The current status and future process of the domestic study of ALPS treated water at Fukushima Daiichi NPS

Agency for Natural Resources and Energy, METI

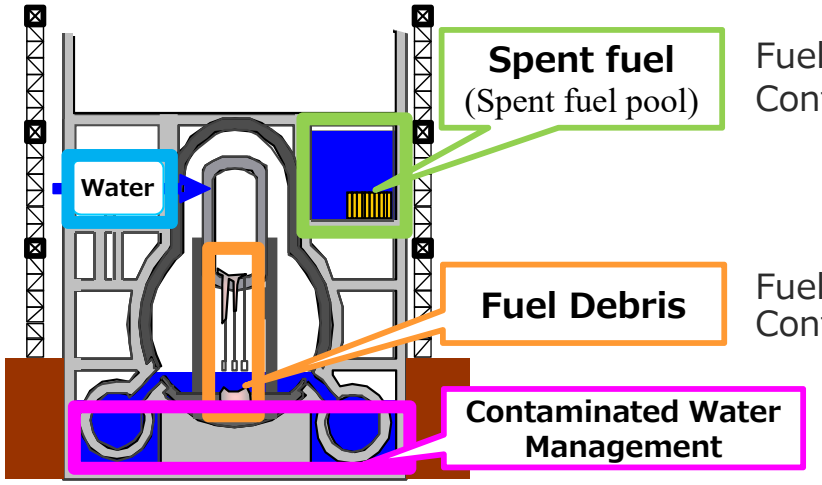
September, 2019

1. Decommissioning of TEPCO 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:

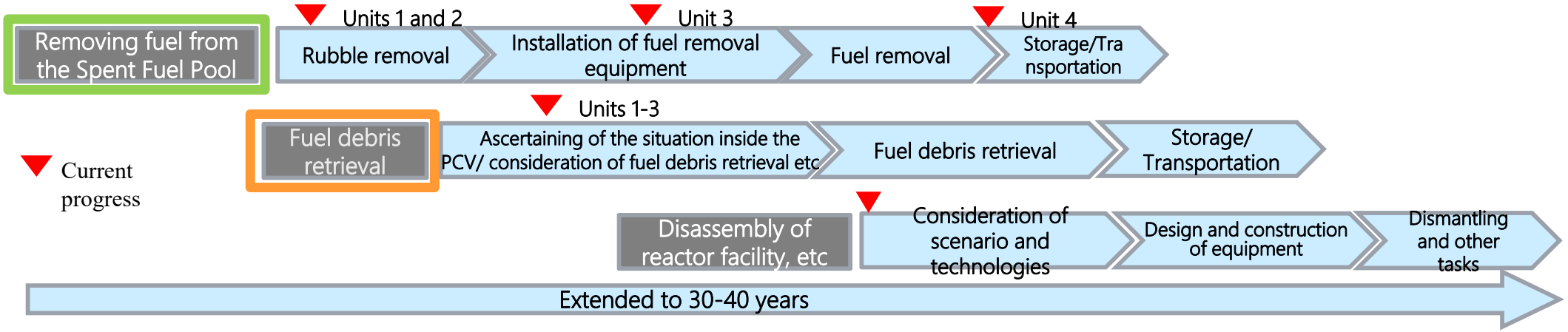
- ✓ Removing spent fuel and fuel debris from the Reactor Building
- ✓ Reducing the risks associated with contaminated water and radioactive waste

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



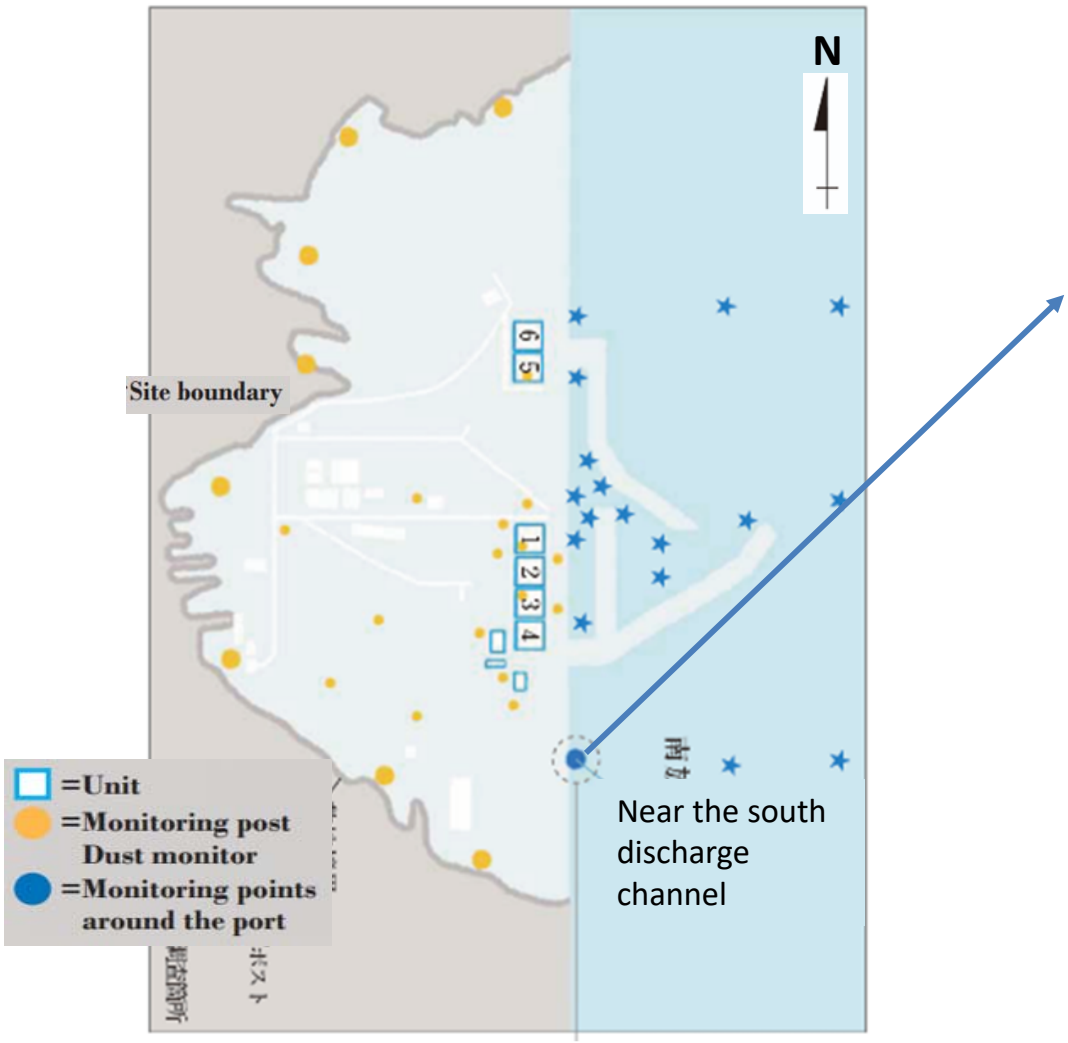
Fuel that remains after its usage for power generation.
Continuous cooling is needed to suppress the heat

