

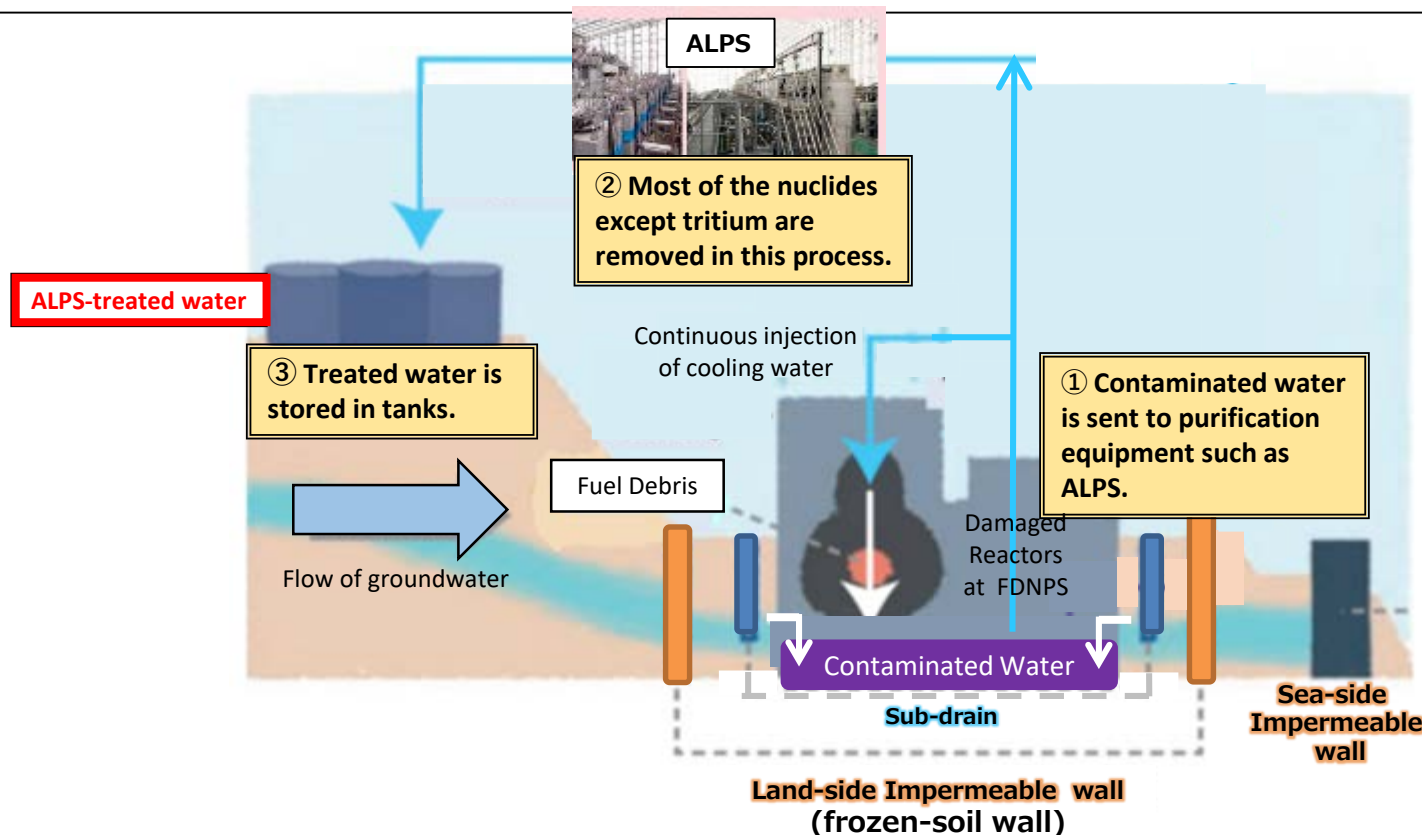
# **The Outline of the Handling of ALPS Treated Water at Fukushima Daiichi NPS (FDNPS)**

**Agency for Natural Resources and Energy  
METI**

**February 2020**

# Generation of contaminated water, purification process and tank storage

- ◇ **Water gets contaminated when it touches the damaged reactors and fuel debris in buildings.**
    - **The level of groundwater outside is controlled to be higher** than that of contaminated water inside the buildings to prevent the water flowing out of the building.
      - ➡ **Groundwater keeps flowing into the buildings**
  - ◇ **TEPCO has been successful in removing most of radionuclides except tritium** from contaminated water.
    - **ALPS** (Multi-nuclide retrieval equipment) and the other equipment have been used. ➡ See more at P13
- **It is ALPS treated water, NOT -contaminated water, that is stored in the tanks.**
  - **Radioactive materials in ALPS treated water are reduced to about 1/1,000,000 (one millionth).**



# Key figures of ALPS treated water



- ※ About 2 years will be needed for preparation and permission for disposal.
- ※ There is a limited room for further tank construction

## Key Figures for ALPS treated water at the site (As of Dec 12, 2019)

|  |   |
|--|---|
| Number of tanks                          | 965   |
| Tank Storage volume                      | About 1.18 million m <sup>3</sup>                         |
| Planned capacity<br>(Under current plan) | About 1.37 million m <sup>3</sup><br>(by the end of 2020) |
| Annual increase of<br>ALPS treated water | About 50,000~60,000m <sup>3</sup> /year                   |



