Basic policy on handling of the ALPS treated water

13 April, 2021

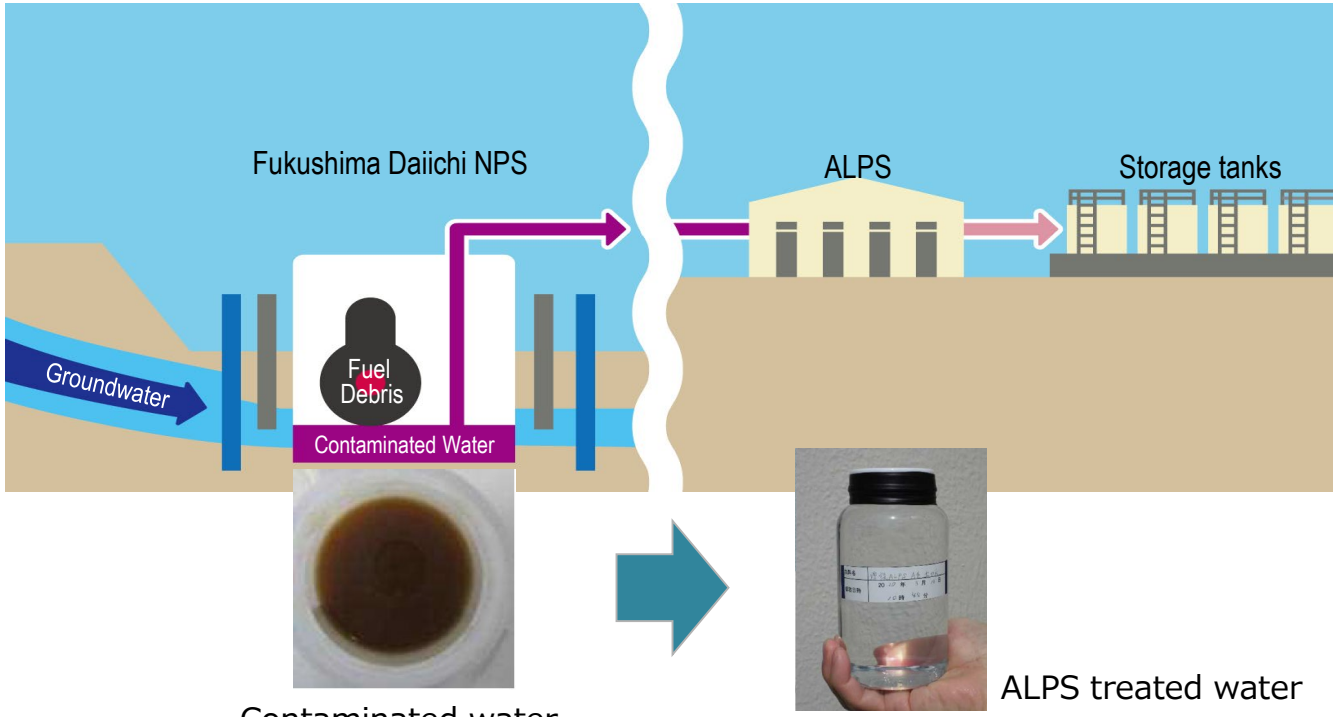
Ministry of Economy, Trade and Industry

1. Background: Contaminated water and ALPS treated water

- "**Contaminated water**" contains a large amount of radioactive materials, and have been generated in buildings every day since the accident.
- "**ALPS treated water**" is water in which most of radionuclides are removed by ALPS (Advanced Liquid Processing System) to meet the regulatory standards for discharge with an exception of tritium.

→ *"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.*



1. Background: Water stored in tanks

About 30 % (ALPS treated water)

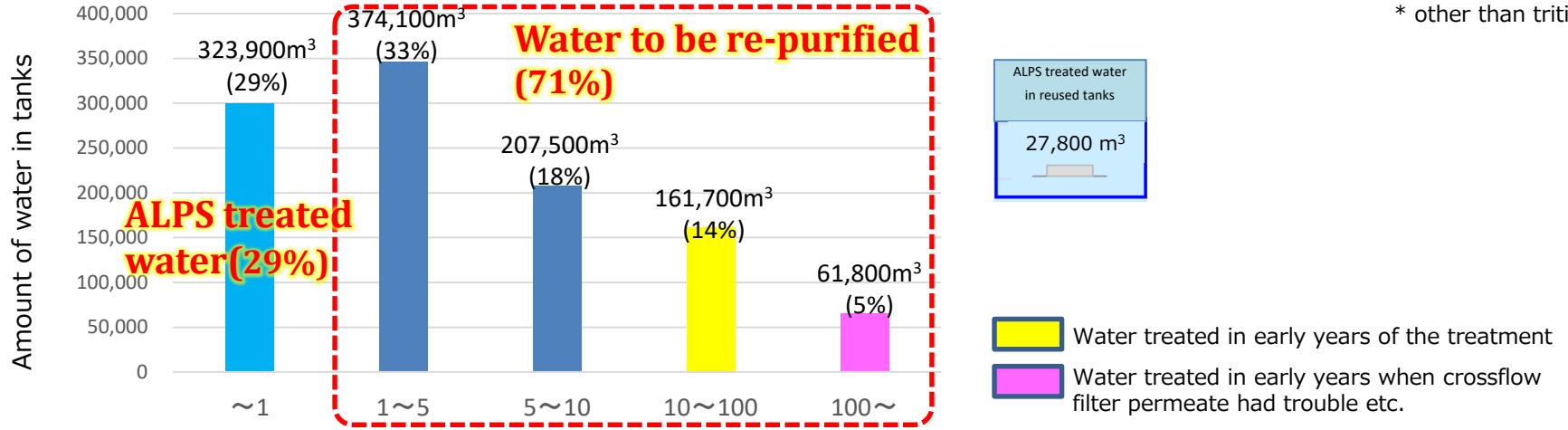
→ concentration of radionuclides other than tritium meets the regulatory standards for discharge.