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

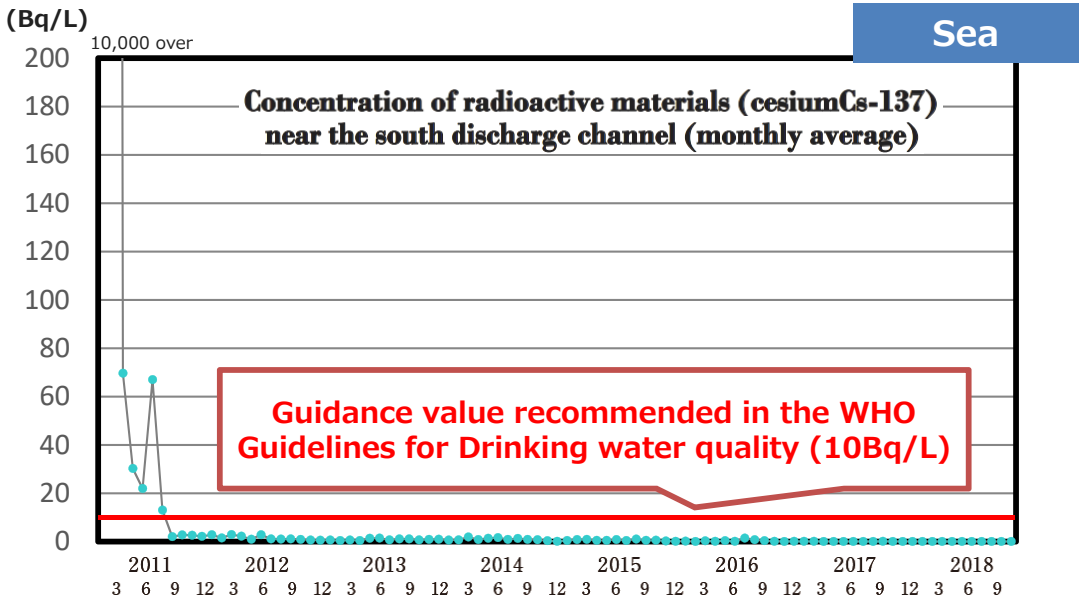


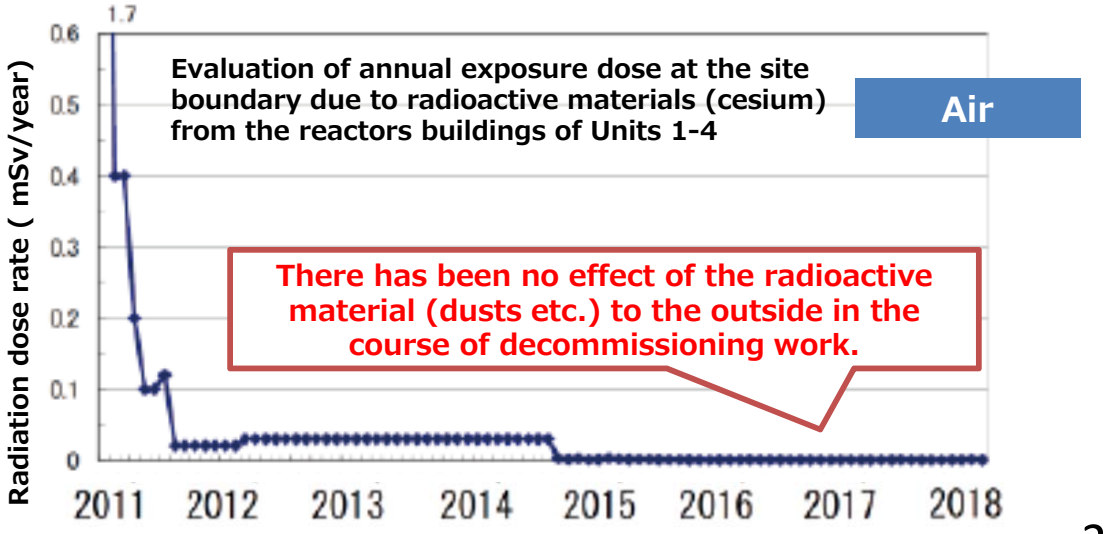
2-1. Impact on the Surrounding Environment

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



Whole map of Fukushima Daiichi Nuclear plant





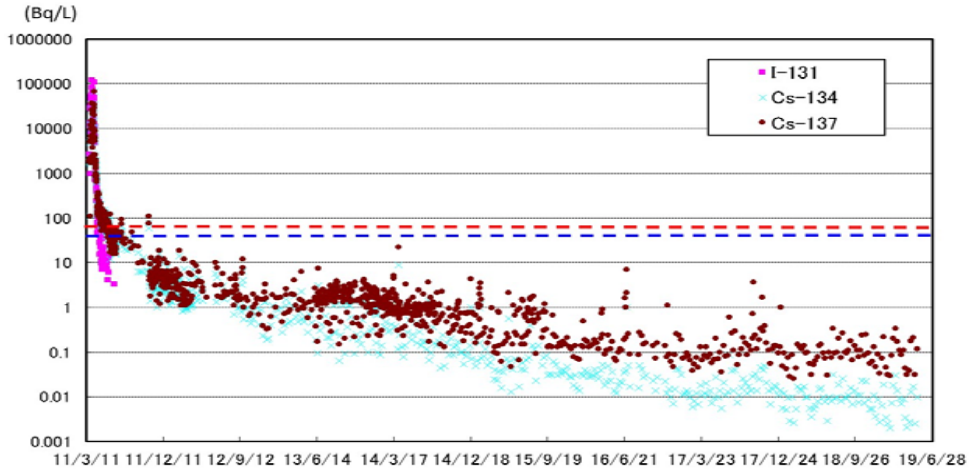
2-2. Seawater radiation monitor near Fukushima Daiichi NPS

Regulatory Limit Specified by Reactor Regulation
- Cesium 137: 90Bq/L
- Cesium 134: 60Bq/L