**Time to reach its full capacity (forecast): around summer of 2022**

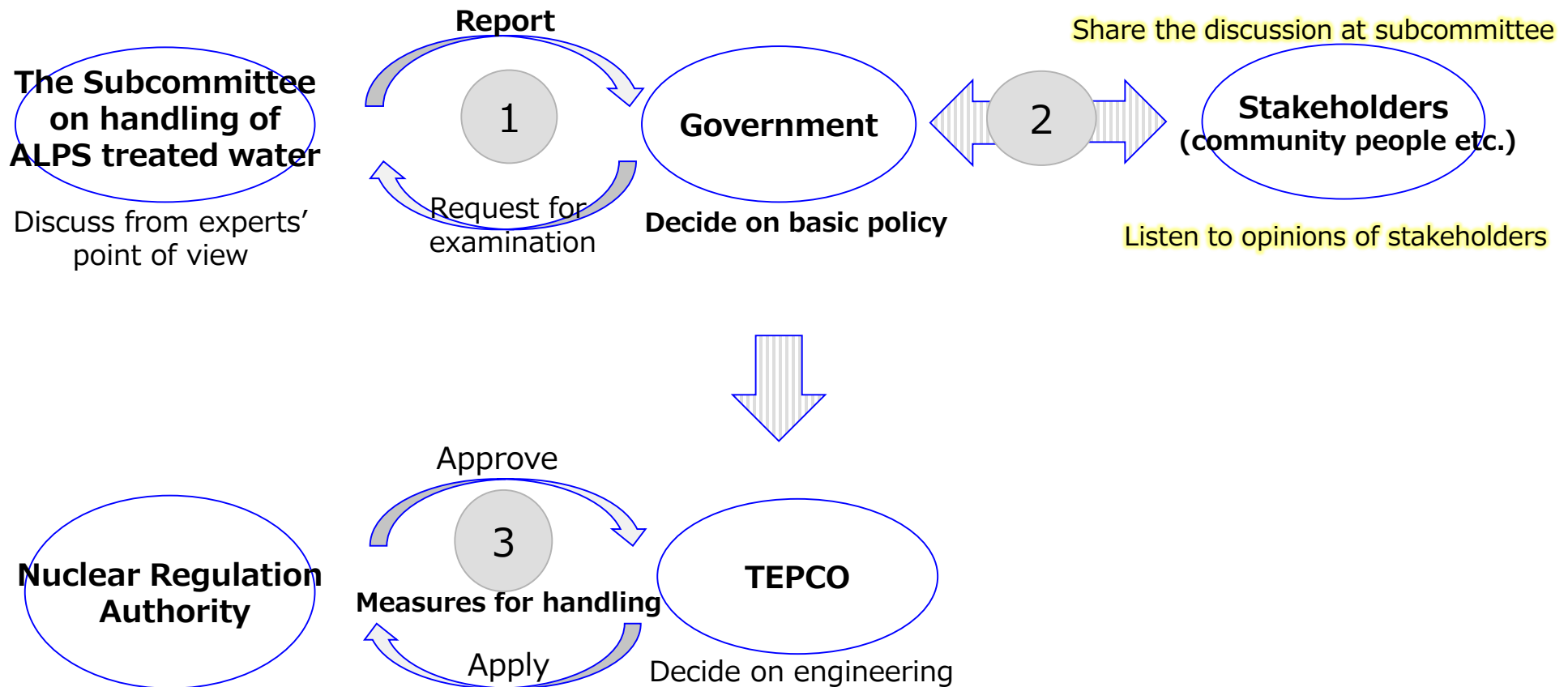
|  |  |
|--|--|
| Amount of Tritium (tritiated water) in tanks | <b>Approx. 860 TBq* (16g)</b><br>(*TBq = $1 \times 10^{12}$ Becquerel) |
| Average Concentration of Tritium             | <b>0.73 MBq/L</b><br>(*MBq = $1 \times 10^6$ Becquerel)                |

- ※ As of Oct 31, 2019
- ※ Currently, several kinds of radionuclides other than tritium are found in ALPS treated water in tanks. → See page 13
- ※ If the treated water is discharged into the environment, it will be re-purified and diluted to meet the standards for discharge.

➤ **Role of the subcommittee:**

- 1) to examine in a comprehensive manner, such as countermeasures for reputational damage, and
- 2) to compile report for the government

➤ **GOJ will decide its basic policy**, after receiving report of subcommittee and discussing with stakeholders.



# The key points of the draft report (1): Basic approach

- **Reputational damage still remains and affects reconstruction of Fukushima.**
- **"Coexistence of reconstruction and decommissioning" is a basic principle:**
  - Returning of residents and reconstruction efforts in the surrounding area have been proceeding.
  - Additional reputational damage should not be caused by a hastened disposition of ALPS treated water.
- **Disposition of ALPS treated water needs to be completed until the completion of the decommissioning:**
  - with necessary storage, and
  - with due consideration to the minimization of the impact on reputation
- **In deciding the disposition of the ALPS treated water, the government must also compile a policy for countermeasures against reputational damage.**

## The key points of the draft report (2): disposal methods

- Vapor release and Discharge to the sea have been conducted and recognized as feasible methods.
- There are precedents for discharge to the sea in Japan and it is easy to operate necessary facilities. Thus this can be conducted with certainty.
- Radiation impact of both methods is considerably small compared to natural exposure to radiation.

|                  | Vapor release   | Discharge to the sea   |
|------------------|---|--|
| Technical Issues | <ul style="list-style-type: none"> <li>● Precedent in case of accident at NPP overseas<br/>* Vapor is also released from reactors in normal operations at the time of ventilation.</li> <li>● In Japan, there is no example of vapor release in order to dispose liquid waste.</li> <li>● Difficult to predict how the released vapor is diffused into the air</li> <li>● Difficult to establish proper monitoring methods</li> </ul> | <ul style="list-style-type: none"> <li>● Precedents exist world-wide</li> <li>● More reliable option<br/>* precedents in Japan and easiness of operating facilities</li> <li>● Relatively easy to predict how discharged water is diffused in the ocean</li> <li>● Easy to examine proper monitoring method</li> </ul> |
| Social issues    | <ul style="list-style-type: none"> <li>● Difficult to compare the social impacts of two methods<br/>* Social impact is greatly dependent on consumer psychology.</li> </ul>   |  |
|                  | <ul style="list-style-type: none"> <li>● May attract significant social concern</li> </ul>  | <ul style="list-style-type: none"> <li>● May attract particularly large social concern if no countermeasure for reputational damage is taken</li> </ul>  |

**The following three options have many insurmountable issues (regulatory, technological, and timewise)**

**Geosphere injection** : Need to seek for appropriate sites, and monitoring methods have not been established

**Hydrogen release** : Further technological development would be required for pretreatment and scale expansion.

**Underground burial** : In solidification process, water including tritium will be evaporated. New regulations may be necessary.  
Area for disposal yard will be needed.

# Impact assessment for environmental release of ALPS treated water

## [Conditions]

- Using **UNSCEAR<sup>\*1</sup> assessment model<sup>\*2</sup>** and precondition that all the treated water stored in tanks (containing 860TBq of tritium) is discharged in one year.