About 70 %

→ 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.

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



"The regulatory standards for discharge" is the limit of concentration applicable to the discharge of radioactive waste to the environment, which is stipulated in ***the ordinance of the Reactor Regulation Act. If the water contains multiple nuclides, the sum of the ratio should be less than "1".***

(Ref.) Results of re-purification performance test

- TEPCO analyzed 62 nuclides which are subject to the removal and Carbon-14.
- For water contains multiple nuclides, the regulatory standards for discharge is the sum of the ratios be **less than "1"**.

Sum of the ratios of concentration of each readionuclides relative to the regulatory standards for them (other than tritium)

	Before	After
Water with high concentration	2,406	0.35
Water with low concentration	387	0.22

https://www.tepco.co.jp/en/decommission/progress/watertreatment/images/201224.pdf

Basic policy on handling of the ALPS treated water -1

1. (1) Basic premise

- Reconstruction are being observed in affected areas, while rumor-based adverse impacts on reputation remain on industries, especially in the agriculture, forestry, fishery and tourism industries. *(→ P5)*

  → The Government of Japan will continue to take charge in prioritizing the reconstruction and revitalization.

- Systematic decommissioning efforts are essential for reconstruction and revitalization, in order to achieve both reconstruction and decommissioning. Handling of the ALPS treated water has been examined. *(→ P6)*

- Large areas are needed for fuel debris retrieval. The current situation where the tanks and piping facilities occupy increasingly large areas of the site can be a critical bottleneck in future decommissioning work, unless their placement is reviewed. It has been pointed out that the existence of the tanks themselves is a cause of the adverse impacts on reputation, and that the risk associated with deterioration or disaster may increase. *(→ PP7-8)*

Progress in reconstruction efforts

- People has been gradually returning to the area and reconstruction is progressing.
- However, rumor-based adverse impacts on reputation remain on industries, especially in the agriculture, forestry, fishery and tourism industries.
- The Government of Japan will continue to take charge in prioritizing the revitalization and reconstruction.

Number of people and size of area subject to the evacuation order

	(August 2013)		(March 2020)
Number of people subject to the evacuation order	81 thousand	→	22 thousand
Area under evacuation order	About 1,150㎢	→	About 340㎢

Joban Line has resumed full service (March, 2020)

Situation of agricultural and fishery industry (2010=100%)

Agricultural production (Fukushima)	89% (2018)
Fishery production (Coastal fishing and offshore trawl fishery)	17% (2020)

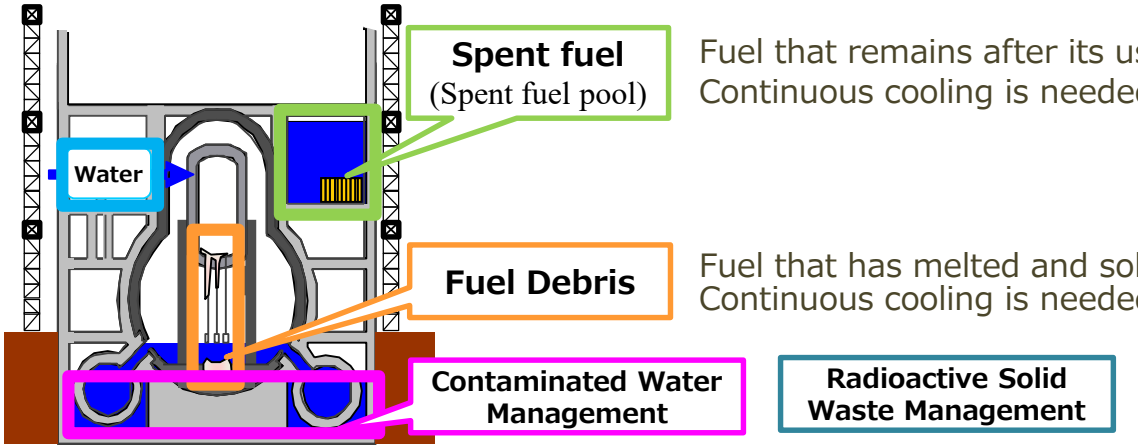
Fish market at Ukedo port (April, 2020-)

Decommissioning of TEPCO's Fukushima Daiichi NPS

◇ **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

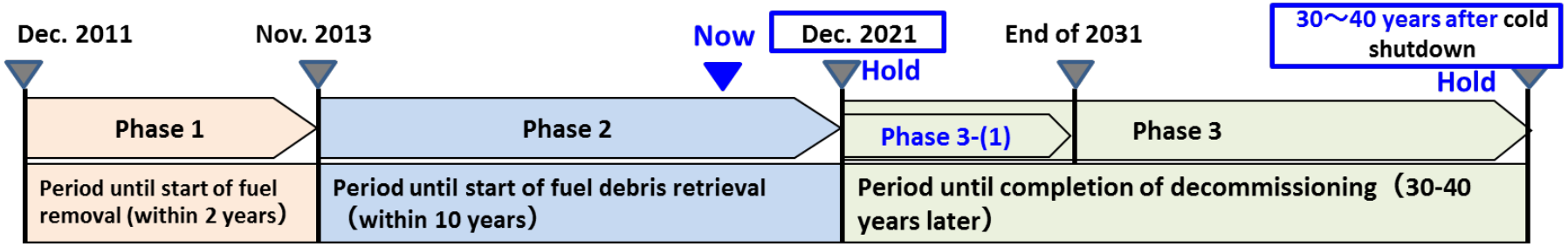
◇ **Safe and steady decommissioning is a prerequisite for reconstruction of Fukushima**



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

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

Mid-and-Long-term Roadmap (December, 2019)