Bq/l

Fukushima Daiichi NPS

① North side of units 5 and 6 discharge channel

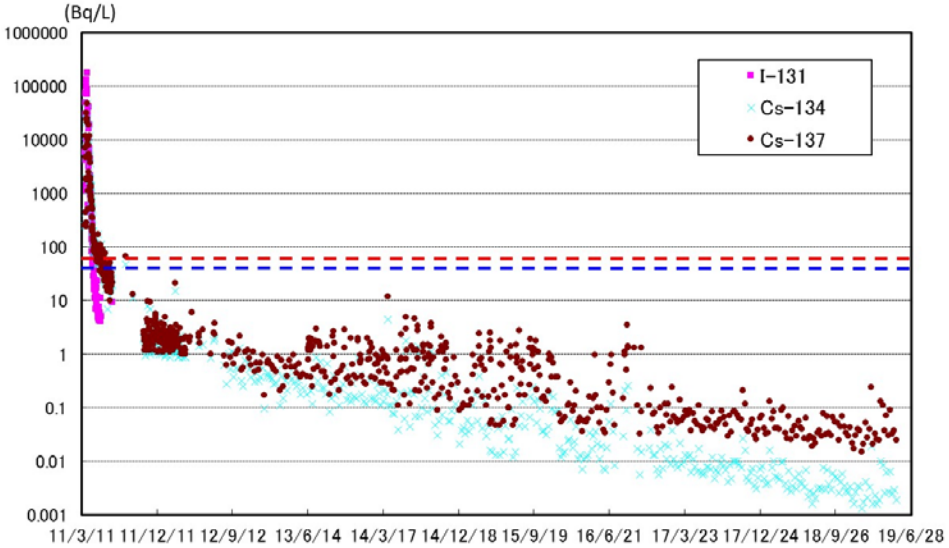


② Real time monitoring

<TEPCO's website>

http://www.tepco.co.jp/en/nu/fukushima-np/f1/seawater/index-e.html

③ Near South Discharge Channel



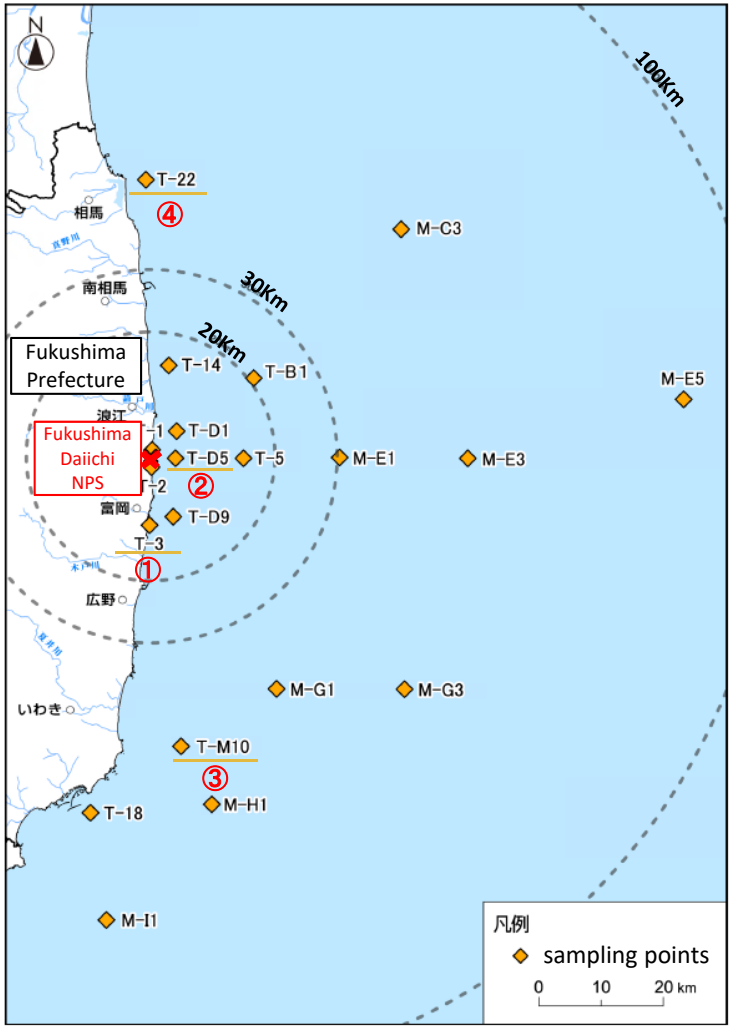
2-3. Seawater radiation monitor near Fukushima Daiichi NPS

IAEA assessment (December 2013)

As the Government of Japan received IAEA's assessment that reads "ongoing monitoring in the surrounding ocean area has detected no significant increase in radiation levels outside the port or in the open sea, and has shown that radiation levels in these areas remain within the standards of the WHO's guidelines for drinking water.", and "the IAEA considers the public is safe", there has been no leakage of contaminated groundwater at a level which has any impact on the public safety.

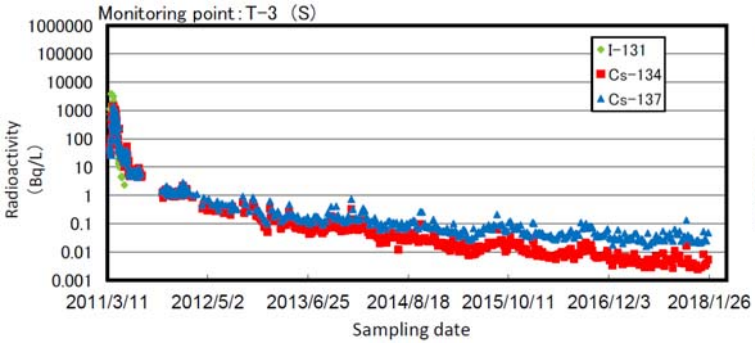
(Source : IAEA website) https://www.iaea.org/sites/default/files/recoveryoperations201213.pdf

Seawater sampling points



～20Km from Fukushima Daiichi NPS

①



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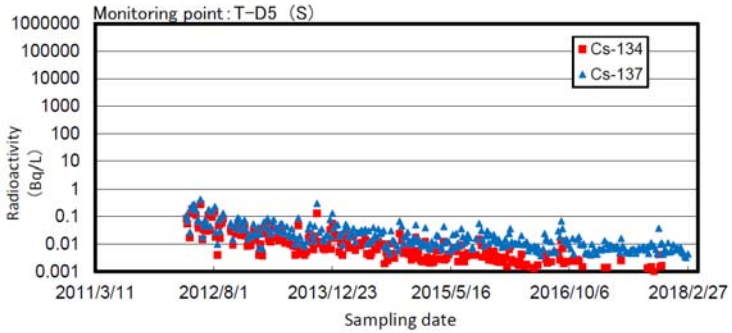
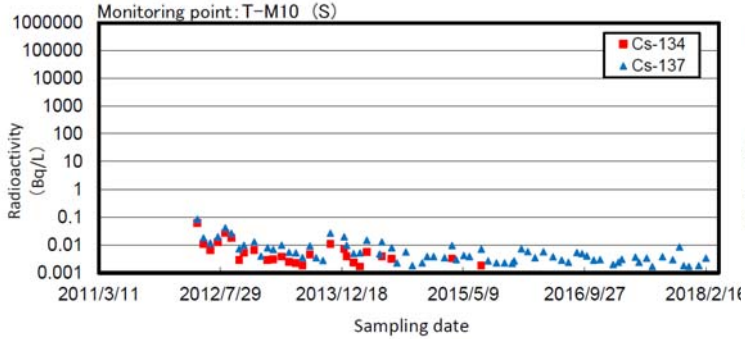
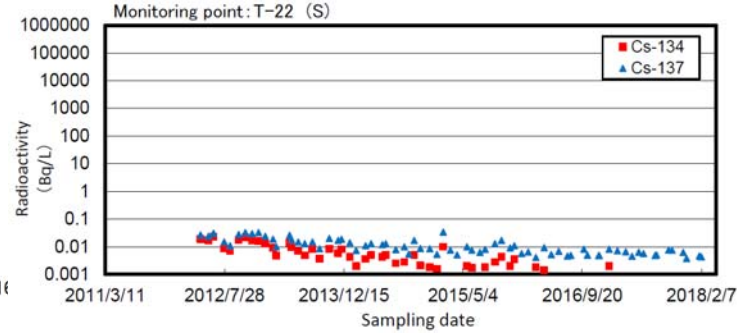


30～100Km from Fukushima Daiichi NPS

③



④



(Source : NRA website)
https://radioactivity.nsr.go.jp/en/contents/8000/7742/24/engan.pdf

3. Generation of contaminated water, purification process and tank storage

◇ **Contaminated water in buildings** is generated by continuous water injection to fuel debris in reactors

- **To Prevent leakage** of the contaminated water from the buildings:
  - ✓ **The level of groundwater outside is controlled to be higher** than that of contaminated water inside the buildings.