(\*1: UNSCEAR: The United Nations Scientific Committee on the Effects of Atomic Radiation)

(\*2: re-assessed with Japanese food consumption)

[Ref. UNSCEAR 2016 Report, Annex A “Methodology for estimating public exposures due to radioactive discharges”]

[case 1] Vapor release ----- Approx. **0.0012 mSv/year** (1.3 μSv/year)

[case 2] Discharge to the sea ---- Approx. **0.000071 to 0.00081 mSv/year** (0.071 to 0.81 μSv/year)

- In both discharge methods, the impact of the radiation from the discharge is considerably small, compared with annual natural exposure in Japan: 2.1 mSv/year (2,100 μSv/year).

| Exposure dose [mSv/y] | Vapor release※1 | discharge to the sea※2 |
|-----------------------|-----------------|------------------------|
| All radionuclides※3   | 0.0012※4        | 0.000071~0.00081       |
| - tritium             | 0.0012          | 0.0000068              |

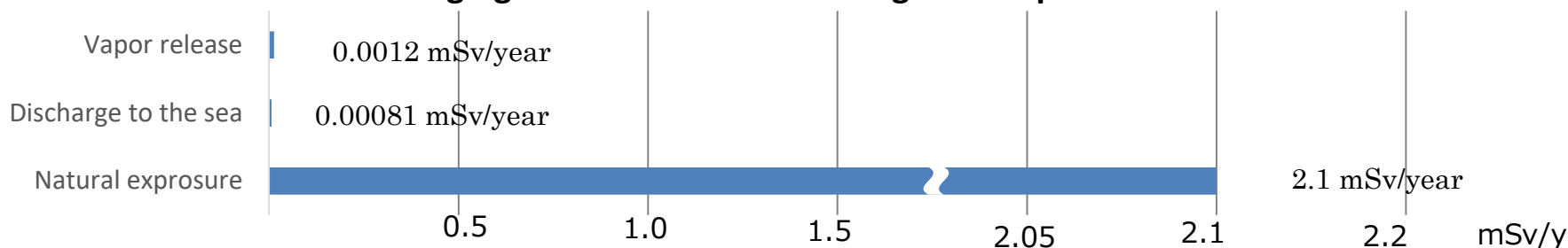
※1 Sum of external dose from the atmosphere and soils, and internal dose from inhaling the air and ingesting terrestrial life (at 5km points from the FDNPS)

※2 Sum of external dose from beaches and internal dose from ingesting marine life.

※3 Estimation was conducted on the two assumptions that “ND (Not Detected)” nuclides are 1) their ND value and 2) zero.

※4 For exposure dose for [case 1 (vapor release)], there is no difference between the results from two assumptions

## Comparison of radiation impact between natural exposure and discharging treated water containing 860 TBq of tritium



## ● UNSCEAR Model\*

- Made for public exposure assessment in the case of radionuclides discharge, both to the air and to the sea, on the assumption that there has been constant discharge\*\*.

\* Re-assessment was made using national health and nutrition examination survey in Japan.

\*\* assess the public exposure in the 100th year, on the assumption that there will be a continuous and constant discharge for 100 years

### [Case 1] Vapor release

- Public exposure is calculated as the sum of external dose from the atmosphere and soil, and internal dose from inhaling the air and ingesting terrestrial life (at 5km points off the leeward side of the FDNPS).
  - Rate of the time staying outside: 0.2
  - Rate of the local terrestrial food: 0.25
  - Amount of Food consumption per person (kg/year): Japan (Ref: Asia+Pacific) (Grains 155 (141.5), Plants/Fruits 188 (240.8), Mild/Dairy products 41.8 (44.5), Meat/Internal organs 35.4(29.5))

### [Case 2] Discharge to the sea

- Public exposure is calculated as the sum of external dose from beaches and internal dose from ingesting marine life.
- For the assessment, sea area is divided into local sea areas (area with 1 billion m<sup>3</sup> of sea water) and regional sea area (with 1000 trillion m<sup>3</sup>)
  - Rate of marine food from local sea area: Fish 0.25, Crustacea 1.0, Mollusk 1.0
  - Rate of marine food from regional sea area: Fish 0.75, Crustacea 0, Mollusk 0
  - Amount of Food consumption per person (kg/year): Japan (Ref: Asia + Pacific) (Fish 21.7 (6.9), Crustacea 1.42(1.4), Mollusk 1.97 (2.4))

### Other parameters for the assessment

- Assumption of concentration of tritium before dilution : 1 M Bq/L  
(concentration rate will be set to meet the standard before discharge)
- Concentration of radionuclides other than tritium before dilution: Data of the treated water stored in K4 tank area\*\*  
(\* \*\* Radionuclides that are not detected (ND) is assumed to be 1) their ND value and 2) zero, <sup>14</sup>C = 10Bq/L)



# The key points of the draft report(3):

## 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 radionuclides other than tritium
- Stop the disposition process in case of emergency  
e.g. environmental situation, malfunction of facilities
- Determine the details (starting time, volume, and period of disposition),  
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

