tritium” cannot be removed** by purification, and **remains in the treated water at the level higher than its regulatory standards** for discharge.*

** C-14 also cannot be removed by ALPS, but its concentration is far lower than its regulatory standard for discharge*



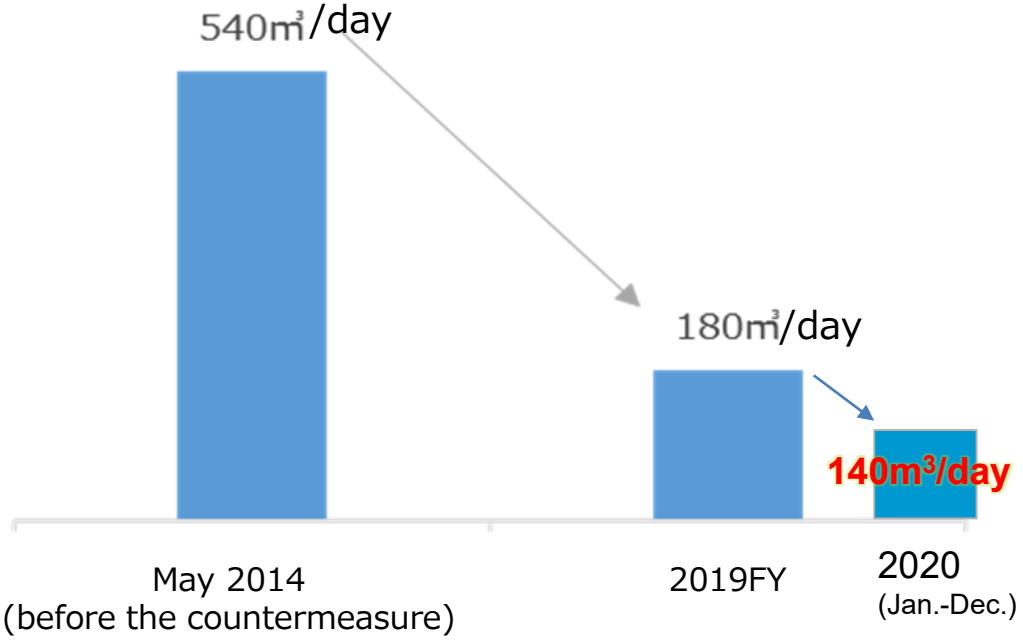
Contaminated water

ALPS treated water

(Ref.) Decrease in volume of treated water stored per day

◇**The frequency of an additional tank installation has decreased to "once a week", compared to "every two days" around 2014.**

- ✓ The volume of treated water stored in tanks per day has been decreased through countermeasures such as installation of frozen-soil walls and sub-drains.
- ✓ Volume of the **treated water at FDNPS** is **about 1.24 million m³** (as of December 17, 2020)
- ✓ Capacity of the tanks is about 1.37 million m³



*(Ref.) rate of contaminated water generation** (per day)*

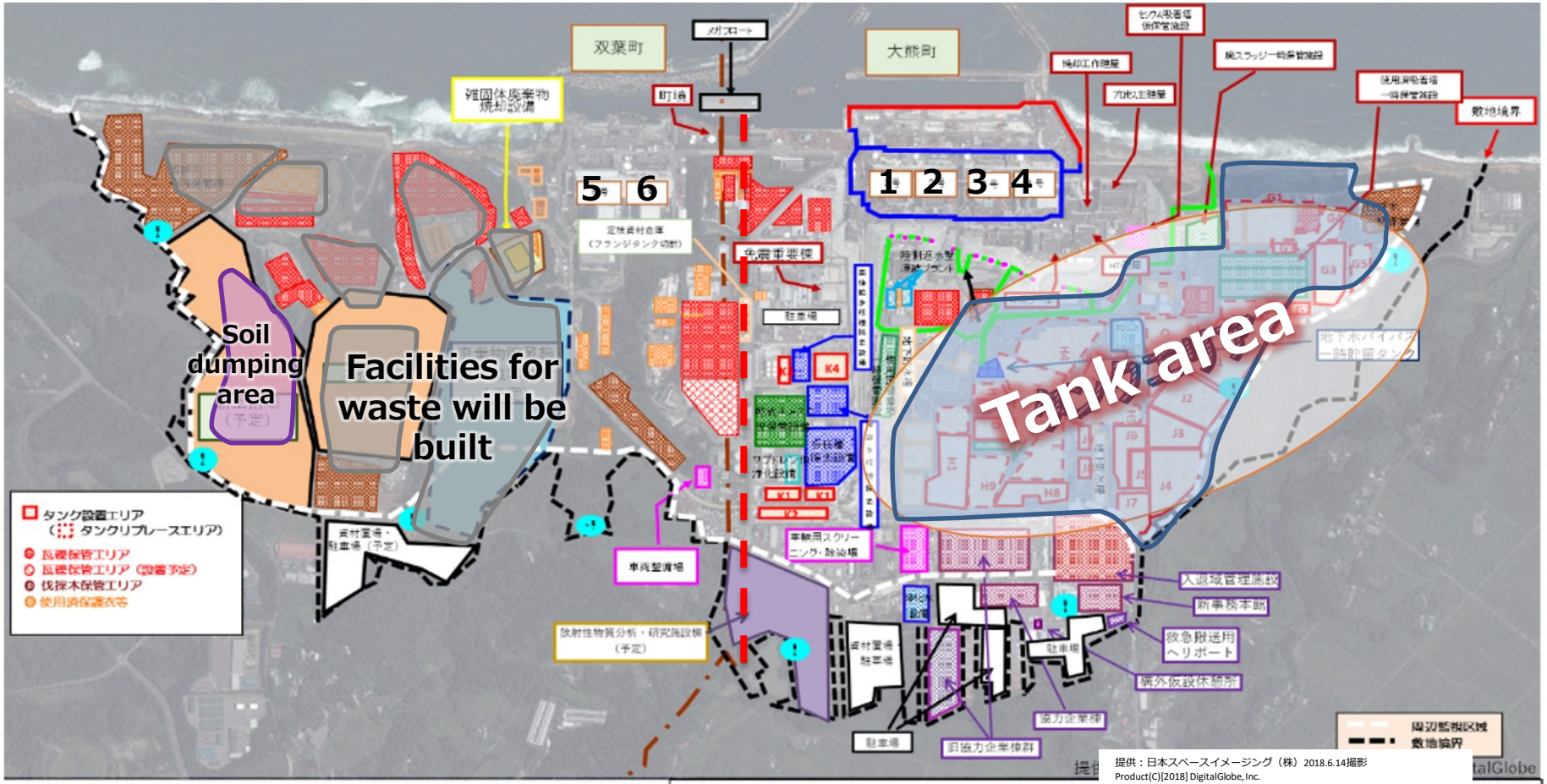
*** rate of contaminated water generation has a correlation to that of treated water stored in tanks par day.*