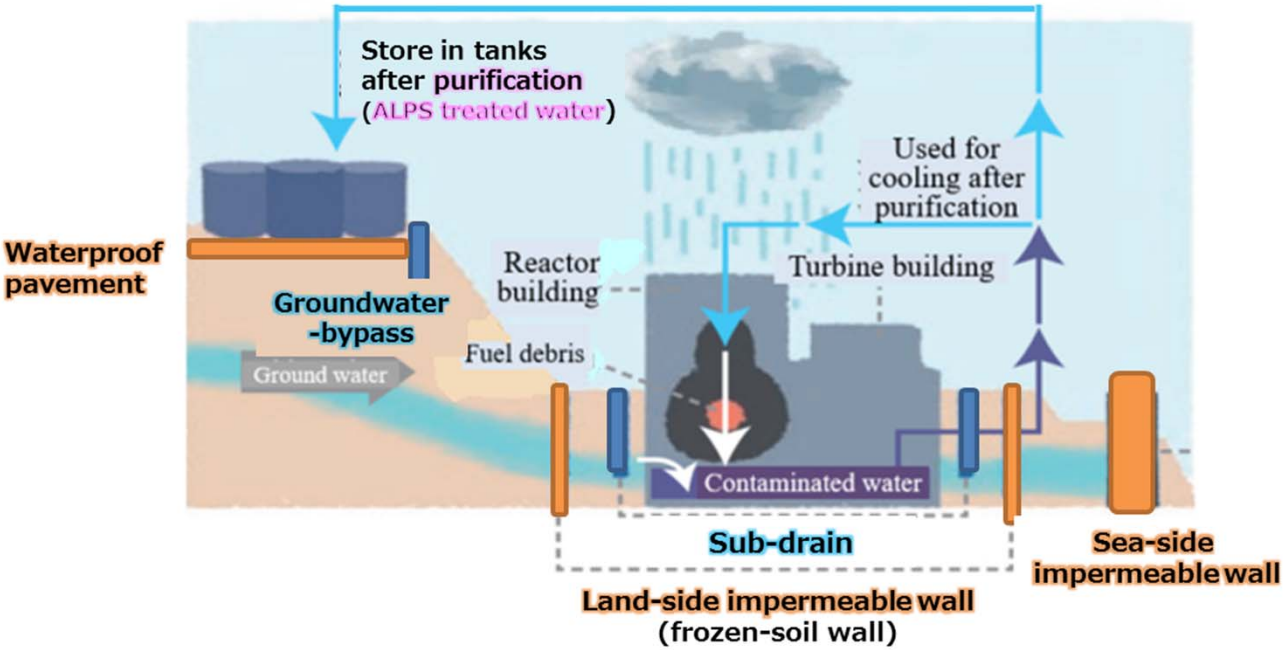
    ⇨ **Groundwater keeps flowing into the buildings** and mixes with contaminated water and **the amount of contaminated water in the buildings keeps increasing.**

    * Fuel debris retrieval is necessary to suppress the rate of arising contaminated water

- **To Purify the contaminated water:** ⇨ **"ALPS treated water"**
  - ✓ ALPS (Multi-nuclide retrieval equipment) and the other equipment have been used; and
  - ✓ **Most of the radionuclides except tritium were removed.**

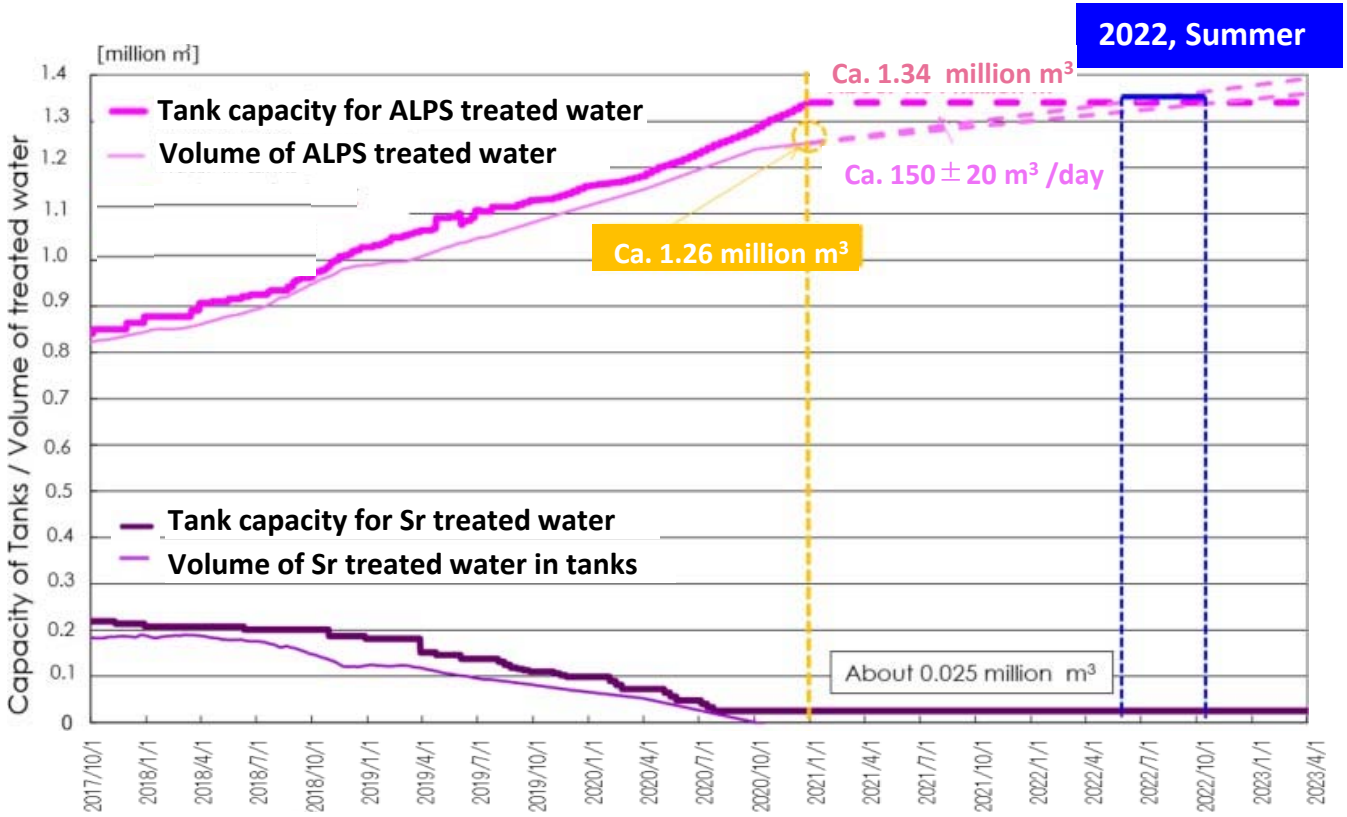
At present, ALPS treated water (≠contaminated water) is being continuously stored on site.

Bird's eye view of tank area



4. Discussion at ALPS subcommittee (9 August, 2019)

- Report from TEPCO at subcommittee (9 August, 2019)
  - *Tank construction capacity: 1.37 million m³ by the end of 2020*
    - * ***Time to reach its full capacity (forecast): around summer of 2022***
  - ***TEPCO will further examine its plan, considering limitation of site use as well as the tanks and other facilities which will be needed for decommissioning*** .
- The subcommittee will continuously discuss on the handling of ALPS treated water including continuation of storage.



[Examples of facilities which will be needed for decommissioning work]

1) Tanks to store ALPS treated water

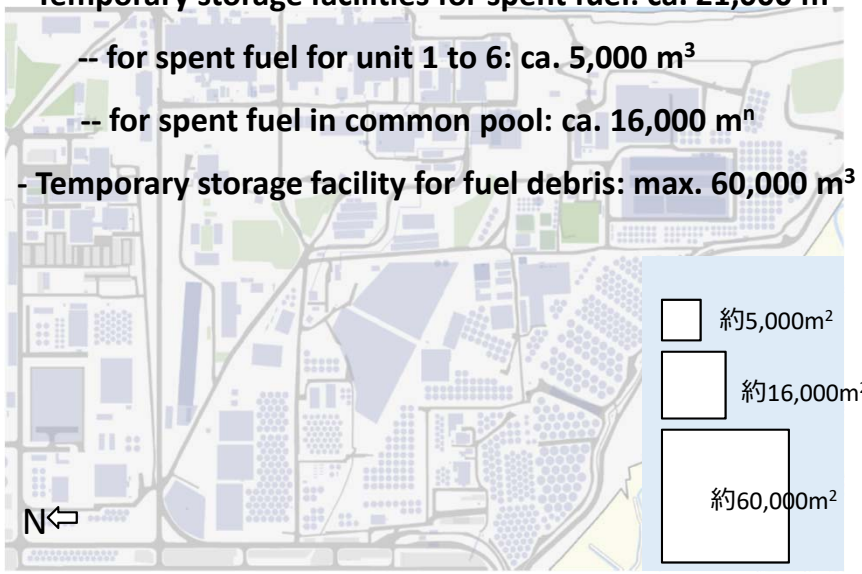
2) Temporary storage facilities for spent fuel and fuel debris