Current situation of the treated water

Tank groups storing water

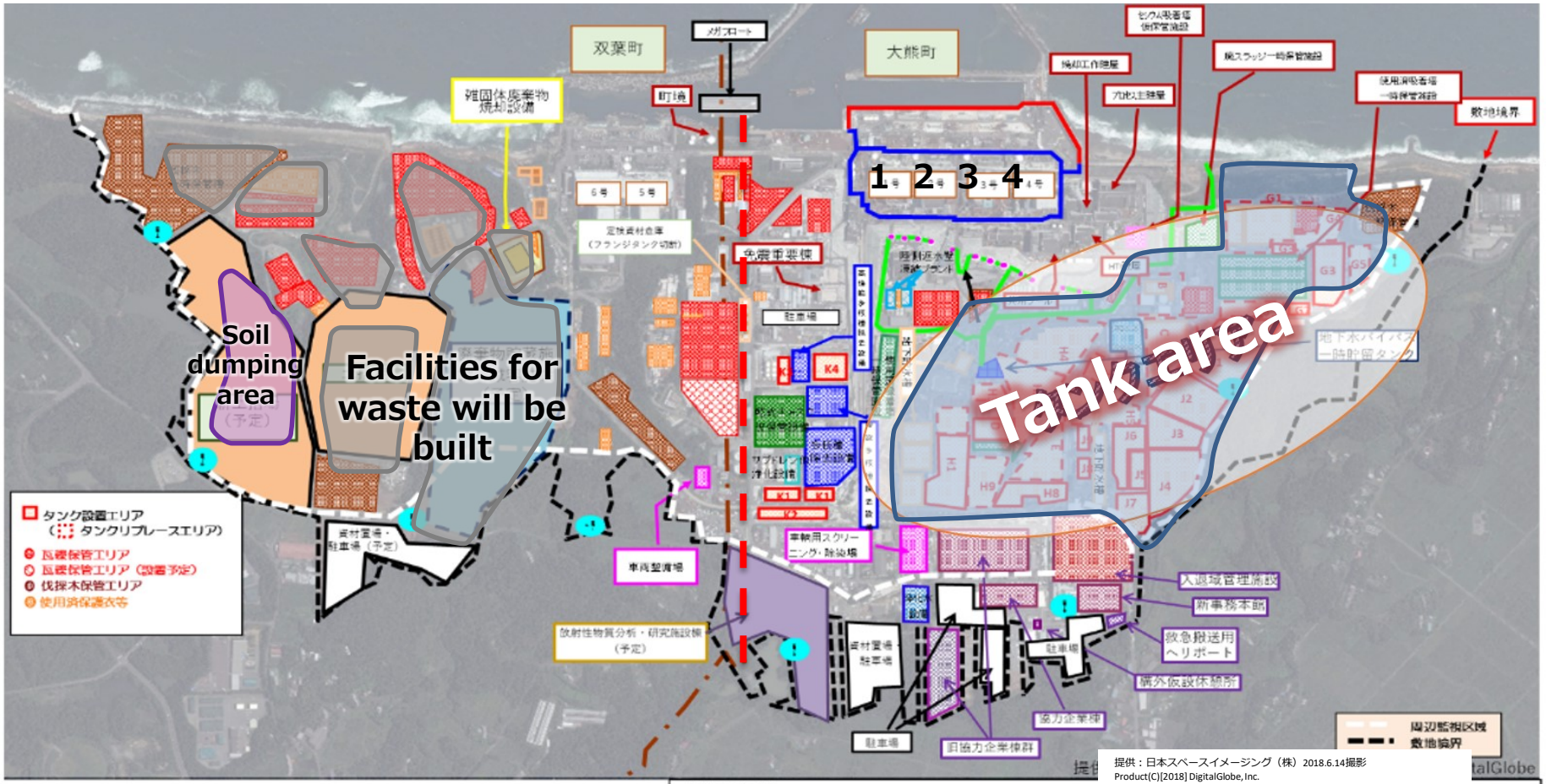
Status of water in tanks at FDNPS (As of November, 2020)	
Tank storage volume	About 1.23 million ㎥
Tank capacity (at the end of 2020)	About 1.37million ㎥
Increase of treated water	About 50,000 to 60,000 ㎥/year

- ***ALPS treated water*** *is water in which most kinds of nuclides other than tritium to meet the national regulatory standards for discharge based on the ICRP recommendations.*

(Ref.) Site layout of Fukushima Daiichi NPS

◇ 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。

Basic policy on handling of the ALPS treated water -2

1. (2) Background: towards issuing basic policy

- For more than six years, the handling of the water has been studied by experts. The **report was published in February 2020**. *(→ Appendix 1, PP19-21)*
  - Five options which were regarded as technically feasible were examined and "discharge into the sea was more reliable method of implementation."
  - Long-term storage: "the additional space for installing more tanks than currently planned is limited"
  - Tritium separation: "no technologies have been judged as being close to practical use"

  → IAEA acknowledged that the options suggested by the committee is "based on a sound scientific and technical basis of analysis"

- After publication of the subcommittee's report:*(→ Appendix 1, PP22-24)*
  - hundreds of meetings were held with local municipalities and relevant people in agricultural, forestry and fishery industries and various other parties concerned;
  - 7 times of "meeting for hearing opinions" were held, with the attendance of vice ministers of related ministries;
  - more than 4,000 opinions have been received.