## <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

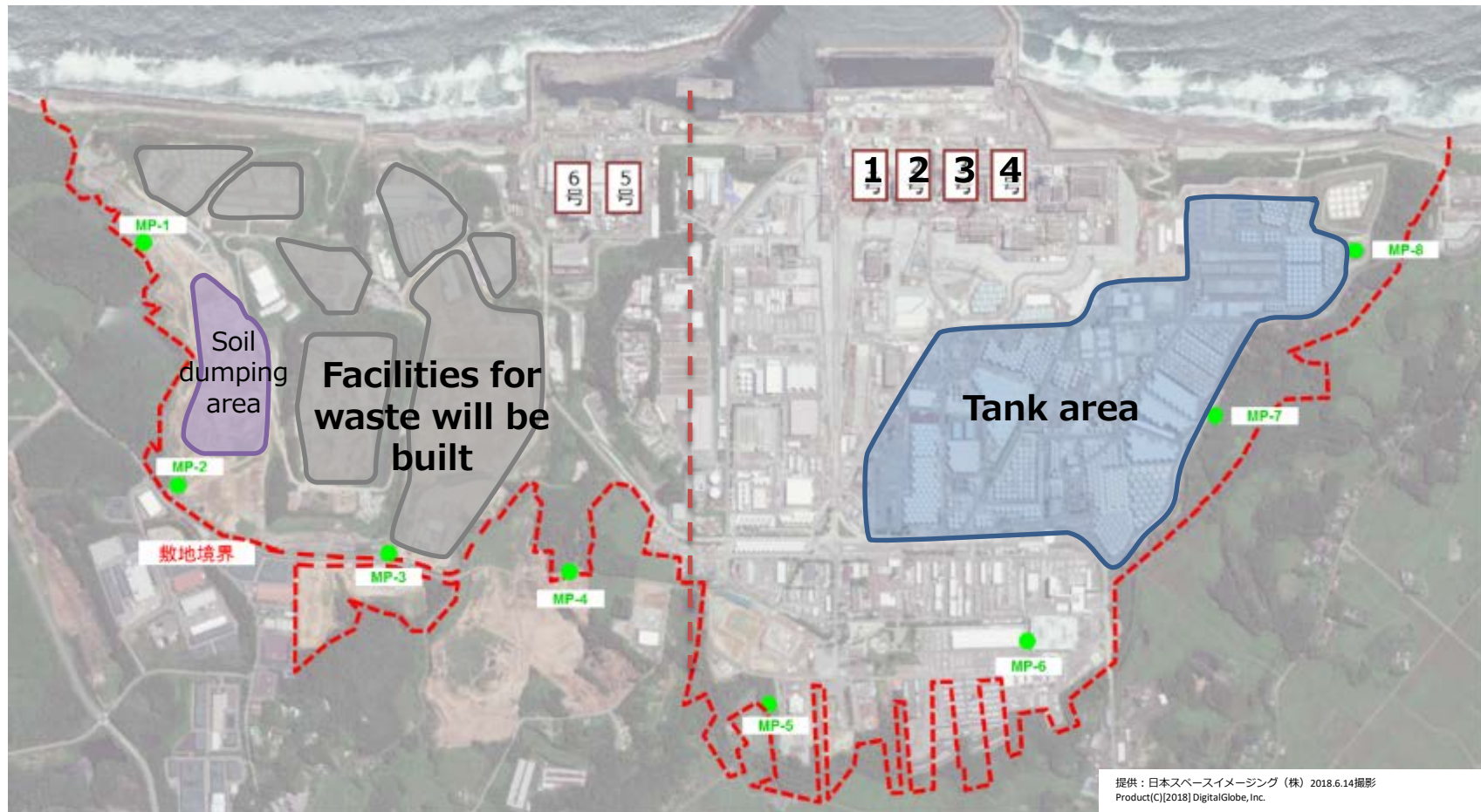
### < Economic measures>

- 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.

# The key points of the draft report(4):Possibility of storage continuation

- There is a limited room for construction of additional tanks.  
(Tank capacity under the current plan: approx. 1.37 million m<sup>3</sup>)
  - ✓ Areas where flanged tanks used to be built may become available.
  - ✓ For further decommissioning work, **various facilities will be needed** (such as storage tanks for ALPS treated water temporary storage facilities for spent fuel and fuel debris).
- Entire premises should be used effectively, considering its limitation.



# The key points of the draft report(5): Storage at off-site

- **Legally compliant transfer facilities** would be required if ALPS treated water is to be transferred.
    - ✓ Consensus would be needed from the municipalities where a possible transfer route would be located.
  - **At a storage site, operation license and approval of local municipalities** would be needed.
- **The transfer of ALPS treated water to off-site would require significant preparation a wide range of coordination in advance and considerable period of time.**

## [Issues on transfer to off-site]

- **Transfer facilities** in accordance with the laws and regulations would be needed.
  - ex. **Pipeline:** physical protection facilities (fence, etc.) surrounding the pipelines would be needed.
  - ex. **Vehicles or ships:** need to carry type L transport casks (maximum volume of 4 m<sup>3</sup>)  
procedure for transport outside the nuclear site would be needed.
- **Consensus would be needed from local municipalities** where a possible transfer route would be located.
- **Leakage risk** during transfer cannot be ruled out.

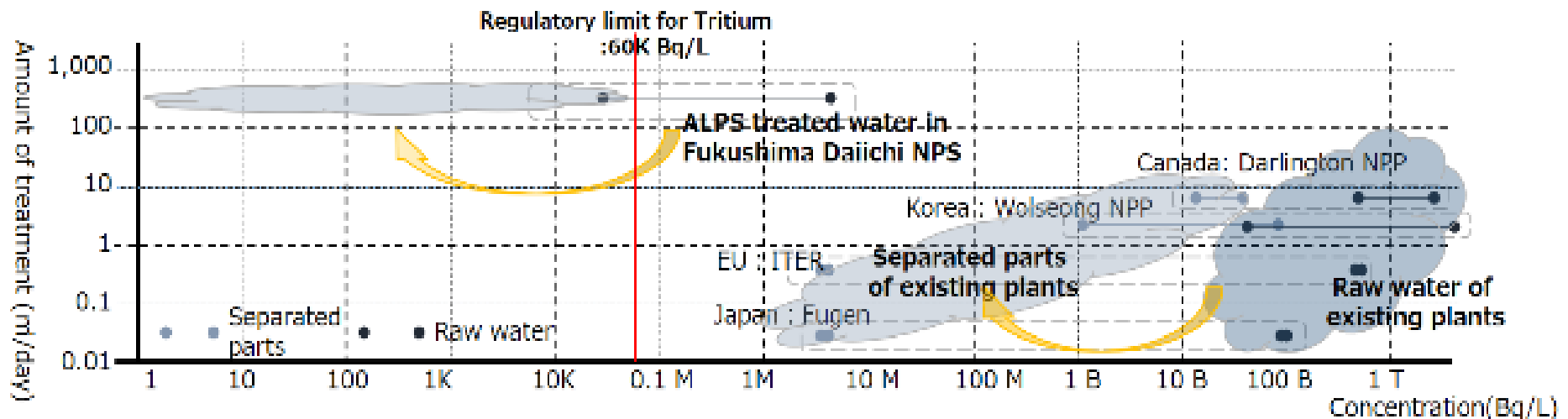
## [Issues on off-site storage]

- **Operation license** for a storage site in accordance with the laws and regulations.
- **Consensus from local municipalities** at the storage site would be needed.

# The key points of the draft report(6): Tritium separation technology

**Tritium separation** → removing highly concentrated tritiated water (HCTW) from lowly concentrated tritiated water (LCTW).

- Large volume of **LCTW** needs to **be disposed of**.
- **HCTW** needs to **be stored continually**.
- Results of preceding cases in which existing tritium separation technologies were utilized show:
  - ✓ **Throughput is less**, and its **original tritium concentration is higher** than the case of ALPS treated water
  - ✓ **LCTW** is either **reused or disposed**
- Demonstration project for tritium separation technology (2014-2016) revealed that **there was no technology close to practical use**.
- Technological trends should be monitored carefully and continuously.