- Temporary storage facilities for spent fuel: ca. 21,000 m³

-- for spent fuel for unit 1 to 6: ca. 5,000 m³

-- for spent fuel in common pool: ca. 16,000 mⁿ

- Temporary storage facility for fuel debris: max. 60,000 m³



【Source】
TEPCO handout material, The 13th Subcommittee on Handling ALPS Treated Water

5. Current attributes of ALPS treated water

◇ Two regulatory Standards:

1) **Applicable to storage**: to keep site boundary dose levels less than 1mSv/year Current operational goal of ALPS

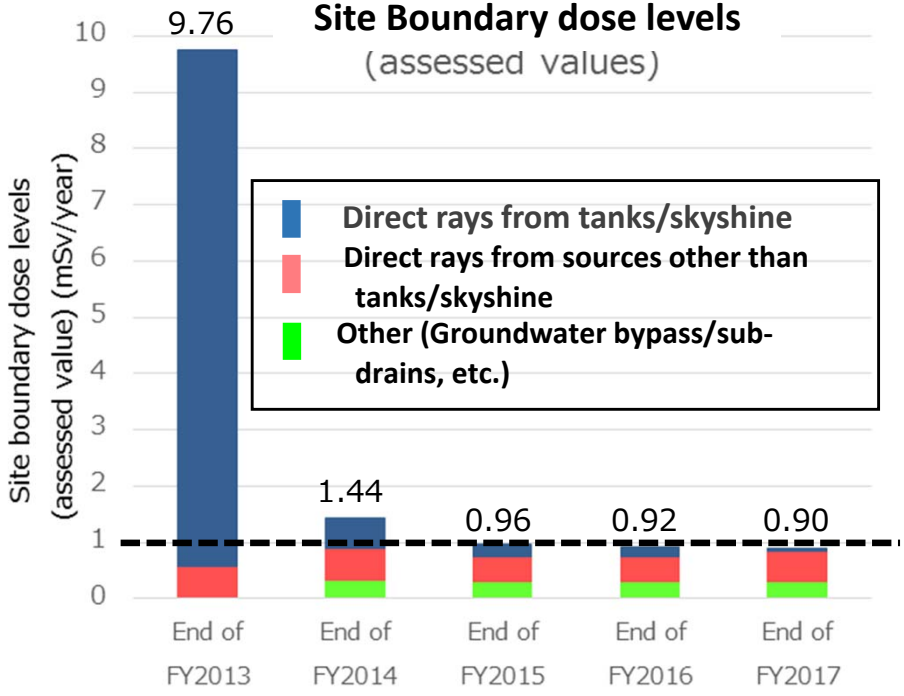
2) **Applicable to release to the environment**: to keep radionuclides concentrations of treated water less than the regulatory limit.

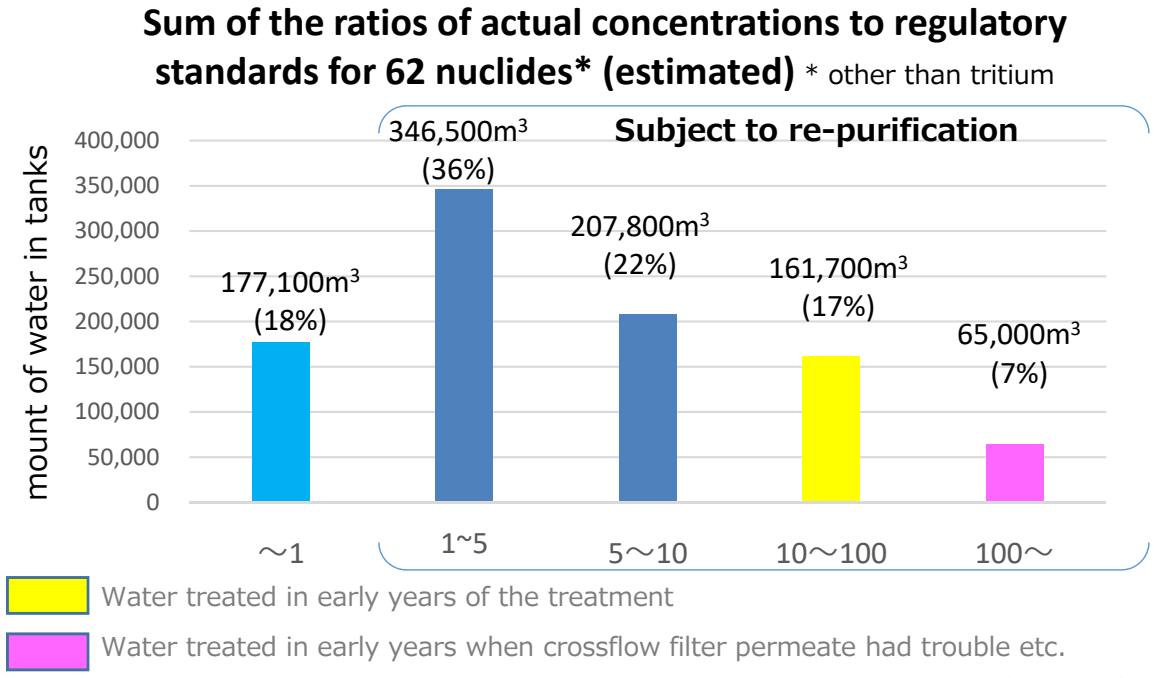
◇ There are various concentration of ALPS treated water in the tanks, because:

- 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 early years, before improvement of ALPS performance, concentrations of ALPS treated water is relatively higher.

◇ **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.





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

6. What is Tritium?

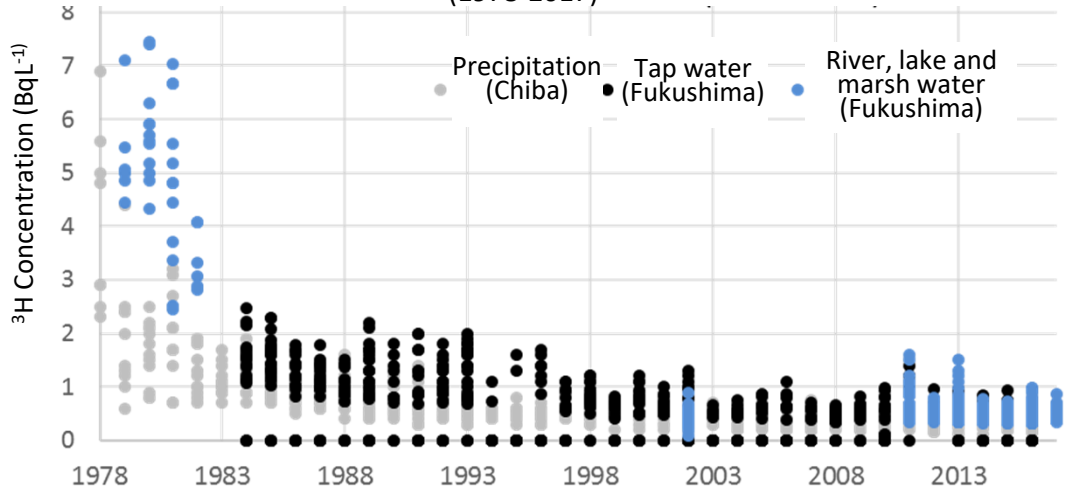
◇ **Tritium is a relative of hydrogen that emits weak radiation**.

◇ **Tritium exists naturally** and is found in water such as water vapour in the atmosphere, rain, sea water, and tap-water.

