Decommissioning and Measures for Contaminated Water at Fukushima Daiichi NPS

Agency for Natural Resources and Energy, METI

February, 2019

Decommissioning of TEPCO Fukushima Daiichi NPS

◇ **Decommissioning** of Fukushima Daiichi is **a continuous risk reduction activity** to protect the people and the environment from the risks associated with radioactive substances* **by removing the spent fuel and fuel that has melted and solidified (fuel debris) from the Reactor Building.**

*For example, the impact of radiation from spent fuel and fuel debris, the leakage of highly-concentrated contaminated water, and the dispersal of dust containing radioactive substances.

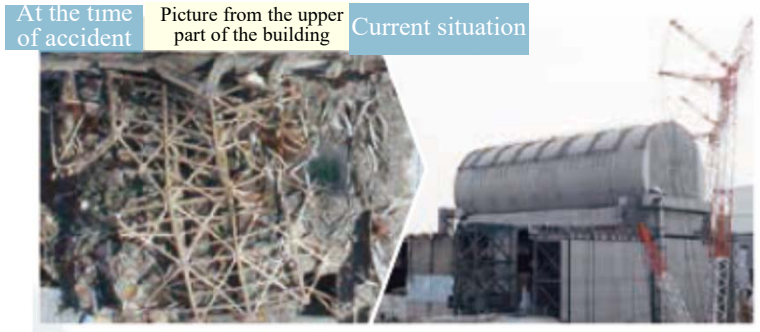
◇ Moreover, it is also necessary to reduce the risks associated with contaminated water and waste that is generated in the course of decommissioning.

◇ Moving **forward in a safe and steady manner with decommissioning and contaminated water countermeasures** at the power plant, is a **major prerequisite for the reconstruction of Fukushima**.

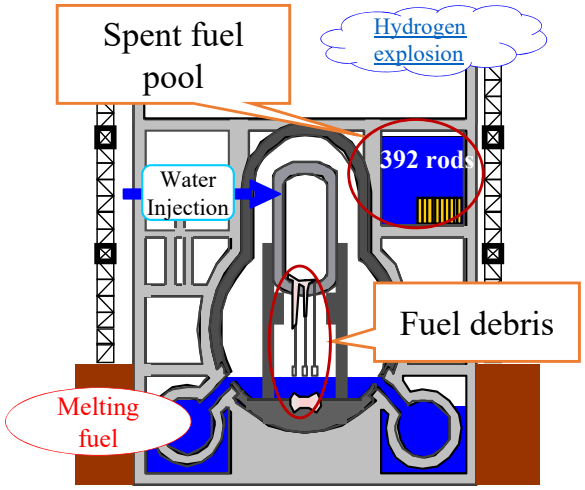
Spent fuel: Fuel that remains after it is used for power generation. It is necessary to cool this spent fuel continuously due to the decay heat it generates after use.

Fuel debris: Fuel that melted and solidified again during the accident. This fuel debris must be continuously cooled.

<Reference> Status of Unit 3



<Reference> Internal condition of Unit 2



Units 1 and 2 / Unit 3 / Unit 4

Removing fuel from the SFP → Rubble removal → Installation of fuel removal equipment → Fuel removal → Storage/Transportation

Units 1-3

Fuel debris retrieval → Ascertaining of the situation inside the PCV/ consideration of fuel debris retrieval, etc → Fuel debris retrieval → Storage/Transportation

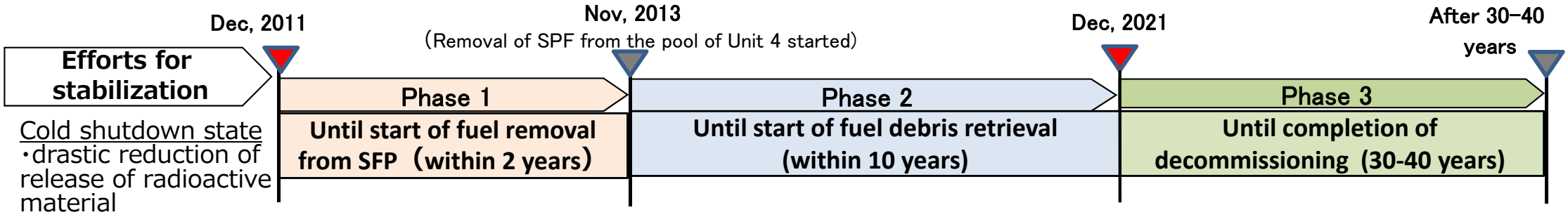
▼ Current progress

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

Work of decommissioning extended to 30-40 years

Process（milestones）of the Roadmap

Maintain overall the framework of decommissioning



Processes for grasping the status of counter measures

Contaminated water management	Reduce contaminated water generation to about 150 m ^{3} / day.	Within 2020
	Store of all treated water in welded-joint tanks	FY 2018
Stagnant water treatment	①Separate connection between Units 1 and 2 and between Units 3 and 4	Within 2018
	②Reduce radioactive materials in stagnant water in the buildings by one-tenth of the 2014 year-end.	FY 2018
	③Complete treatment of stagnant water in buildings	Within 2020
Removal of spent fuels	①Start spent fuel removal at Unit 1	FY 2023 (an outlook)
	②Start spent fuel removal at Unit 2	FY 2023 (an outlook)
	③Start spent fuel removal at Unit 3	Mid FY2018
Retrieval of fuel debris	①Decide on the method for fuel debris retrieval from the 1st implementing Unit	FY 2019
	②Start fuel debris retrieval from the 1st implementing Unit	Within 2021
Solid Radioactive waste	Establish technical perspective on measures of treatment / disposal and on safety.	Around FY2021