  → The Government attaches great importance to the ALPS subcommittee repot and diverse opinions the Government has received, and sets basic policy on handling of the ALPS treated water

Basic policy on handling of the ALPS treated water -3

2. The handling of the ALPS treated water

- The Government selects discharge into the sea, based on achieving certain and consistent compliance with their regulatory standards set forth based on the recommendation of the ICRP and considering the successful precedence in Japan, as well as in conducting secure and sound monitoring. *(→ Appendix 1)*

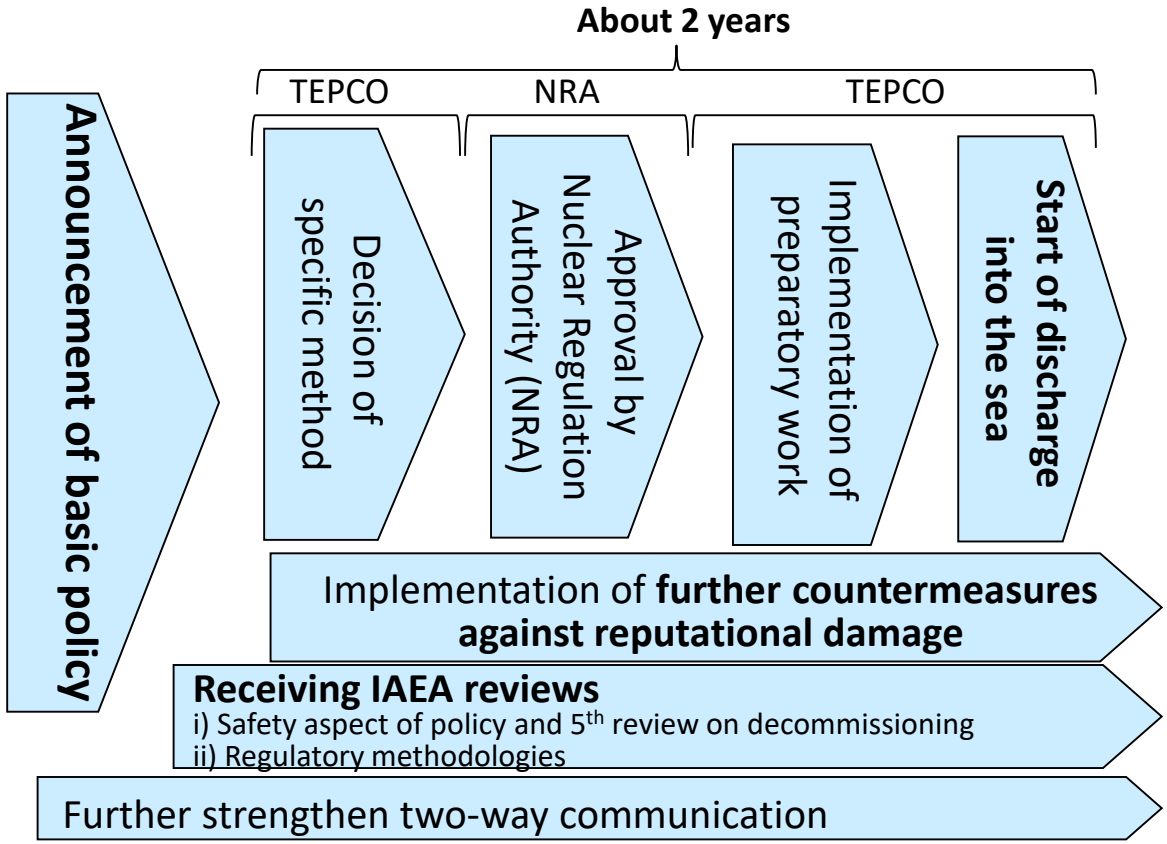
  → IAEA acknowledged that the option is “routinely used by operating nuclear power plants and fuel cycle facilities in Japan and worldwide” and “technically feasible.”

- TEPCO must comply with the regulatory standards stipulated in the Reactors Regulation Act which has been set based on the recommendations of ICRP. The safety of the public and environment will be ensured as it was always been. *(→ Appendix 1)*

- As a responsible member of the international community, Japan will continue to proactively provide information with highly transparent manner.

2. (1) Basic policy on handling of ALPS treated water

- Based on more than six years of comprehensive study by experts, reviews by the IAEA, and engagement with parties concerned, the Government of Japan published **the Basic Policy** on handling of the ALPS treated water at FDNPS on 13 April 2021.
- **Subject to the approval** of the independent Nuclear Regulation Authority (NRA) to the detailed plan, **TEPCO can start the discharge into the sea** (envisaged to take place approximately after **two years**).



Basic policy on handling of the ALPS treated water -4

3. Specific Method of discharge of the ALPS treated water into the sea

- The Government requires that TEPCO will proceed with concrete preparations such as the construction of facilities for discharge and other works, to start discharge of ALPS treated water into the sea from the premise of FDNPS, approximately after two years

1) A method of discharge that minimizes adverse impacts on reputation *(→ p13)*

i. Tritium

- **Concentration:** 1,500 Bq/L

  → 1/40 of the regulatory standard (60,000Bq/L), 1/7 of WHO drinking water guideline level (10,000 Bq/L)

- **Annual amount of discharge**: **Less than 22 trillion Bq/year** (Operational target value before the accident)

ii. Radioactive material other than tritium:

- To be re-purified to below the regulatory standards for discharge and sufficiently diluted

→ Suppress adverse impacts on reputation by ensuring safety

2) Strengthen and enhance marine monitoring

- Strengthen and enhance marine monitoring before and after the discharge, having participation and observation by agriculture, forestry, fisheries, local municipalities and other businesses *(→ P16)*