# The key points of the draft report(7): Characteristics of ALPS treated water

## ◇ Two regulatory standards:

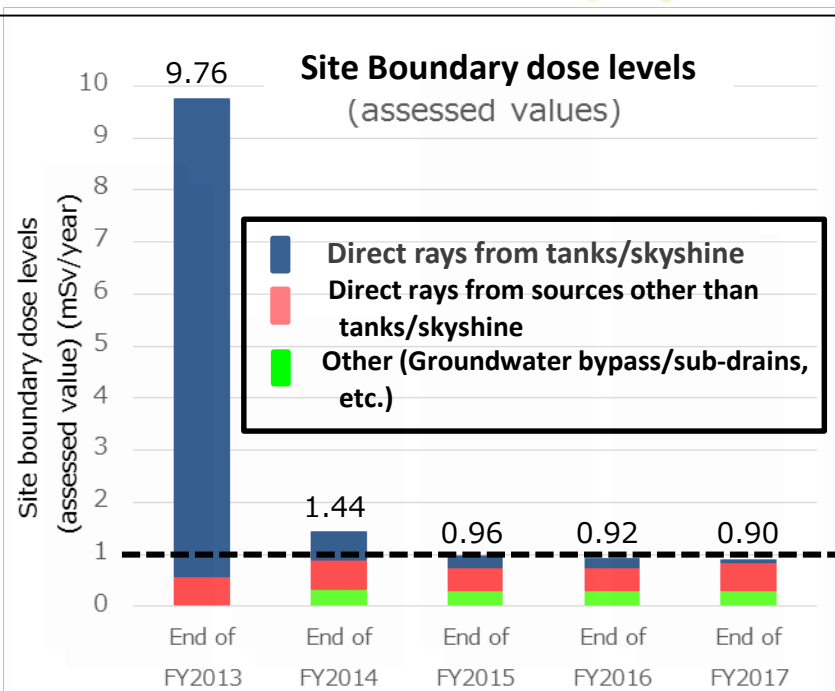
- 1) **Applicable to storage**: to keep site boundary dose levels less than 1mSv/year Goal currently achieved through ALPS
- 2) **Applicable to release to the environment**: to keep radionuclides concentrations of treated water less than the regulatory limit.

## ◇ There are various concentration of ALPS treated water in the tanks, because:

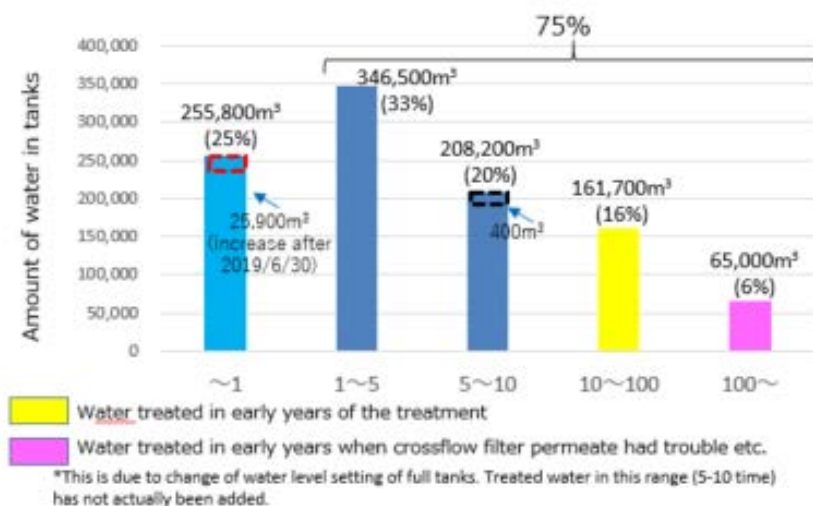
- Concentration of ALPS treated water depends on the attributes of water to be treated and operation management of ALPS such as frequency of absorbent exchange; and
- Especially in the first few years after the accident, which was before improvement of ALPS performance, concentrations of tritium in ALPS treated water was relatively high.

## ◇ In case of releasing ALPS treated water to the environment, the water needs to satisfy standard 2).

- TEPCO announced to re-purify ALPS treated water, to meet standard 2) for radionuclides other than tritium.