around 540m³/day *(in May 2014, before measures were taken)* → ***around 140m³/day*** *(in 2020)*

(Ref.) Site Layout of Fukushima Daiichi

◇ Tanks as well as a variety of **facilities are needed to be built**.

- ✓ (e.g.) **temporary storage facilities for spent fuel and fuel debris**
- ✓ analytical facilities for various samples



【補足事項】
○本配置図は，現状（2017年9月）の敷地の利用状況と現段階の利用計画に基づき作成。
○また、将来の廃炉作業の進捗に応じて、施設の設置・廃止が必要となることから、適宜計画の見直しを実施。

Why are two options suggested by the expert committee feasible?

◇**"1) Vapor release" and "2) discharge into the sea"** are suggested by the committee in February 2020.

- ✓ **Both option 1) and 2) are recommended to be realistic**, because of the **precedents and track records** for them.
- ✓ **"2) Discharge into the sea" can be implemented more reliably**, considering the ease of discharge facilities operation and proper monitoring methods.

◇**The International Atomic Energy Agency (IAEA)** acknowledged that the options suggested by expert committee is **"based on a sound scientific and technical basis of analysis".**

Comparison of "vapor release" and "discharge into the sea"

1) Vapor release	2) Discharge into the sea
● A precedent in case of accident at NPP overseas * Vapor is also released from reactors in normal operations at the time of ventilation. ● Difficult to predict how the released vapor is diffused into the air and to establish proper monitoring method	● Precedents exist world-wide ● Relatively easy to predict how discharged water is diffused in the ocean and easy to examine proper monitoring method

The key points of the draft report of the ALPS Subcommittee
Countermeasures against reputational damage

1) **Well planned disposition process**
2) **Expansion and enhancement of countermeasures building on best practices**
3) **Continuous and flexible response**

＜1. Well planned disposition processes ＞

- **Re-purify the water to remove** radionuclides other than tritium
- **Stop the discharge process in case of emergency**
  e.g. environmental situation, malfunction of facilities
- **Determine the details (starting time, volume, and period of discharge),** while listening to opinions of stakeholders
- **Disseminate information** in a considerate and an easy-to-understand manner
  - ✓ Concentration of pre-disposition ALPS treated water
  - ✓ Monitoring results of surrounding environment
- **Explain safety of surrounding environment by** utilizing diffusion simulation

The key points of the draft report of the ALPS Subcommittee : - continued

<2. Expansion and enhancement of countermeasures building on best practices>

< Risk communication>

- to convey relevant information

- **Disseminating information** on the disposal method and scientific knowledge in advance
- **Providing information** via:
  - ✓ SNS, mass media
  - ✓ On-site lectures
- **Strengthening information dissemination abroad**
  - ✓ Basic information on decommissioning
  - ✓ **Disposition methods in the world** as well as precedents outside of Japan

< Economic measures>

- for reputational damage

- **Constructing analytical framework** for:
  - ✓ environmental monitoring, and
  - ✓ food sampling measurement
- Utilizing **third-party certification** to secure consumer trust, such as
  - ✓ GAP (Good Agricultural Practice)
  - ✓ MEL (Marine Eco-label)
- **Developing new market channels** by
  - ✓ **Promotion events** for Fukushima products
  - ✓ **Allocation of special sales staff** in stores
  - ✓ Opening of **on-line stores** etc.

(Ref.) What are the IAEA's findings on the disposal options of the ALPS treated water ?

■ Statements made by IAEA Director General Rafael Grossi in February 2020:

"**The IAEA considers the disposal options (discharge into the sea and vapor release) as technically feasible and in line with international practice**."

"Once a decision is taken on the way forward, **the IAEA would be ready to assist in its implementation, for example in radiation monitoring**. It could help provide reassurance to the public – in Japan and elsewhere – that **any releases of water would be within international standards**."

■ IAEA Review Report on the ALPS Subcommittee Report etc. (2 April 2020)

- **The two options selected (discharge into the sea and vapor release) are technically feasible and would allow the timeline objective to be achieved.** *(Acknowledgement 4)*
- **The IAEA Review Team also notes that the ALPS treated water will be further purified as necessary to meet the regulatory standards for discharge before dilution.** *(Acknowledgement 4)*
- **The IAEA Review Team is not aware of a solution currently available for the separation of tritium** commensurate with the concentration and the volume of ALPS treated water. *(Acknowledgement 3)*
- **The IAEA Review Team holds the view that a decision on the disposition path for the stored ALPS treated water must be taken urgently, considering safety aspects and engaging all stakeholders.** *(Advisory Point 1)*