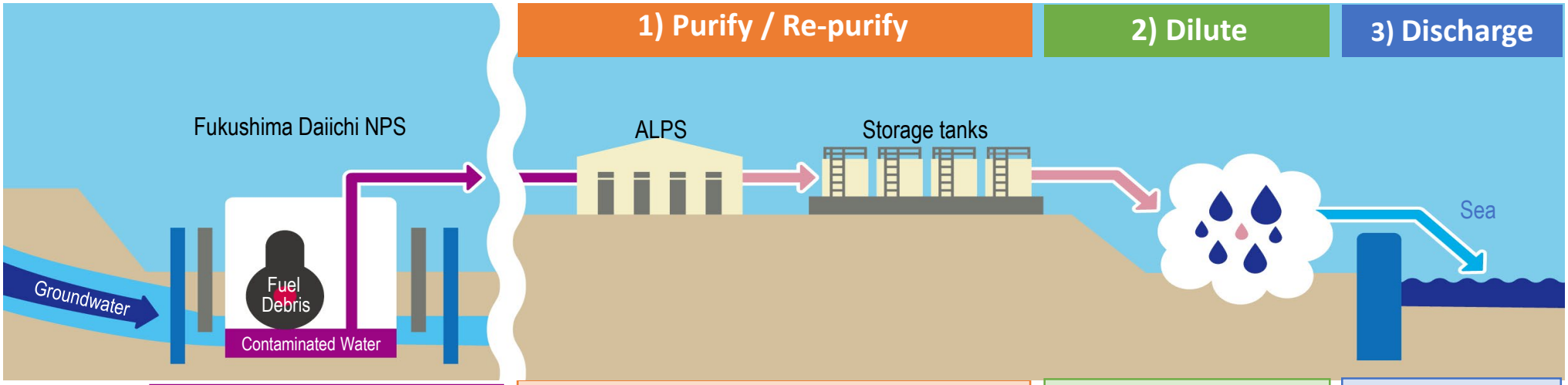
- Securing credibility of analytical capability with the cooperation of IAEA

→ **Additional measures** based on international standards and practices for the assessment will also be taken. (To be published in due course.) *(→ PP14-15)*

2. Basic policy: (2) The handling method

Three Step Approach to meet the regulatory standards for discharge

Japan's regulatory standards for discharge are set based on the recommendations of the International Commission for Radiological Protection (ICRP), keeping additional public radiation below 1mSv/year.



Contaminated Water is generated when groundwater touched the damaged reactors and debris.

Remove almost all kinds of nuclides other than tritium* to the maximum extent, and meet the national regulatory standards set based on the ICRP recommendations

ALPS Treated Water

Dilute more than **100 times to make tritium to at the most 1/40th of the national regulatory standards (1,500Bq/L)** **

Subject to the approval of NRA, discharge will be started (envisaged after two years) ***

*Carbon-14 also cannot be removed through purification process, but Carbon-14 contained in the water stored in tanks is far below the level of national regulatory standards (at the most 1/10 th of the standard). After dilution, the level of Carbon-14 will go down to at the most 1/1000th of the standards.

**Concentration of the nuclides other than tritium becomes negligible in purification/re-purification and dilution process.

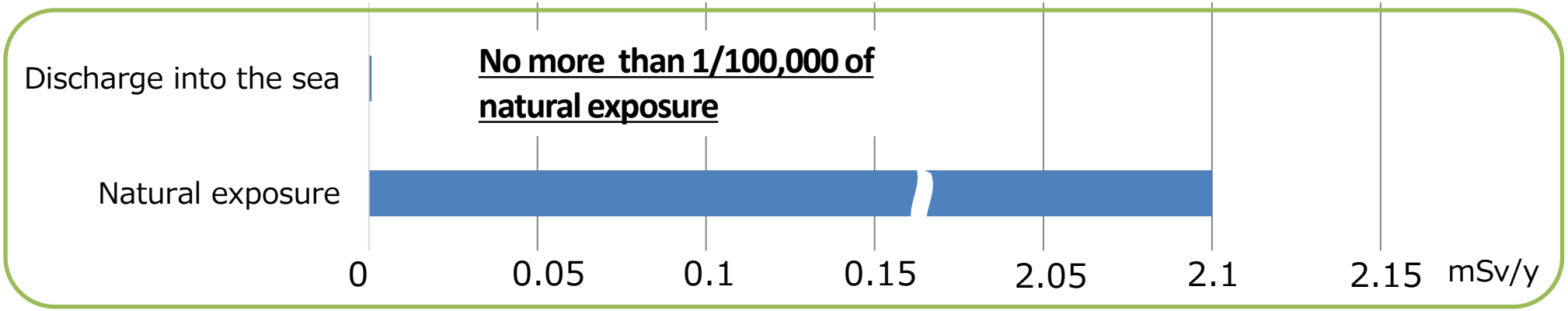
*** Annual emission of tritium will be less than 22 trillion Bq/year.

2. (3) Radiation impact assessment to the public

- The impact assessed with UNSCEAR's methodology* would be less than **1/100,000** of the natural radiation exposure (2.1 mSv/year) in Japan.

Premise: This estimate is calculated, assuming that 22 trillion Bq per year of tritium and other radionuclides in the ALPS treated water will be discharged after the ALPS treatment.

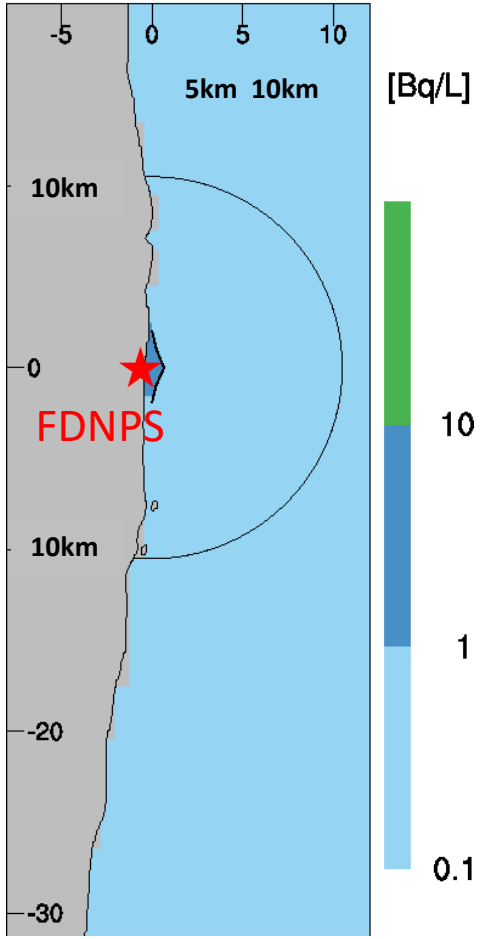
Comparison of radiation impacts from natural exposure and discharge of ALPS treated water*