**Sum of the ratios of actual concentrations to regulatory standards for 62 nuclides\* (other than tritium)**

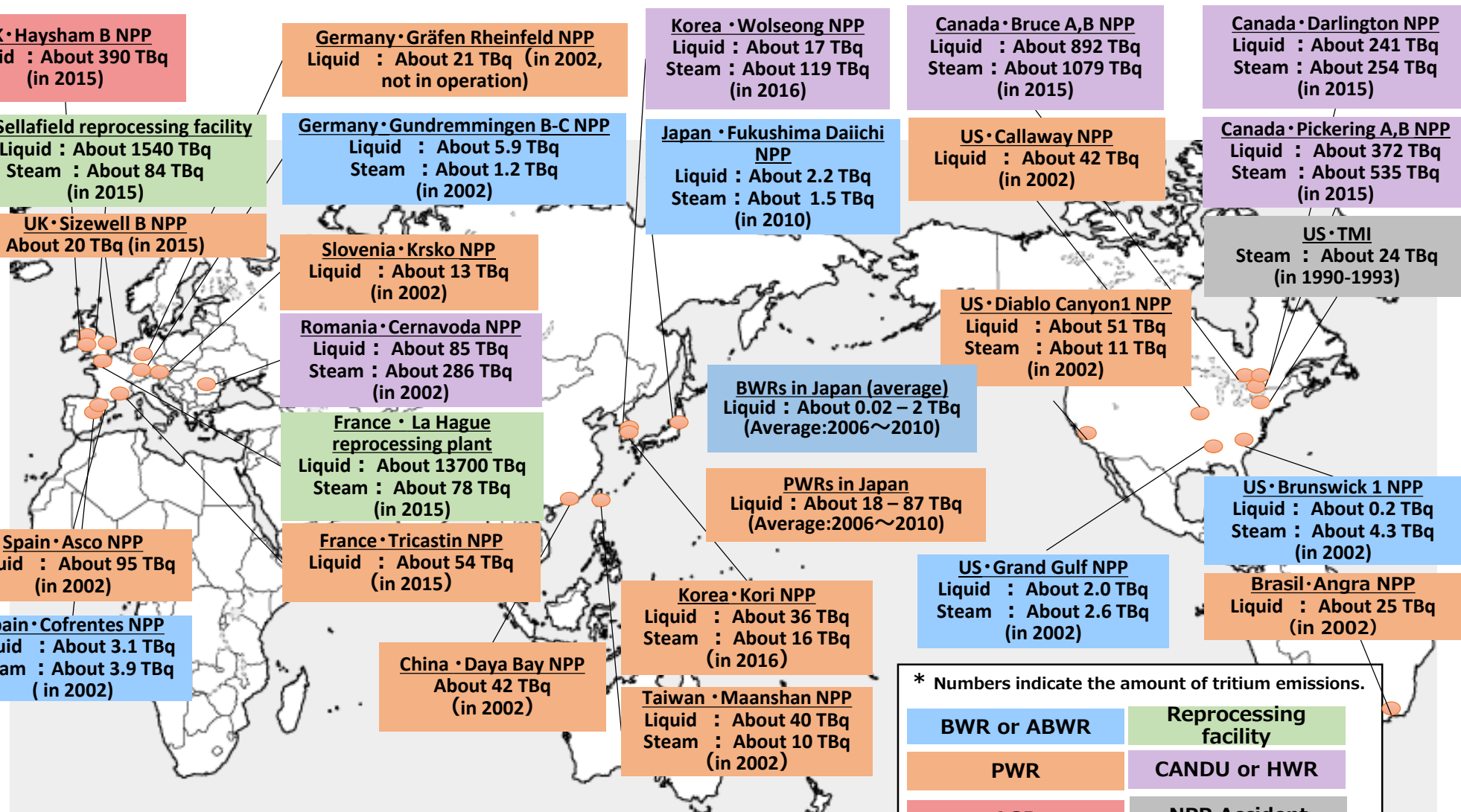


\*These drawings are quoted from "Treated water portal site (TEPCO HP)"



# The key of the draft report(8): Examples of tritium emission

[Ref.] Annual Tritium emissions from nuclear facilities around the world



Source : UK : Radioactivity in Food and the Environment, 2015

Canada : Canadian National Report for the Convention on Nuclear Safety, Seventh Report

France : Tritium White paper 2016

Korea : FY2016 Survey on environmental radioactivity around the nuclear power plant and evaluation report, KHNP

Other countries : UNSCEAR「2008 Annual report」 Japan : Fukushima Pref. and TEPCO report 2010 (data period from April 1, 2010 to March 11, 2011)

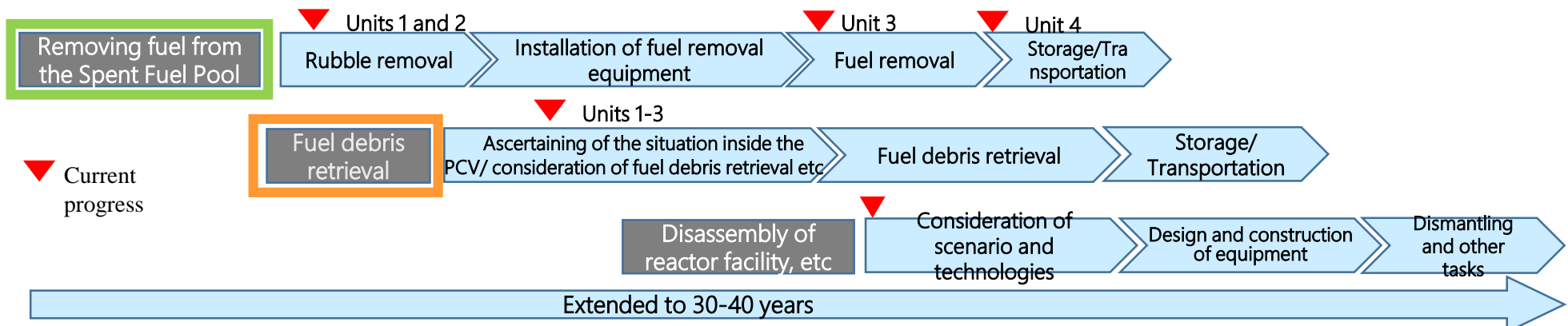
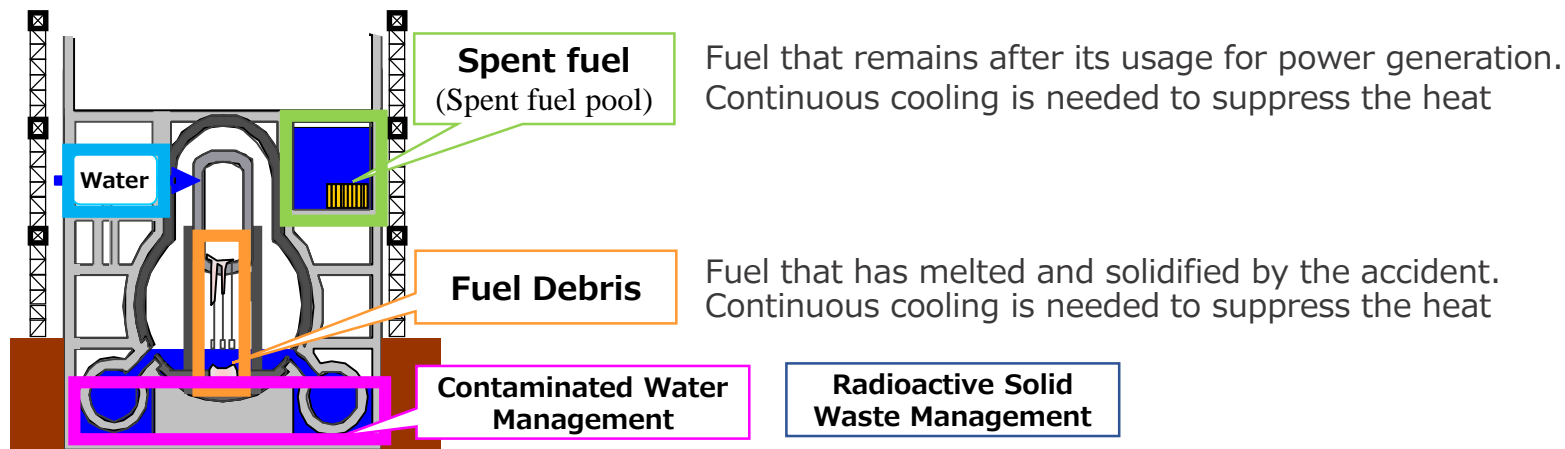
<Ref.>  $1 \times 10^{12} \text{Bq} \approx \text{about } 0.019 \text{g}$  (Tritiated water)