Photo Credit: Dean Calma / IAEA

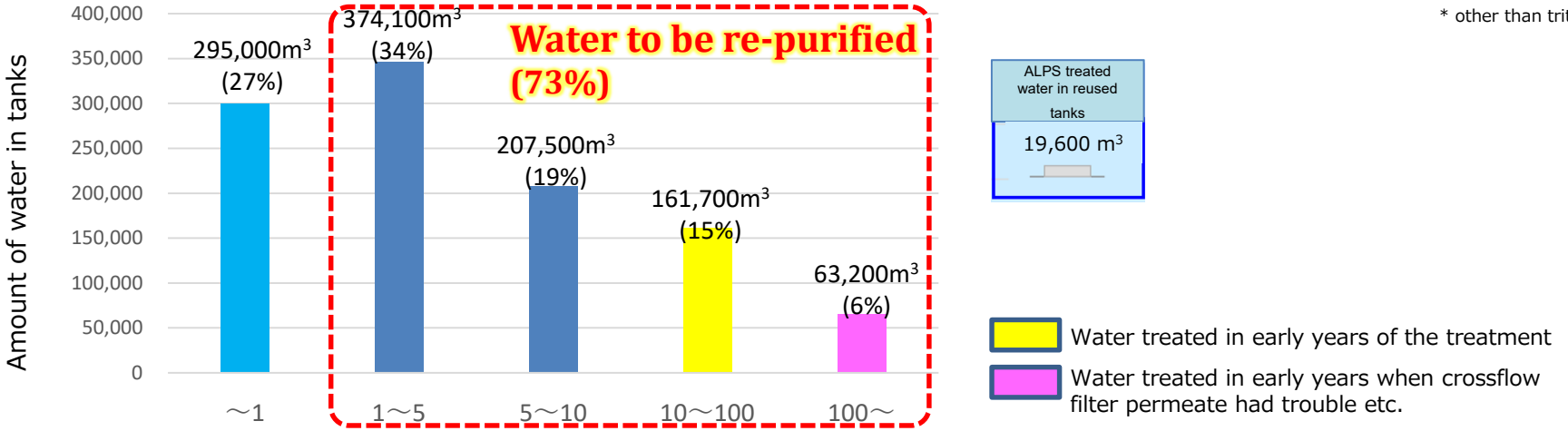
■ Fukushima Status Update at IAEA website https://www.iaea.org/newscenter/focus/fukushima/status-update

Characteristics of ALPS treated water

- ✓ Regarding **about 30 %** of the treated water stored in tanks, the concentration of radionuclides other than tritium meets the regulatory standards for discharge.
- ✓ Regarding **about 70 %** of the water, concentration of radionuclides exceeds the regulatory standards. It will be **re-purified** to meet the regulatory standards with an exception of tritium.

  * In early years, the ALPS treatment has been carried out by prioritizing the volume of water treatment to quickly reduce the radiation impact to outside the site. There were also cross filter permeate troubles and other troubles.
- ✓ **Re-purification test** shows that the **ALPS has ability to remove the radionuclides sufficiently.**
- ✓ In the case of releasing it to the environment, the treated water will be **sufficiently diluted also to meet the regulatory standard for tritium.**

Sum of the ratios of actual concentrations to regulatory standards for 62 nuclides* (as of November, 2020)



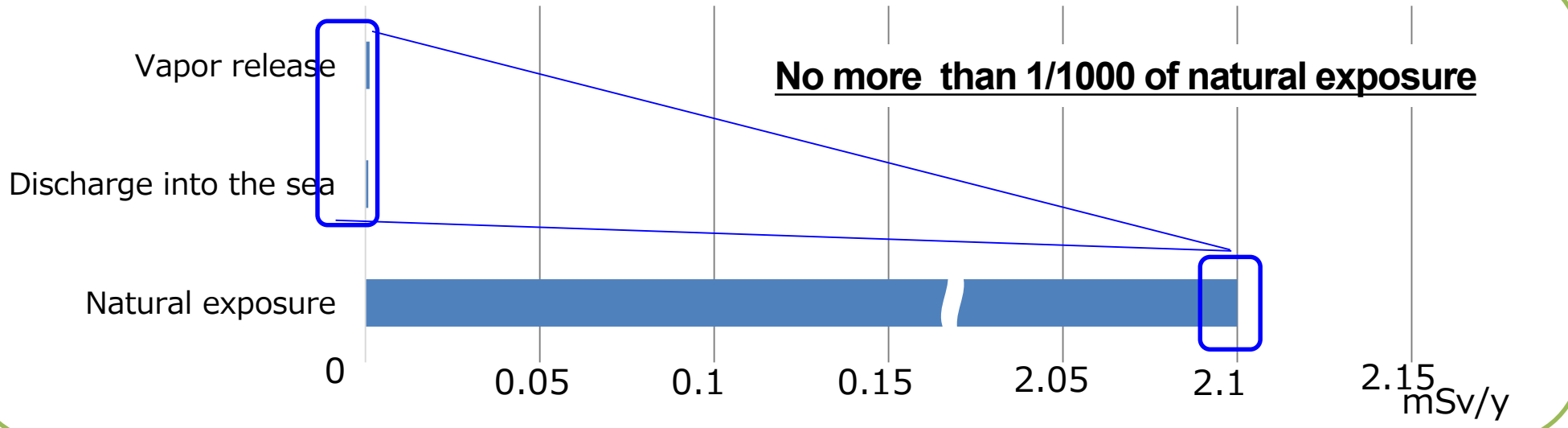
*** "less than 1" means that the water concentration meets the regulatory standards for**

How much is the radiation impact of treated water release?

◇**The impact of the radiation to human health as a result of the discharge is considerably small.**

- ✓ Even if the entire amount of the ALPS treated water containing tritium and other radioactive material were to be disposed of in one year*, the impact would be **no more than 1/1000 of the exposure impact of natural radiation** in Japan.