- The methodology for assessing the radiation exposures of general public from discharges of radionuclides to the environment was designed by United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)

2. (3) Dispersion simulation

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



Premise: 22 Trillion Bq of tritium (the operational target value for discharge before the accident) is discharged per year. Planned discharge will be conducted within this target

Area above 1 Bq/L
* To about 1.5 km to the north
* To about 1.5 km to the south
* To about 0.7 km to offshore

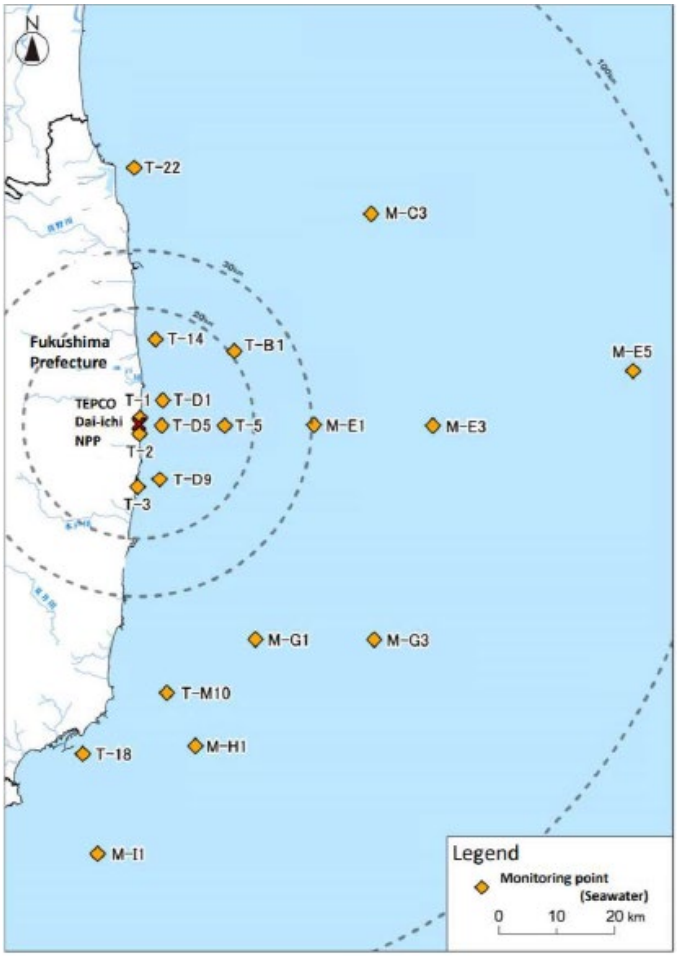
⇒**Additional measures** based on international standards and practices for the assessment will also be taken. (To be published in due course.)

2. (3) Environmental monitoring

- The Government will strengthen and enhance monitoring before and after the discharge
- Invite participation of the local governments and fishery people
- Transparency will be ensured by activities such as IAEA monitoring project.

Source: Nuclear Regulation Authority (NRA), Japan https://radioactivity.nsr.go.jp/en/

Source: NRA Japan
https://radioactivity.nsr.go.jp/en/contents/8000/7745/24/okiai.pdf



Basic policy on handling of the ALPS treated water -5

4. Measures to respond adverse impacts on reputation

1) Increase public understanding to minimize adverse impacts on reputation

- Provide information based on scientific evidence
- Cooperation with the IAEA

2) Measures for production, processing, distribution and consumption phases

- Strengthen and enhance support fishery industry, develop/cultivate sales channels
- Initiatives to attract more tourists

3) Measures to respond to reputational damage in case of occurrence

5. Further steps for the future

1) Establishment of the meeting to follow-up implementation status

2) Tritium separation technology

- Since no technology for separating tritium has yet been found as being immediately practical use at the Fukushima Daiichi NPS, the discharge will be conducted with dilution.
- However, new technological trends will be carefully and continuously monitored, and if a viable technology emerges, it will be implemented as rapidly as practicable.

Appendix 1. Discussion on the ALPS treated water issue

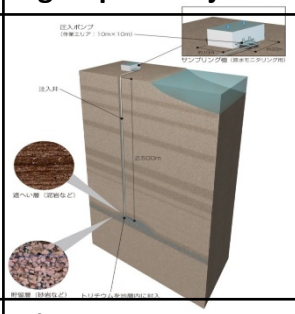
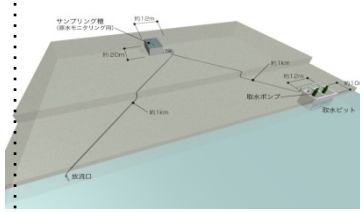
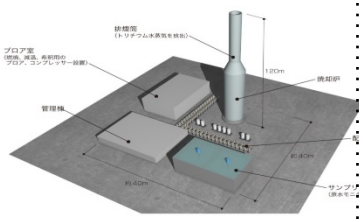
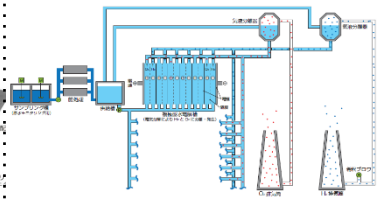
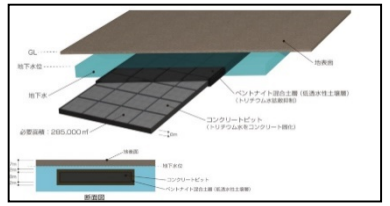
Appendix 2. Information on Tritium

Appendix 1. Discussion on the ALPS treated water issue

(1) Tritiated water task force (2013-2016)

- ✓ Technical feasibility (including monitoring to ensure safety), regulatory feasibility period and cost of **five handling methods** were examined;
- ✓ Verification project showed that **the separation technology for tritium could not be utilized**.

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.