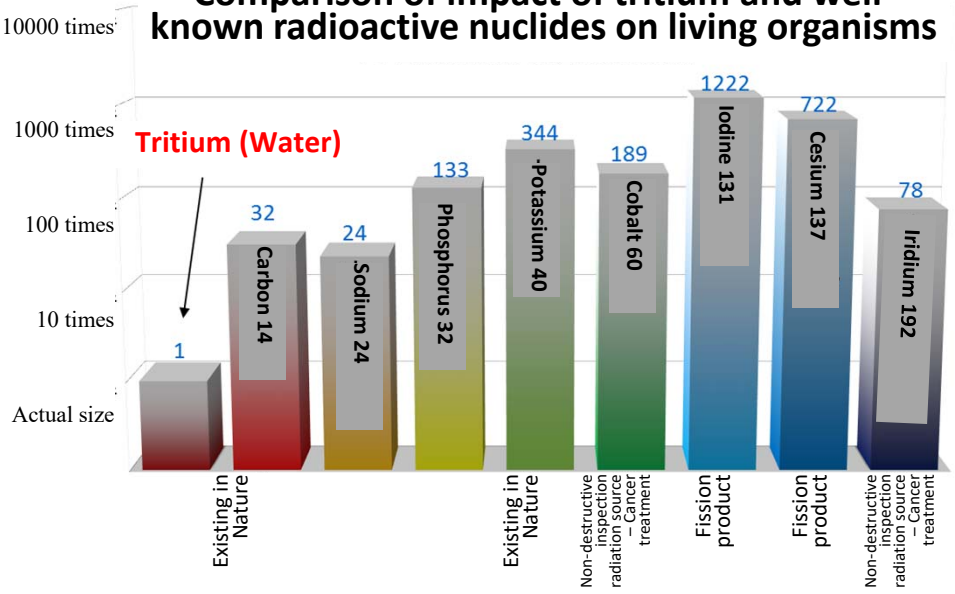
- **It has not been found that tritium concentrates in human beings and particular living organisms**, as tritiated water has similar properties as water.
- **Impact on health** is very low, **around 1/700 of that of Cesium 137.**
- The total annual amount of tritium, which is generated at domestic nuclear power plants (NPPs) and released to the sea*, is around 1.7 times as much as that of tritium found in precipitation in Japan. (* 5 year average before 2011)
- **NPPs in Japan 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.**

  *Overseas NPPs also discharge water containing tritium whose concentration is under standard limits.

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



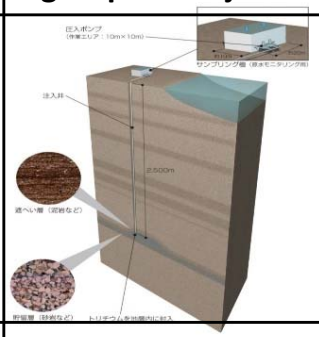
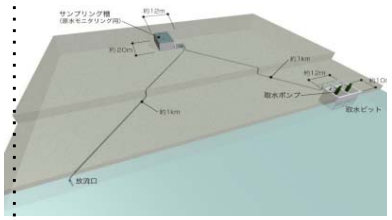
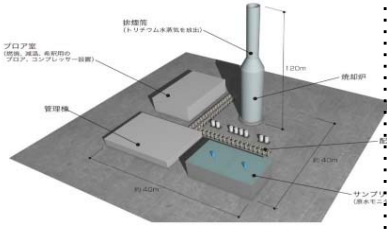
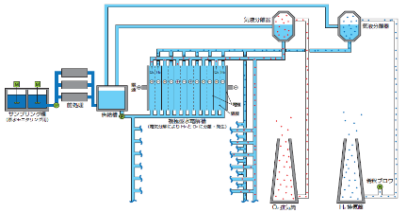
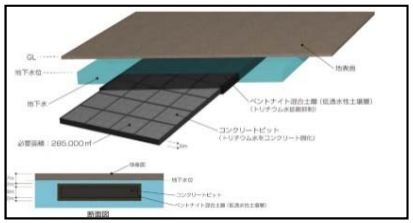
Comparison of impact of tritium and well-known radioactive nuclides on living organisms



7. Examination status of handling of ALPS treated water

- **"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-)"**
  Handling of ALPS treated water has been continuously 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.

8. Examination at ALPS subcommittee

◇ Toward the decision on handling of ALPS treated water, **"The Subcommittee on Handling ALPS Treated Water"** has started its examination from November 2016

- In a comprehensive manner, including the perspective of countermeasures for reputational damage.

◇ For the purpose of listening the concerns on handling methods an itself from the public widely, **public hearings** were held in Fukushima and in Tokyo in August 2018.

- **Issues raised at the public hearing has been examined at the subcommittee**.

◇ **Examination status at the subcommittee will be shared** to the international society.

- Example (METI website) https://www.meti.go.jp/english/earthquake/nuclear/decommissioning/index.html#cwi

＜ Issues raised at the public hearing ＞

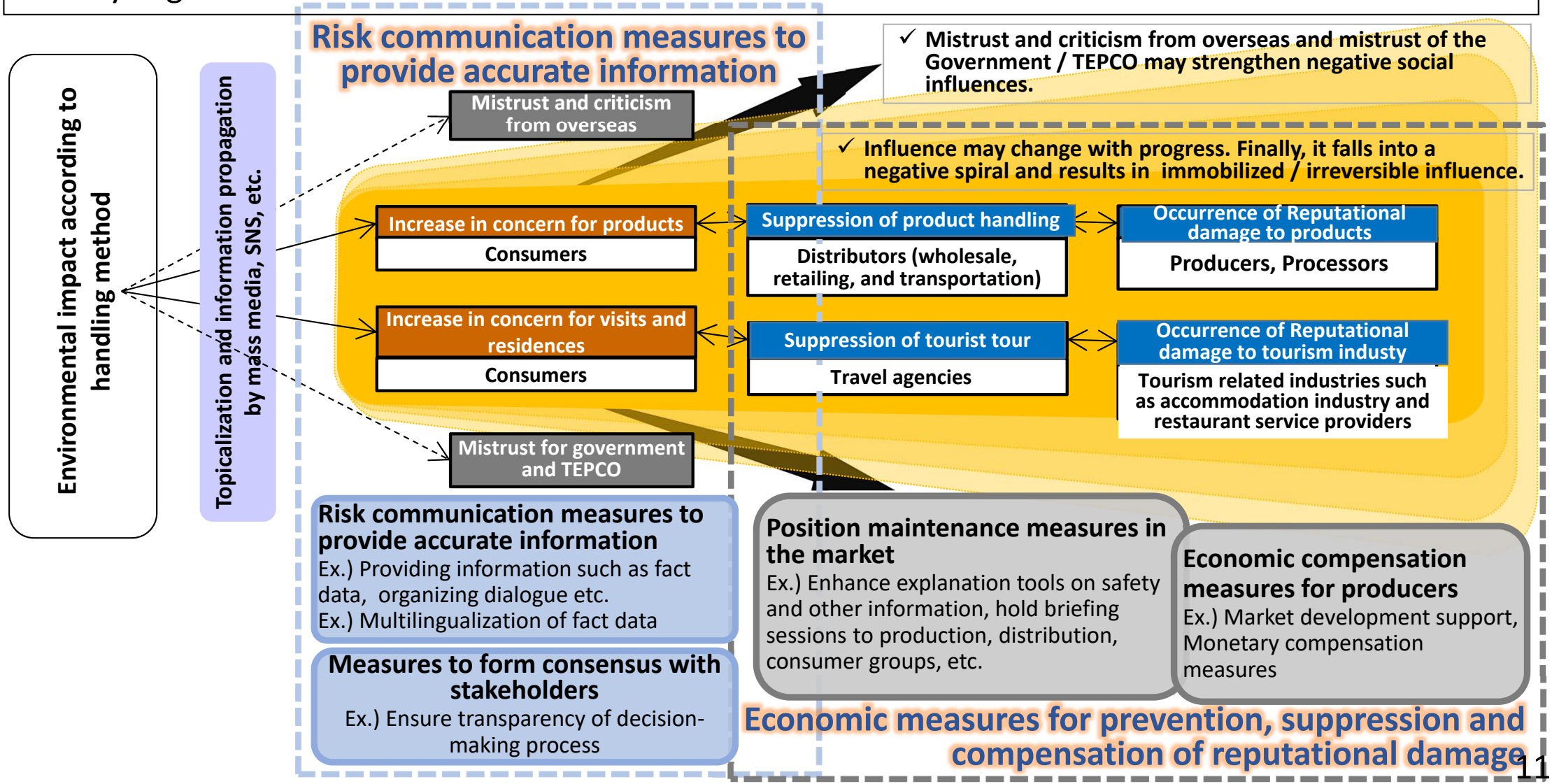
1) Biological effects of tritium (30 November, 2018)
2) Treatment of radionuclides other than tritium (1 October, 2018)
3) Environmental monitoring (20 November, 2018 and 8 December, 2018)
4) Countermeasures for reputational damage
5) Handling method (9 August, 2019)
6) Continuation of storage (9 August, 2019)
7) Consensus building