Comparison of radiation impacts from natural exposure and discharge of whole treated water in one year*



* Based on a UNSCEAR-specified method.
* All volume of the ALPS treated water stored in tanks is discharged in one year, and similar amounts are discharged during following 100 years.
* The treated water contains 860 trillion Bq of tritium and the other radionuclides.

Simulation of diffusion (TEPCO's draft study report March 24, 2020)

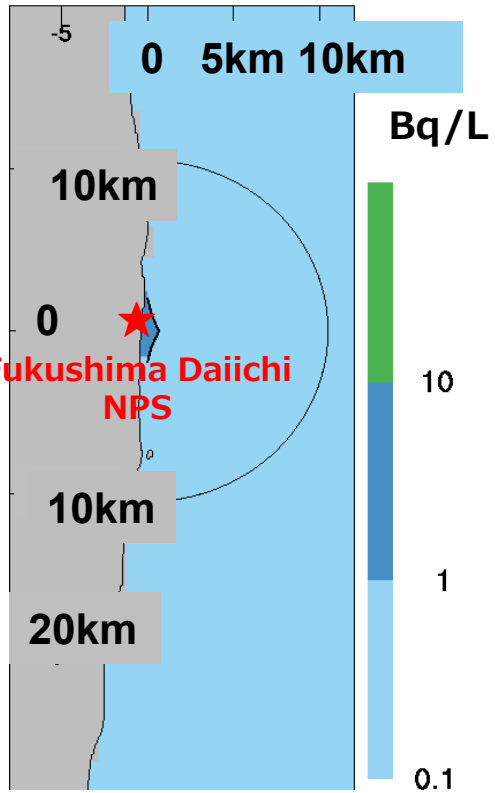
Vapor release

- There is no diffusion simulation model available for vapor.
  - i. Simple evaluation is difficult: It requires consideration of morphological changes in vapor due to weather conditions, advection caused by groundwater or rivers, re-release, and transpiration from plants
  - ii. Knowledge of continuous simulation is not available

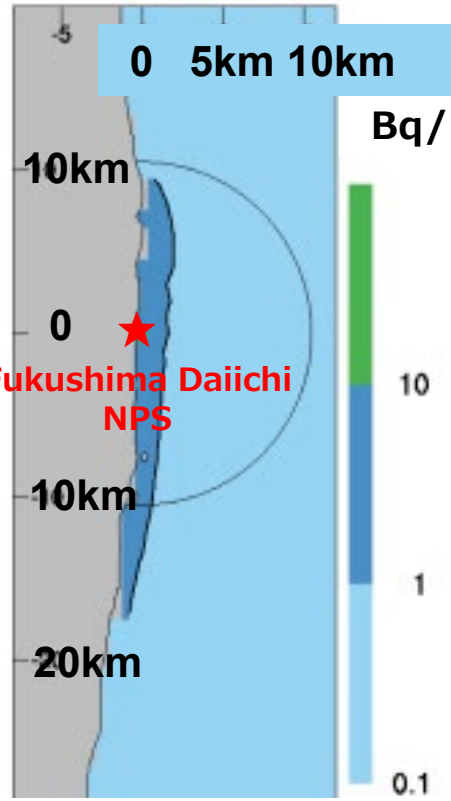
Discharge into the sea

- The areas in which tritium concentration exceeds the background level (1 Bq/L) will be limited to within 2km offshore from the FDNPS.
- Even in the areas, the level of tritium concentration (1 to 10 Bq/L) is far lower than the WHO drinking water guideline value (10,000 Bq/L).