Appendix 1. Discussion on the ALPS treated water issue

(2) Subcommittee on handling of ALPS treated water (2016-2020)

i) Both **discharge into the sea** and **vapor release** were suggested as feasible options.

-- **Discharge into the sea" can be implemented more reliably**, considering the ease of discharge facilities operation and proper monitoring methods.

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

ii) Both to transfer the treated water to outside the site and to store the treated water in tanks outside the site will **increase risks outside the site**.

-- In addition, it is necessary to obtain understanding from related local governments and local residents, which takes a considerable amount of time.

iii) **The ALPS treated water will be re-purified** to meet the regulatory standards for discharge, and then **sufficiently diluted**.

(Ref.) What are the IAEA's findings on the handling 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

(Ref.) "Meeting for Hearing Opinions" about the ALPS treated water

- 7 "Meetings for Hearing Opinions" have been held in 2020 in Fukushima Prefecture and Tokyo metropolitan area based on the suggestion by the ALPS Subcomittee.
- 29 groups (43 people) of local concerned parties, local governments, and national groups such as economy, tourism, distribution, and consumers participated.

Main opinions from "Meetings for Hearing Opinions"

*Concerns for safety of the ALPS treated water
*Concerns for negative impact on reputation and delay in reconstruction
*Concerns for the consensus process
*Proposals for handling of the ALPS treated water and R&D on tritium separation
*Opinions on discharging into the environment

Dates and Locations of Meetings

1st -	6 April, 2020	(Fukushima City, Fukushima Prefecture)
2nd -	13 April, 2020	(Fukushima City and Tomioka town, Fukushima Prefecture)
3rd -	11 May, 2020	(On-line conference)
4th -	30 June, 2020	(Tokyo metropolitan area)
5th -	17 July, 2020	(Fukushima City, Fukushima Prefecture)
6th -	9 September, 2020	(Tokyo metropolitan area)
7th -	10 October, 2020	(Tokyo metropolitan area)

(Ref.) Public comments

- Period: April 6th-July 31st, 2020 (117 days *)
  *The initial deadline was May 15, 2020 which was set according to the normal procedure. The period was extended until July 31,2020 to receive opinions in a courteous manner.
- Number of submissions: 4,011 (excluding duplicates)

Major Opinions *The following numbers include duplication.

- Concerns for discharge into the sea
  - for safety of the ALPS treated water (About 2,700)
  - for negative impact on reputation and delay in reconstruction (About 1,000)
  - for the consensus process (About 1,400)
- Proposals for handling of the ALPS treated water and R&D on tritium separation (About 2,000)
- Others (Strengthening information dissemination, etc.) (About 1,400)

Listening to opinions of parties concerned

- Since the ALPS Subcommittee's report was published 10th Feb. 2020, the GOJ has conducted hundreds of briefing and discussion sessions with a variety of parties concerned such as residents of Fukushima Prefecture, other prefectures and foreign representatives.

Opinions received*

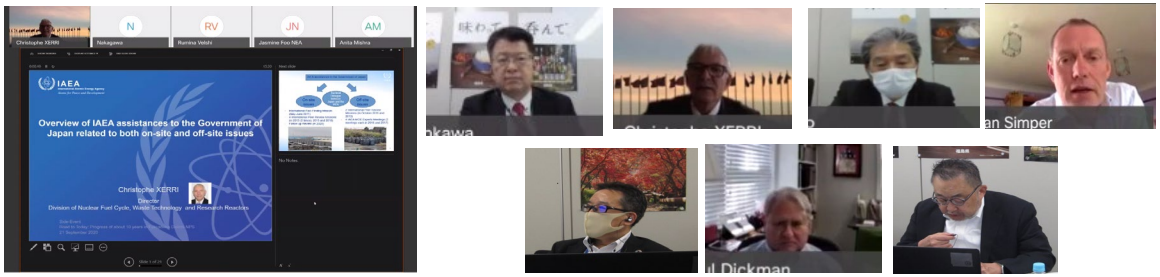
* A large variety of opinions were received, such as;
  -- the pros and cons of the handling options;
  -- concerns and opinions for adverse impact on reputation
  -- concerns for delay in reconstruction

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

- **Briefing sessions for Diplomatic Missions in Tokyo**
- **Technical briefings** on the occasions such as international conventions.
  - ✓ **At WTO/SPS (sanitary and phytosanitary) committee** in March 2021 (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）

Appendix 1. Discussion on the ALPS treated water issue

Appendix 2. Information on Tritium

Appendix 3. Information on tritium:

(1) Characteristics of tritium

◇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

(2) Tritium separation technology

◇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".