# References

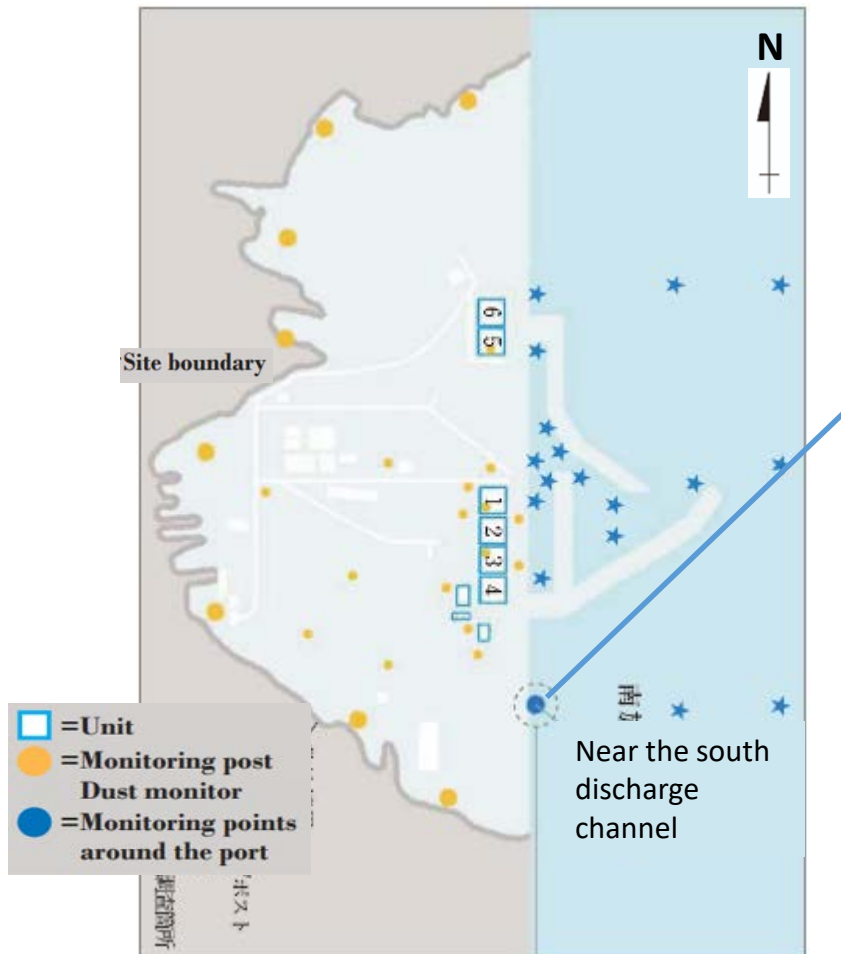


# [Ref.1] Decommissioning of TEPCO Fukushima Daiichi NPS (FDNPS)

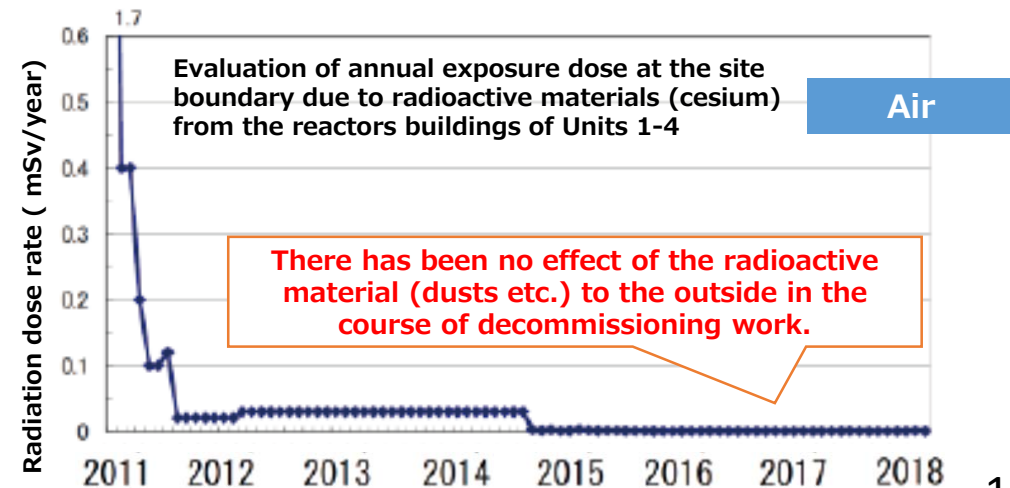
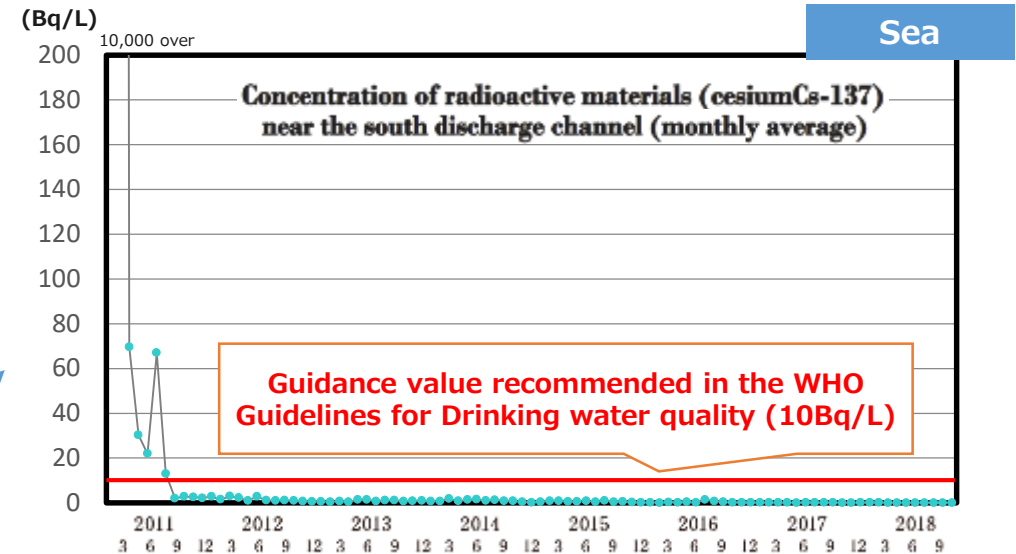
- ◇ **Fukushima Daiichi Decommissioning is a continuous risk reduction activity** to protect the people and the environment from the risks associated with radioactive substances by:
  - ✓ Removing spent fuel and fuel debris from the Reactor Building
  - ✓ Reducing the risks associated with contaminated water and radioactive waste
- ◇ **Safe and steady decommissioning is a prerequisite for reconstruction of Fukushima**



- The environmental impact on the site and surrounding area have been significantly reduced.