Annual discharge of tritium
22 Trillion Becquerel / year*



Annual discharge of tritium
100 Trillion Becquerel / year

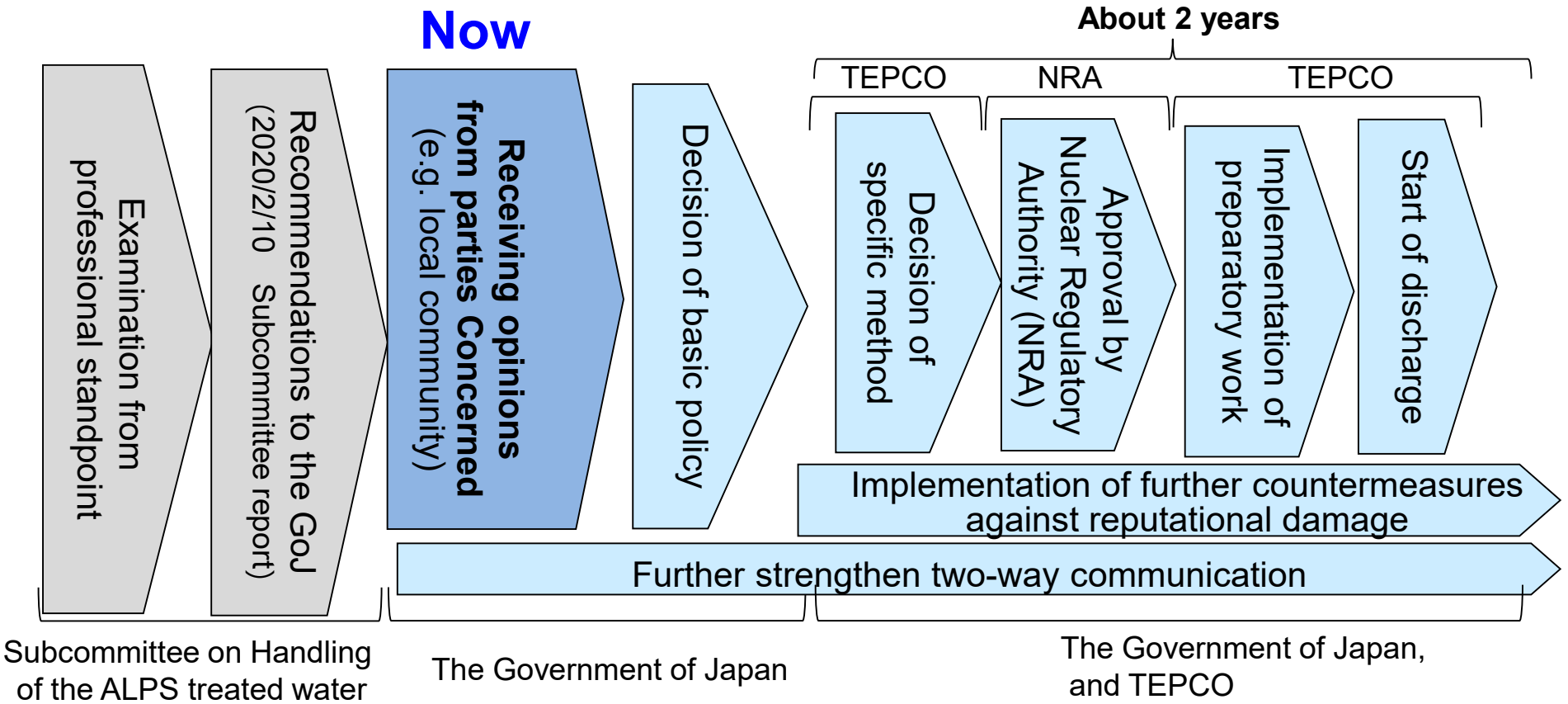


* the operational target value for discharge before the accident

What are the steps toward the handling of treated water ?

◇Considering the opinions received, **the GOJ will decide its basic policy including measures against possible reputational damage.**

◇Based on the governmental basic policy, TEPCO will determine the specific method and will obtain an approval from the Nuclear Regulatory Authority(NRA), and then will start the preparatory work.

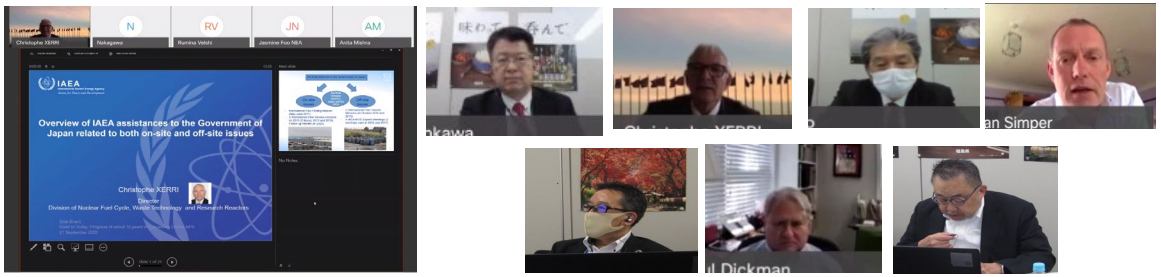


(Ref.) How has the GOJ been providing information to the international community ?

- **Briefing sessions for Diplomatic Missions in Tokyo** have been held.
- **Technical briefings** on the occasions such as international conventions.
  - ✓ **At WTO/SPS (sanitary and phytosanitary) committee** in November 2020 (online), monitoring results of Japanese foods, treated water management were presented.
  - ✓ **At IAEA General Conference** in Sept. 2020, a **side event by Japan** was held to provide **technical briefing on decontamination and treated water management**.
  - ✓ **At the briefing session and site tour for foreign press**, current situation of FDNPS including treated water management are presented by METI and TEPCO.
- **Reports** on the decommissioning progress and the surrounding environment.

https://www.iaea.org/newscenter/focus/fukushima/status-update

Briefing sessions for Diplomatic Missions in Tokyo (Feb.2020)



Side event at 64th IAEA General Conference (Sep. 2020)

What is tritium ? 1) Characteristics

◇Tritium is a relative of hydrogen that **emits weak radiation**.
Tritium exists naturally and is found in rain water, sea water, tap water and inside of human body as a form of tritiated water.

◇Tritium is **taken into the human body** via drinking water and **excreted from the body, and then circulates in nature as the water does**.
It has not been confirmed to be accumulated in humans or specific organisms.

* Tritium concentration for **tap water**: **1 Becquerel/L**
* Amount of Tritium in **human body** : **tens of Becquerel**

What is tritium ? 2) Can tritium be removed ?

◇It is **very difficult to remove tritiated water from water**, as it has the **same properties**.

◇**Experts have concluded** that **there is no tritium separation technology** that is immediately **applicable to the treated water with low concentration and large volume**.

◇**IAEA (International Atomic Energy Agency) is "not aware of a solution currently available** for the separation of tritium commensurate with the concentration and the volume of treated water".

(Ref.) How much tritium is discharged in the environment ?