Appendix 3. Information on tritium: (3-1) Annual discharge from NPPs

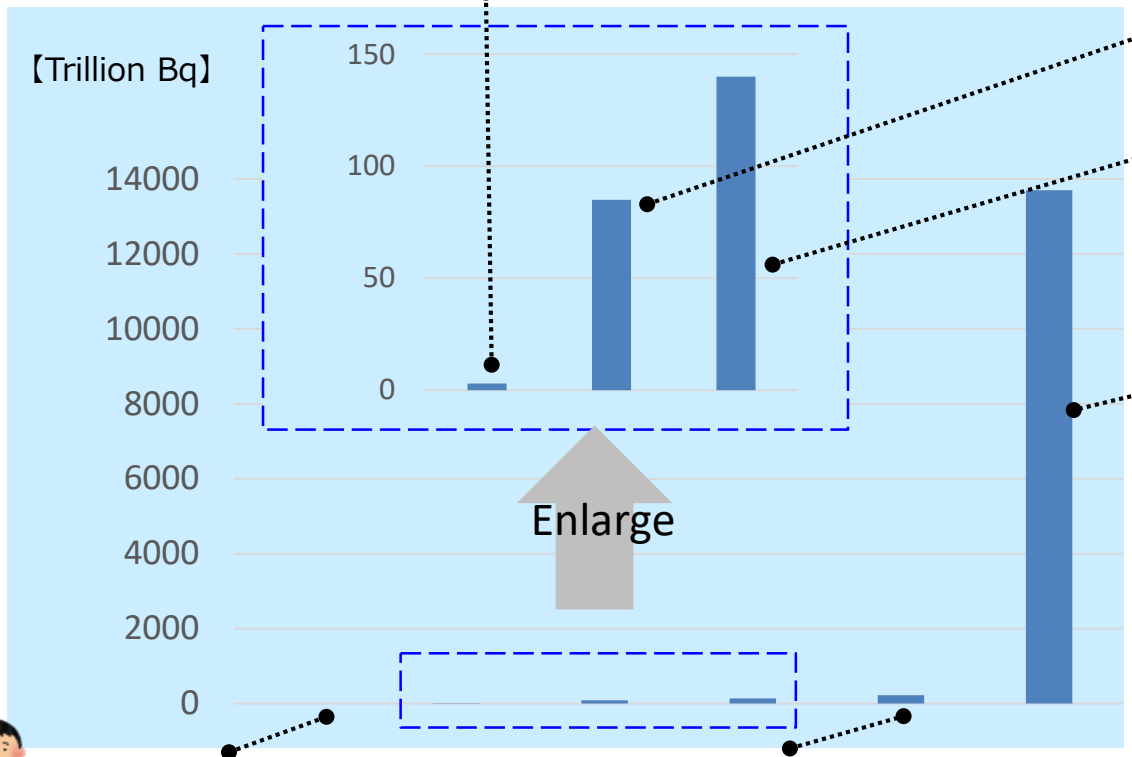
◇Tritium and other radionuclides are discharged from normal reactors:

i) **after removal** of radionuclides other than tritium and **dilution**; and

ii) **in compliance with the regulatory standards** of each country.

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

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



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

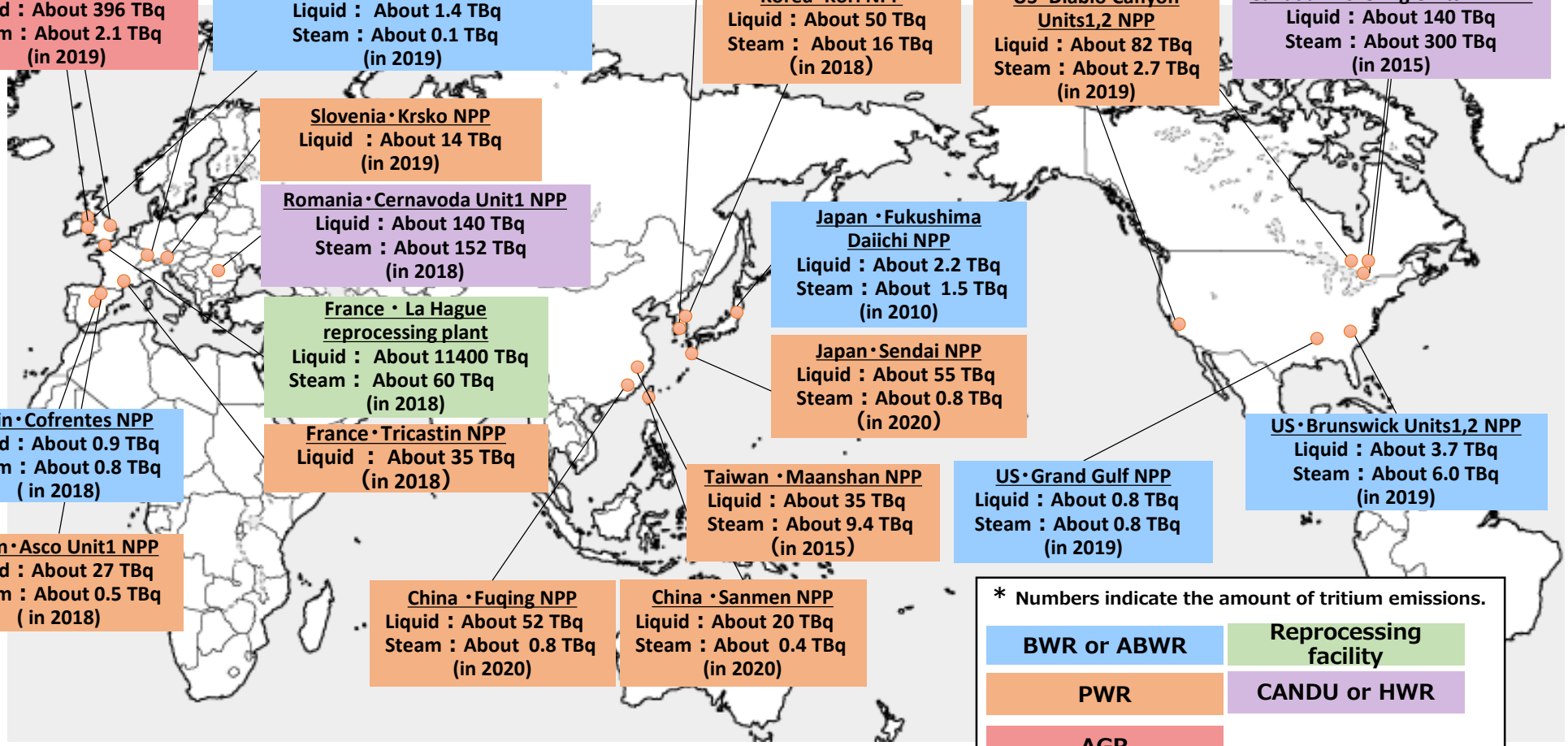
Amount of Tritium discharged from **a reprocessing plant** **【annual】**
(less than **13 quadrillion Bq**/year)

Amount of Tritium stored in Fukushima Daiichi NPS
【total】 (about **780 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)

Appendix 3. Information on tritium: (3-2) 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	

<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 and regions：Prepared from reports published by electricity providers in various countries and regions.