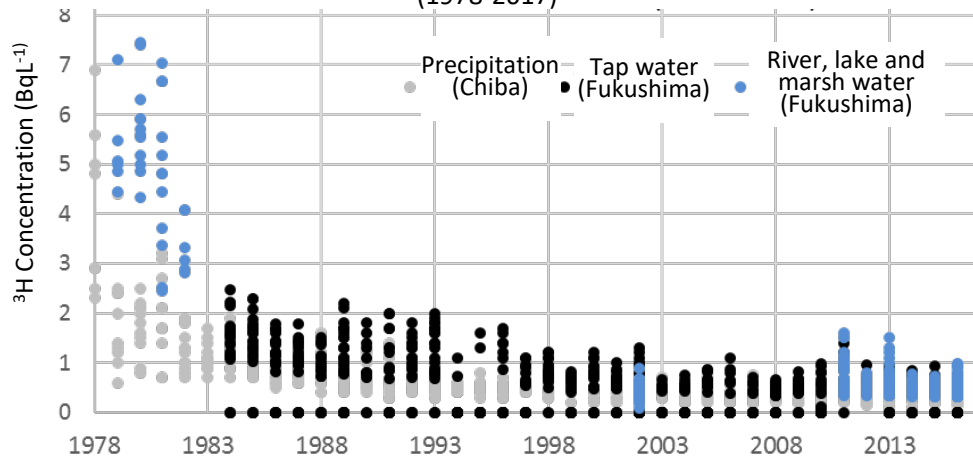
Whole map of Fukushima Daiichi Nuclear plant



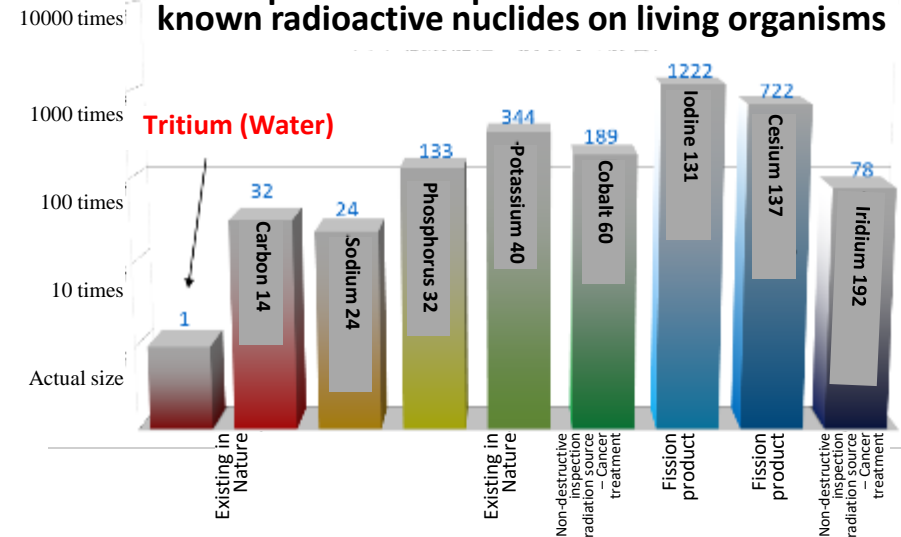
# [Ref.3] What is Tritium?

- ◇ **Tritium is a relative of hydrogen that emits weak radiation.**
  - ◇ **Tritium exists naturally** and is found in water such as water vapor in the atmosphere, rain, sea water, and tap-water, as tritiated water has similar properties as those of water.
- 
- **It has not been found that tritium concentrates in human beings and particular living organisms**
  - **Impact on health** is very low, **around 1/700 of that of Cesium 137.**
  - **NPPs in Japan and overseas have been discharging water containing tritium for more than 40 years in compliance with the standard limits based on the laws and regulations.**
    - ✓ Concentration of tritium in sea water near NPPs are significantly lower than that of drinking water standards in the world.
    - ✓ **It has not been found that tritium from NPPs have an impact on health.**
    - ✓ The amount of tritium, which is generated at domestic nuclear power plants (NPPs) and released to the sea annually\*, is around 1.7 times as much as that of tritium found in annual precipitation in Japan. (\* 5 year average before 2011)

$^3\text{H}$  concentration in river water and tap water in Fukushima pref.  
and  $^3\text{H}$  concentration in precipitation at Chiba pref.  
(1978-2017)



Comparison of impact of tritium and well-known radioactive nuclides on living organisms





## ◆ Decommissioning and Contaminated Water Management at TEPCO's Fukushima Daiichi NPS

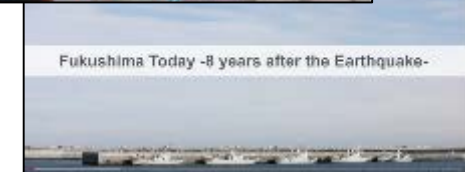
<https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/index.html>

## ◆ Film, Fukushima Today 2019 - Efforts to Decommission and Reconstruction

[https://www.youtube.com/watch?v=v\\_PeSp--Wuk](https://www.youtube.com/watch?v=v_PeSp--Wuk)

## ◆ Film, Fukushima Today - 8 years after the earthquake -

<https://www.youtube.com/watch?v=pKjsSAz5Kws>

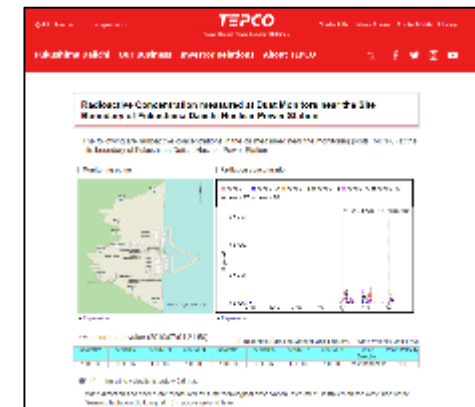


## ◆ Treated Water Portal Site

<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](https://www7.tepco.co.jp/responsibility/decommissioning/1f_newsroom/data/index-e.html)





## ◆ Fukushima Daiichi Status Updates

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



## ◆ IAEA Review mission reports (Press release )

IAEA Team Completes Fourth Review of Japan's Plants to Decommission Fukushima Daiichi (November 13, 2018)

<https://www.iaea.org/newscenter/pressreleases/iaea-team-completes-fourth-review-of-japans-plans-to-decommission-fukushima-daiichi>



IAEA Issues Final Report on Fourth Review of Fukushima Decommissioning (January 31, 2019)

<https://www.iaea.org/newscenter/pressreleases/iaea-issues-final-report-on-fourth-review-of-fukushima-decommissioning>



## ◆ UNSCEAR 2016 REPORT -Sources, effects and risks of ionizing radiation

<https://www.unscear.org/unscear/en/publications/2016.html>



SOURCES, EFFECTS AND RISKS OF IONIZING RADIATION  
**UNSCEAR 2016 Report**