9. Review of countermeasures for possible reputational damage

◇ Various concerns arising from the handling of ALPS treated water may induce reputational damage.

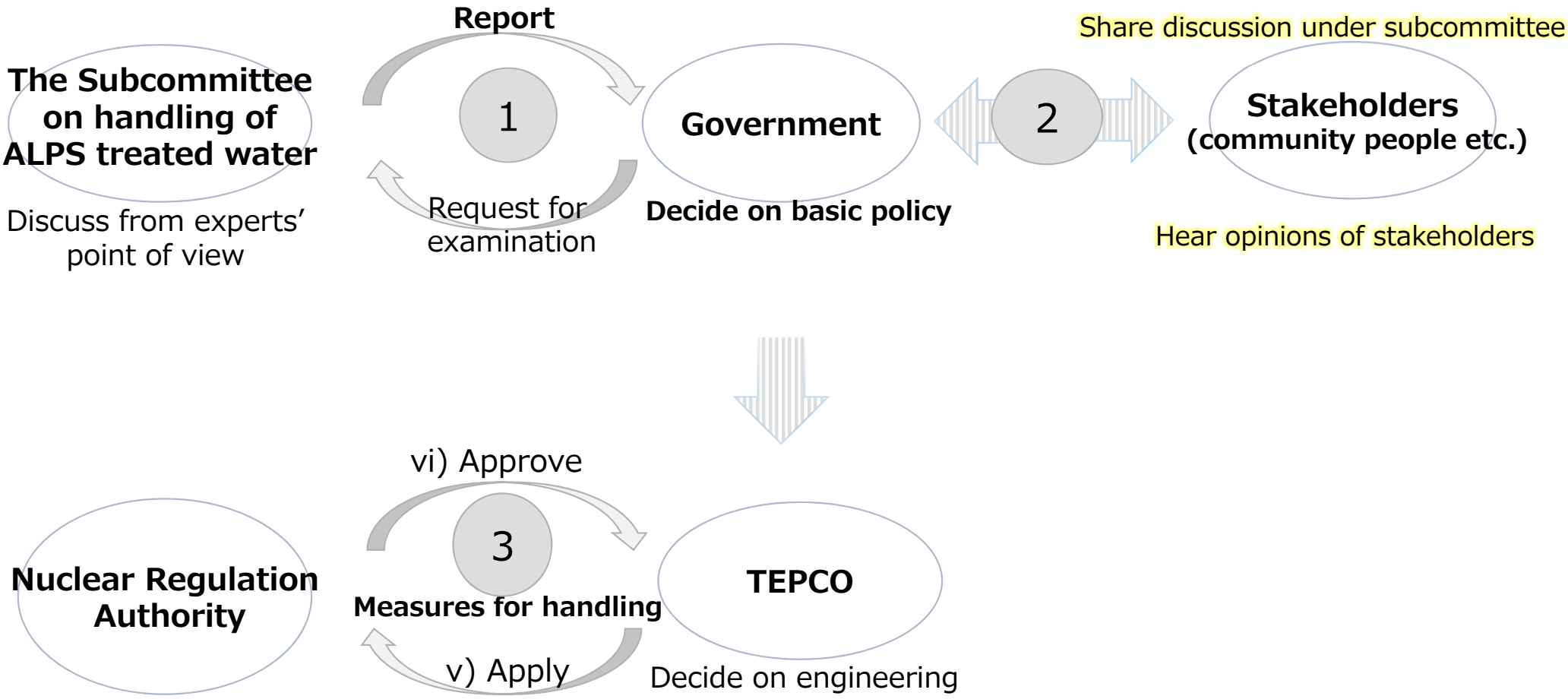
◇ Measures to curb the impacts from handling of ALPS treated water are broadly divided into:
A) risk communication measures for providing accurate information; and
B) economic measures for preventing, suppressing, and compensating the reputational damage.

◇ Appropriate countermeasures for reputational damage should be examined for each layer, by analyzing the occurrence mechanism.



10. Examination Process ahead

- **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 basic policy**, after receiving report of subcommittee and having stakeholder discussion.



11. Summary of the 4th IAEA Review (1)
- Team and scope of the review mission -

2. Review period

November 5-13, 2018

3. Review team composition:

Team leader: Mr. Chrisophe XERRI, Director, Division Nuclear Fuel Cycle and Waste Technology (NEFW), IAEA

13 experts: 9 from IAEA and 4 others from Indonesia, Russia, U.K., U.S.

4. Agenda of the peer review

- ✓ Current situation of Fukushima Daiichi
- ✓ Follow-up of the previous IAEA review
- ✓ Specific issues
  - Management of contaminated water
  - Removal of spent fuel and retrieval of fuel debris
  - Management of radioactive waste
  - Institutional and organizational issues

[Ref.]

1st mission : April 15-22, 2013
2nd mission : November 25 – December 4, 2013
3rd mission : February 9-17, 2015

11. Summary of the 4th IAEA Review (2)
- Main findings-

1. Main findings

- IAEA team said Japan has made significant progress since the accident in March 2011, advancing from an emergency situation towards a stable situation now.

- The team acknowledged a number of accomplishments since the 2015 mission, including:

  - The repair of subdrains and construction of the frozen soil wall around reactor Units 1-4, which have reduced groundwater ingress into the reactor buildings.
  - Improved site working conditions including a reduced need for full protective gear, and real-time radiation monitoring easily accessed by the workforce.
  - Progress towards the removal of spent fuel from Units 1-3 as well as remote investigations of fuel debris by robots.

-The team said the Government of Japan, in engaging all stakeholders, should urgently decide on a disposition path for ALPS treated water. The treated water is accumulating in tanks on site and is expected to reach the currently planned tank capacity within three to four years.

* Totally 17 acknowledgements and 21 advisory points are provided in the preliminary summary report.