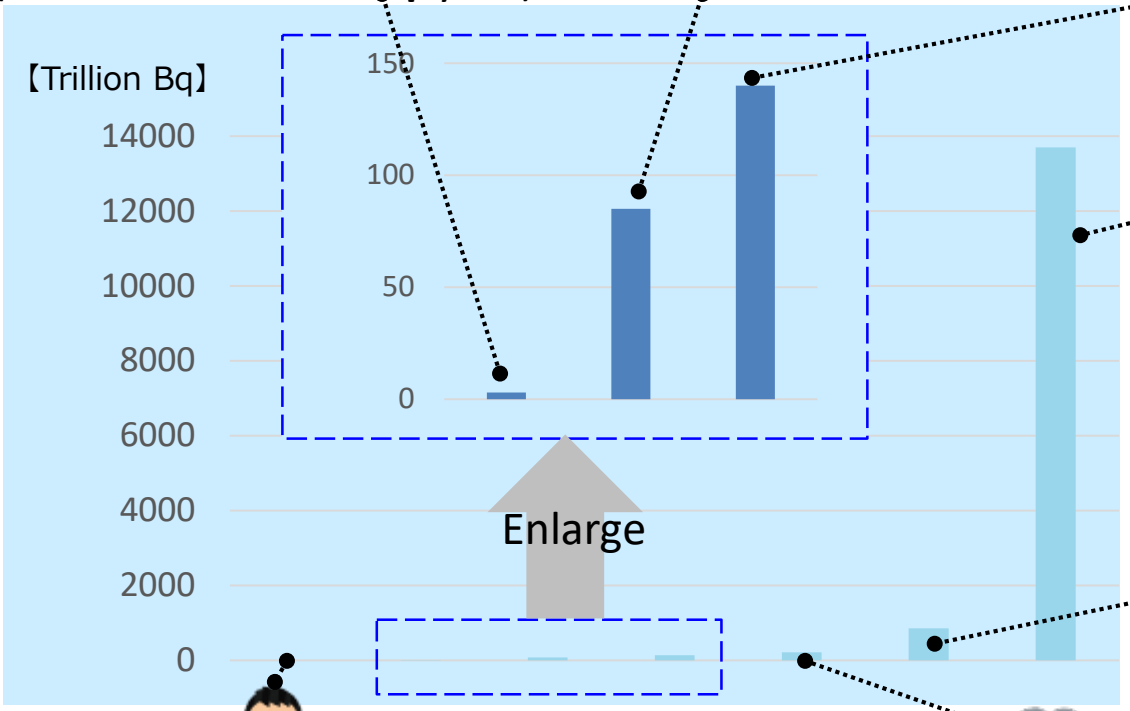
◇**Tritium is discharged from nuclear facilities in and outside Japan, in compliance with the regulatory standards of each country.**

Average amount of Tritium discharged from Boiling Water Reactor type nuclear power plants (NPPs) 【annual】
(less than **2.9 trillion Bq**/year)

Average amount of Tritium discharged from Pressured Water Reactor type NPPs 【annual】
(less than **85 trillion Bq**/year)

Amount of Tritium discharged from CANDU type NPP 【annual】
(about **140 trillion Bq**/year)

Amount of Tritium discharged from reprocessing plant 【annual】
(less than **13 quadrillion Bq**/year)

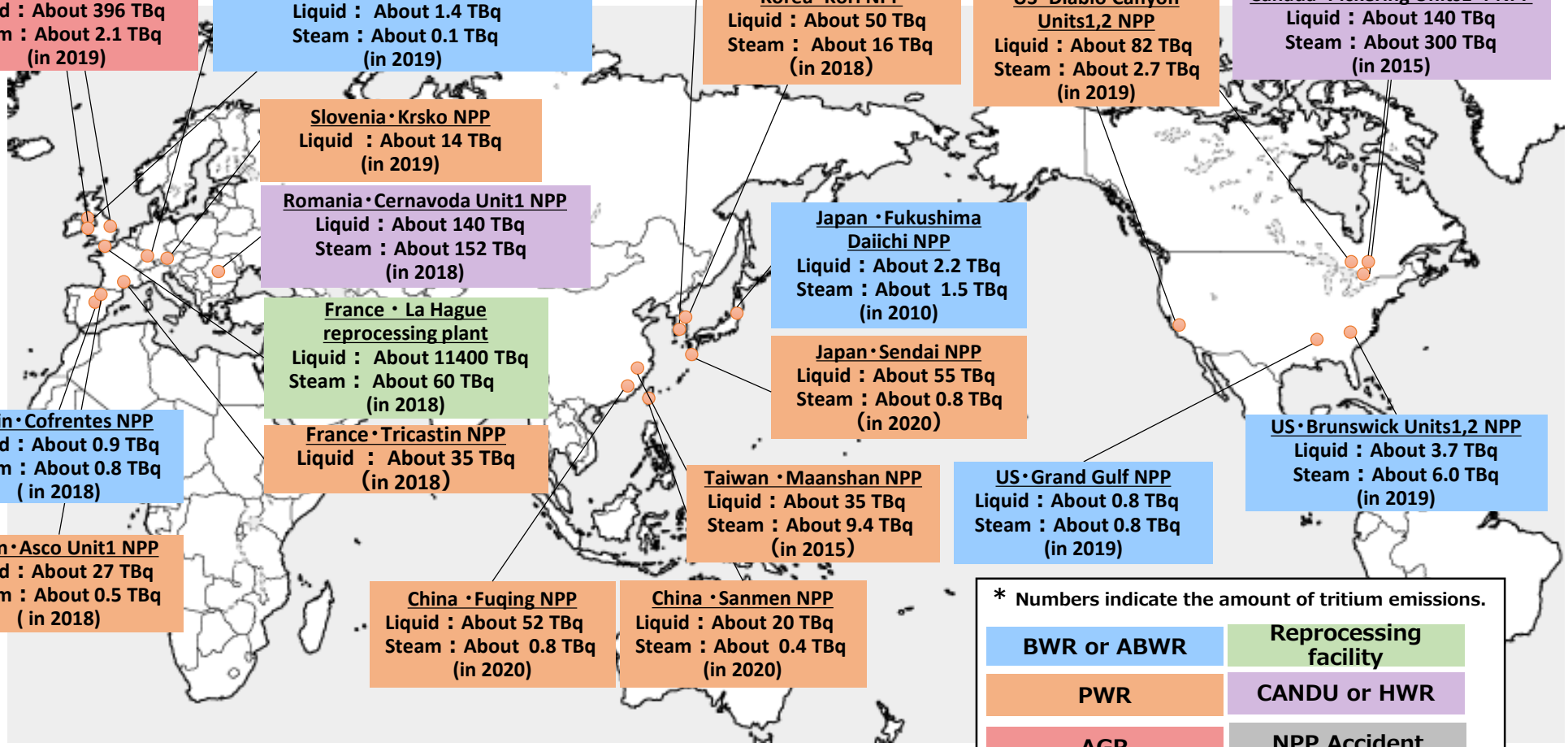


Amount of Tritium stored in Fukushima Daiichi NPS
【total】 (about **860 trillion Bq**)

Amount of Tritium in human body 【total】
(**tens of Bq**)

Amount of Tritium in rainwater in Japan 【annual】
(about **220 trillion Bq**/year)

(Ref.) Examples of tritium emission -Annual discharge from NPPs-



UK・Sizewell B NPP
Liquid：About 28 TBq
Steam：About 0.4 TBq
(in 2019)

UK・Sellafield reprocessing facility
Liquid ：About 423 TBq
Steam ：About 56 TBq
(in 2019)

Korea・Wolseong NPP
Liquid：About 25 TBq
Steam：About 110 TBq
(in 2018)

Canada・Bruce A,B NPP
Liquid：About 756 TBq
Steam：About 994 TBq
(in 2018)

Canada・Darlington NPP
Liquid ：About 220 TBq
Steam：About 210 TBq
(in 2018)

UK・Haysham B NPP
Liquid：About 396 TBq
Steam：About 2.1 TBq
(in 2019)

Germany・Gundremmingen B-C NPP
Liquid： About 1.4 TBq
Steam：About 0.1 TBq
(in 2019)

Korea・Kori NPP
Liquid：About 50 TBq
Steam： About 16 TBq
(in 2018)

US・Diablo Canyon Units1,2 NPP
Liquid：About 82 TBq
Steam：About 2.7 TBq
(in 2019)

Canada・Pickering Units1-4 NPP
Liquid：About 140 TBq
Steam：About 300 TBq
(in 2015)

Slovenia・Krsko NPP
Liquid ：About 14 TBq
(in 2019)

Romania・Cernavoda Unit1 NPP
Liquid：About 140 TBq
Steam：About 152 TBq
(in 2018)

Japan ・Fukushima Daiichi NPP
Liquid：About 2.2 TBq
Steam：About 1.5 TBq
(in 2010)

France・ La Hague reprocessing plant
Liquid： About 11400 TBq
Steam： About 60 TBq
(in 2018)

Japan・Sendai NPP
Liquid：About 55 TBq
Steam：About 0.8 TBq
(in 2020)

Spain・Cofrentes NPP
Liquid：About 0.9 TBq
Steam：About 0.8 TBq
(in 2018)

France・Tricastin NPP
Liquid ： About 35 TBq
(in 2018)

Taiwan ・Maanshan NPP
Liquid：About 35 TBq
Steam：About 9.4 TBq
(in 2015)

US・Grand Gulf NPP
Liquid：About 0.8 TBq
Steam：About 0.8 TBq
(in 2019)

US・Brunswick Units1,2 NPP
Liquid：About 3.7 TBq
Steam：About 6.0 TBq
(in 2019)

Spain・Asco Unit1 NPP
Liquid：About 27 TBq
Steam：About 0.5 TBq
(in 2018)

China ・Fuqing NPP
Liquid：About 52 TBq
Steam：About 0.8 TBq
(in 2020)

China ・Sanmen NPP
Liquid：About 20 TBq
Steam：About 0.4 TBq
(in 2020)

* Numbers indicate the amount of tritium emissions.

BWR or ABWR	Reprocessing facility
PWR	CANDU or HWR
AGR	NPP Accident

<Ref.> 1×10^{12}Bq≒ about0.019g (Tritiated water)

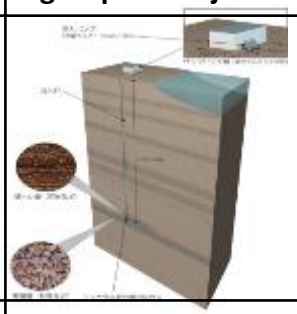
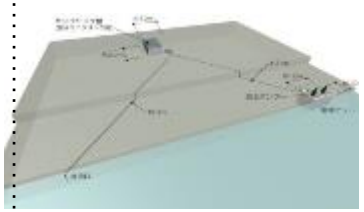
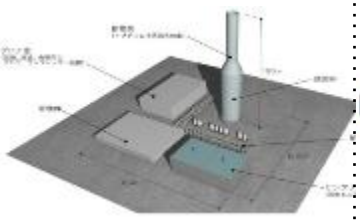
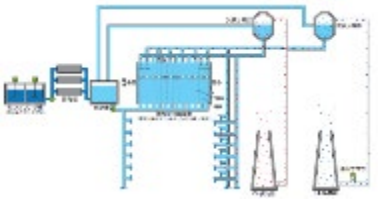
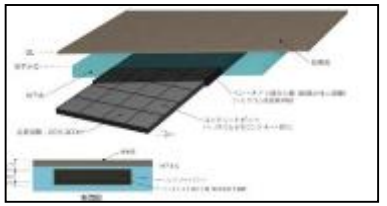
Source：UK： Radioactivity in Food and the Environment, 2019
Canada：Canadian National Report for the Convention on Nuclear Safety
France：Tritium White paper
Other countries ：Prepared from reports published by electricity providers in various countries and regions.