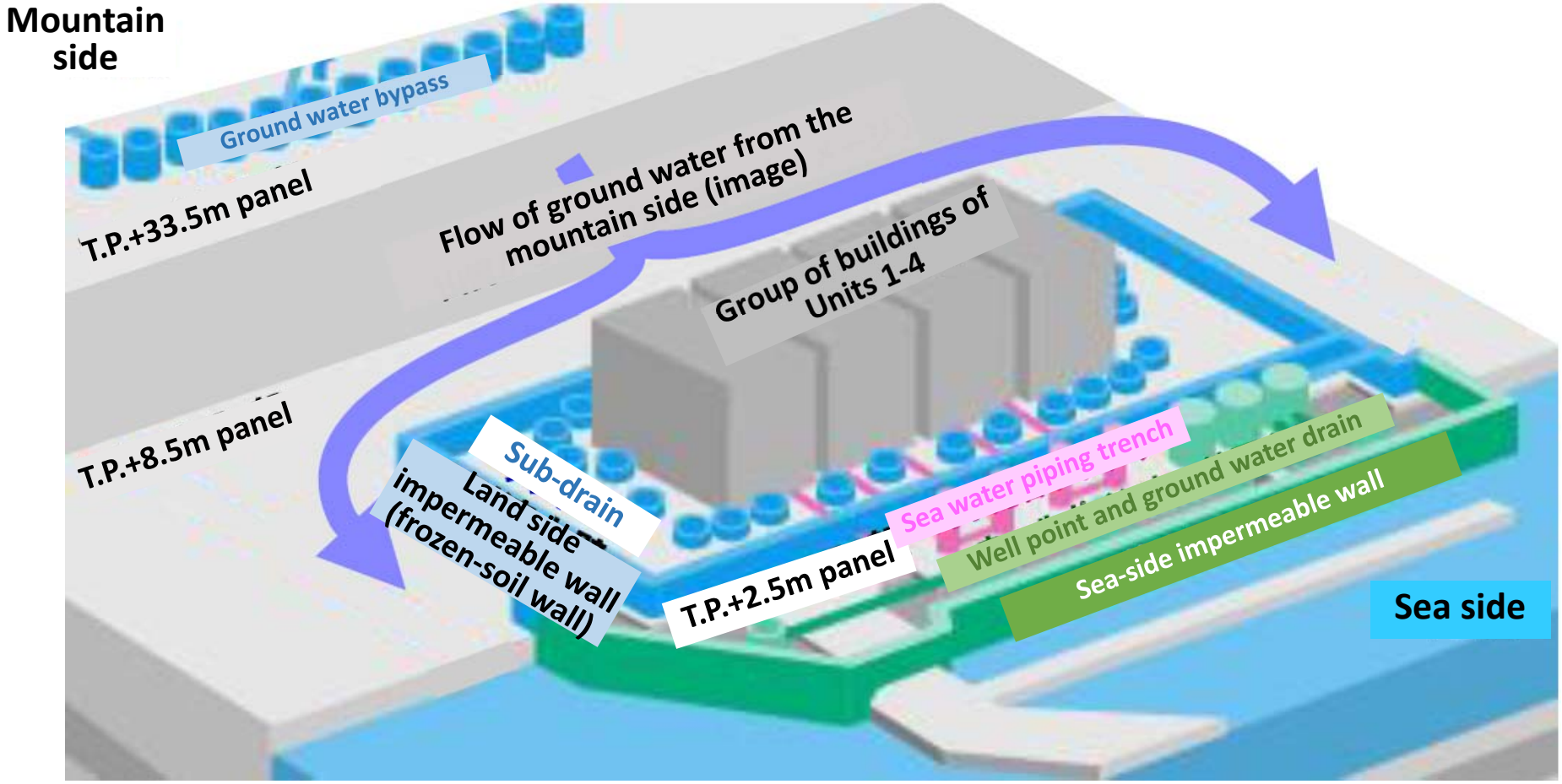
[Ref. 1] Measures to reduce risks associated with contaminated water

◇ **Treatment of highly-contaminated water,** which had accumulated in the sea water piping trench immediately after the accident, **had been completed** (2015).

◇ **The steel sea-side impermeable wall installment** has been prevented outflow of radioactive ground water to the sea (2015-).

◇ Amount of radioactive substances in the stagnant water in buildings has been reduced by treatment (continuous process).

◇ **Amount of contaminated water being generated was reduced** from about 540m^3/day (May 2014) to about 170m^3/day (average for FY2018) by implementing preventive and multi-layered measures, such as land side impermeable wall and sub-drains. (Goal : 150m^3/day by 2020).



[Ref. 2] Concept of Cyclic Cooling in Reactor Building

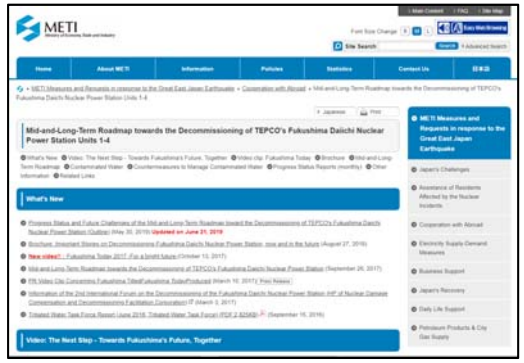
◆ To stably cool down the fuel debris, circulated cooling water is continuously injected into primary containment vessel .

Spent fuel pool
Reactor Building
Primary containment vessel
Reactor pressure vessel
Turbine Building
(Gross β : a few hundred million Bq/L)
Groundwater inflow (A) *
Groundwater
Contaminated water
Pumping water around the bank area (B)*
Added Sr removal function
Cesium removal equipment
KURION
SARRY
Reactor cooling water
Cyclic cooling
Pump
Tank
Desalination device (RO)
(Gross β : ≦a few hundred Bq/L)
(Gross β : a few million Bq/L)
Sr treated water
About 93,000m³
(As of July, 2019)
(A)+(B) equivalent
RO concentrated saline water
0m³
(Completed on May 27, 2015)
Storage tanks
※Residual water : about 600m³
ALPS treated water
About 1,052,000m³
(As of July, 2019)
Storage tanks
Multi-nuclide removal equipment (ALPS)
Storage tanks

* (A) and (B) vary depend on the measures and the precipitation.

[Ref. 3] Information Portal site （1） : Fukushima Daiichi NPS

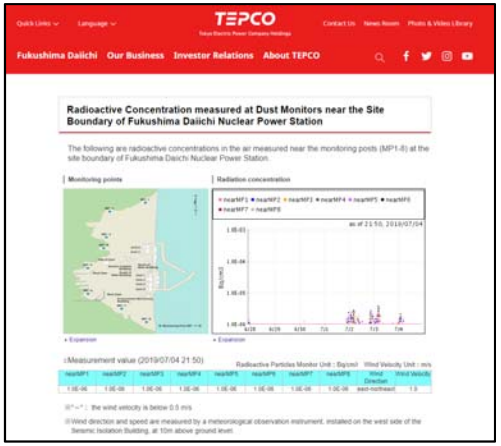
METI
Ministry of Economy, Trade and Industry



- **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 2018**
  - Efforts to Decommission and Reconstruction
  https://www.youtube.com/watch?v=TZV2HRKNvao
- **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.3] Information Portal site （2） : Fukushima Daiichi NPS

IAEA International Atomic Energy Agency

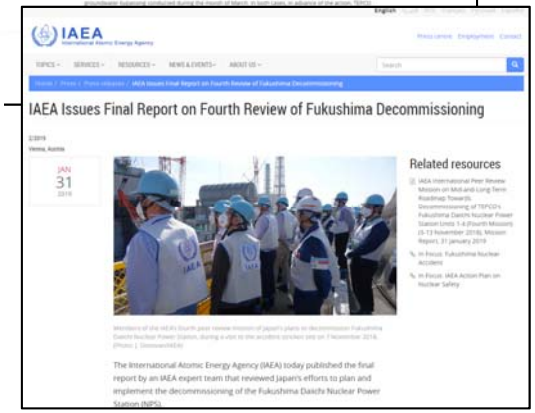
◆ Fukushima Daiichi Status Updates

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

◆ IAEA Review mission reports (Press release)

IAEA 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



United Nations Scientific Committee on the Effects of Atomic Radiation

◆ UNSCEAR 2016 REPORT Annex C
- Biological effects of selected internal emitters-Tritium

https://www.unscear.org/docs/publications/2016/UNSCEAR_2016_Report-CORR.pdf