(Ref.) Handling of ALPS treated water

* 5 options and Long-term storage

- **"The Tritiated Water Task Force (2013-2016)"**
  Technical feasibility (including monitoring to ensure safety), regulatory feasibility period and cost of five handling methods were examined;
  - ✓ All cases were examined on the premise that there is no scientific impact on the human habitant.
  - ✓ Verification project showed that the separation technology for tritium cannot yet put into use.
- **"The Subcommittee on Handling ALPS Treated Water (2016-)"**
  Five handling methods and long-term storage are examined in a comprehensive manner, including from the perspective of countermeasure for reputational damage and of ensuring scientific safety
- **All the measures, throughout their implementation, are subject to the approval of Nuclear Regulatory Authority in accordance with the Reactor Regulation Act.**

Table Results of assessment of Tritiated water task force

Method of disposal	(1) Example of **geosphere injection**	(2) Example of **discharge to the sea**	(3) Example of **vapor release**	(4) Example of **hydrogen release**	(5) Example of **underground burial**
Image					
Technical feasibility	- If proper stratum is not found, commencement of handling will be delayed. - There is no monitoring method established	Examples) - Existing Nuclear facilities' liquid radioactive waste discharge to the sea	Example) TMI-2 - water volume: 8,700 m^3 - Tritium volume: 24 tri. Bq. Tritium conc.: 2.8mil. Bq/L - Total period: 2.8 years	To handle the ALPS treated water, R&D for pre-treatment and scale expansion might be needed.	examples) - Concrete pit disposal site - Shut-off disposal site
Regulatory feasibility	It is necessary to formulate new regulations and standards related to disposal concentration	Feasible	**Feasible**	**Feasible**	New standards might be needed.

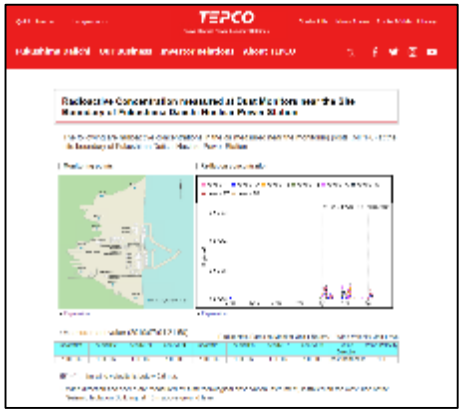
(Ref.) Information Portal site （1）: Fukushima Daiichi NPS

METI
Ministry of Economy, Trade and Industry

- **Decommissioning and Contaminated Water Management at TEPCO's Fukushima Daiichi NPS**
  https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/index.html
- **Film, Fukushima Today 2019**
  - Efforts to Decommission and Reconstruction
  https://www.youtube.com/watch?v=v_PeSp--Wuk
- **Film, Fukushima Today**
  - 8 years after the earthquake -
  https://www.youtube.com/watch?v=pKjsSAz5Kws

TEPCO
Tokyo Electric Power Company Holdings

- **Treated Water Portal Site**
  http://www.tepco.co.jp/en/decommission/progress/watertreatment/index-e.html
- **Observation Data, Fukushima Daiichi NPS**
  https://www7.tepco.co.jp/responsibility/decommissioning/1f_newsroom/data/index-e.html



(Ref.) Information Portal site （2）: Fukushima Daiichi NPS

IAEA International Atomic Energy Agency

Fukushima Daiichi Status Updates

https://www.iaea.org/newscenter/focus/fukushima/status-update

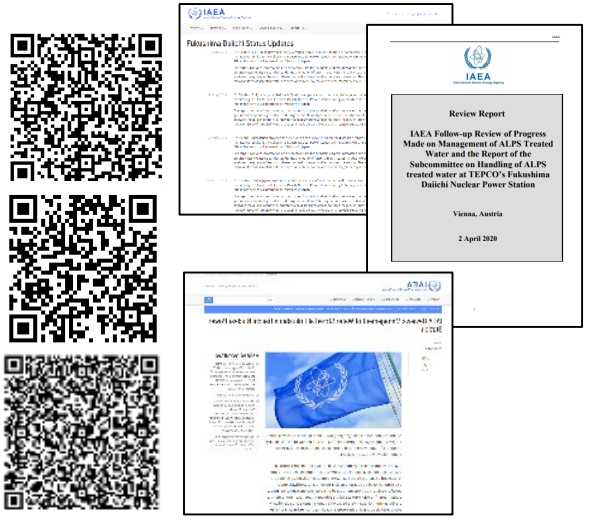
IAEA Review mission reports (Press release)

*IAEA Follow-up Review of Progress Made on Management of ALPS Treated Water and the Report of the Subcommittee on Handling of ALPS treated water at TEPCO's Fukushima Daiichi Nuclear Power Station

https://www.meti.go.jp/English/earthquake/nuclear/decommissioning/pdf/4fu-report.pdf

*IAEA Reviews Management of Water Stored at Fukushima Daiichi Nuclear Power Station (April 2, 2020)

https://www.iaea.org/newscenter/pressreleases/iaea-reviews-management-of-water-stored-at-fukushima-daiichi-nuclear-power-station



NEA NUCLEAR ENERGY AGENCY

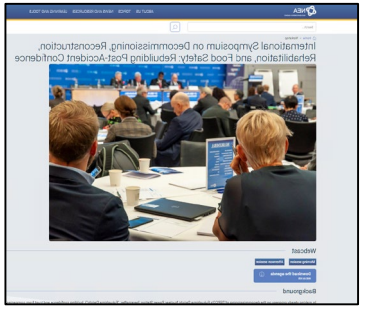
Joint project, Workshop

*Preparatory Study on Analysis of Fuel Debris (PreADES)

https://www.oecd-nea.org/jcms/pl_25169/preparatory-study-on-analysis-of-fuel-debris-preades-project

*International Symposium on Decommissioning, Reconstruction, Rehabilitation, and Food Safety: Rebuilding Post-Accident Confidence (March 26, 2019)

https://www.oecd-nea.org/jcms/pl_27814/international-symposium-on-decommissioning-reconstruction-rehabilitation-and-food-safety-rebuilding-post-accident-confidence



United Nations Scientific Committee on the Effects of Atomic Radiation

UNSCEAR 2016 REPORT

-Sources, effects and risks of ionizing radiation

hhttps://www.unscear.org/unscear/en/publications/2016.html