[Ref.] Essence of the revised Mid-and-Long-Term Roadmap (Sept. 2017)

1. Basic stance for the revision

i) Maintain disciplines of "top priority on safety" and "emphasizing importance on risk reduction"

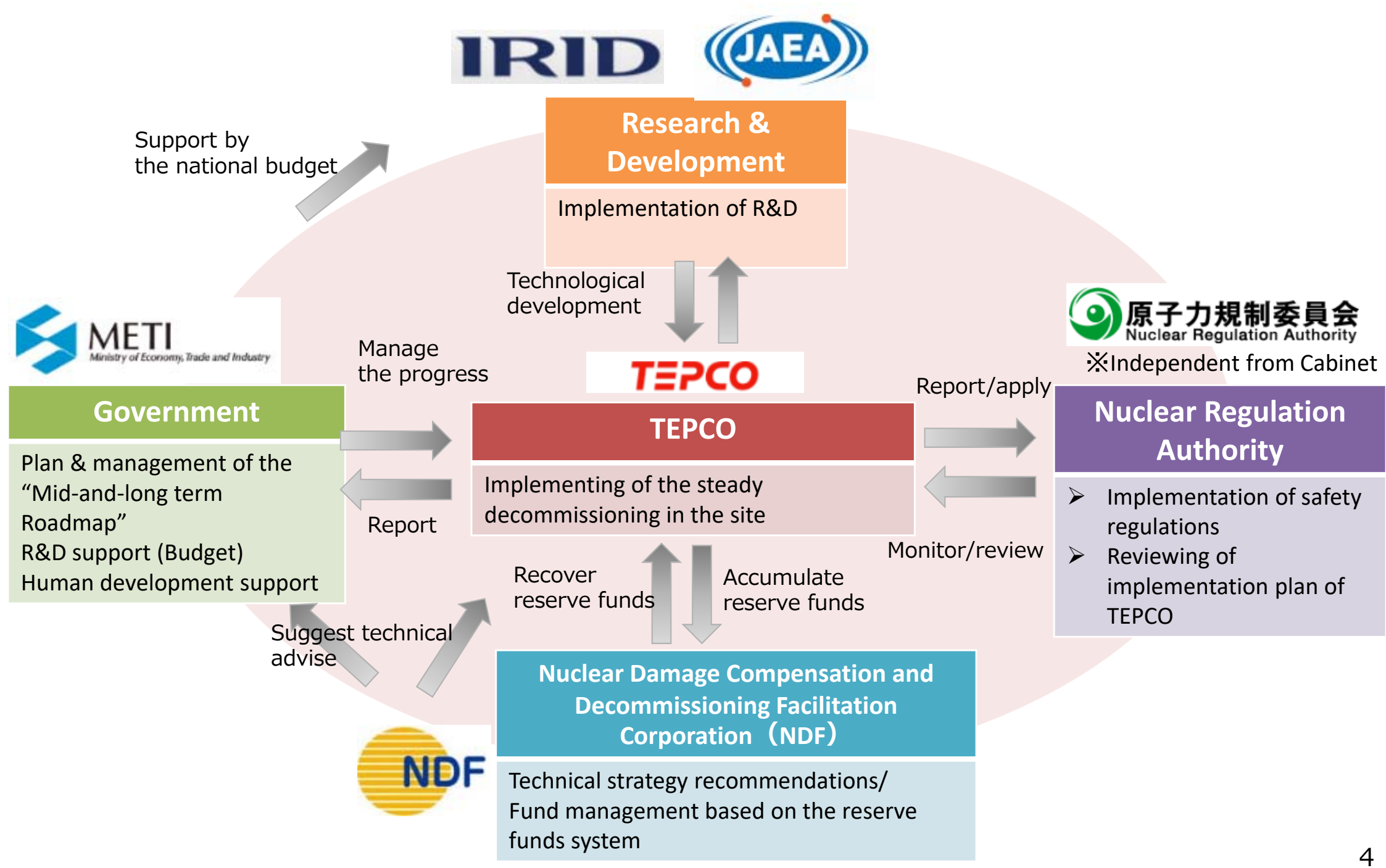
ii) Optimize the entire decommissioning project as the site conditions had become more clear as decommissioning progresses

iii) Emphasize and further strengthen communication with local communities and society

2. Essence of the revision

i) Retrieval of fuel debris ✓ NDF compared and examined multiple retrieval methods, then formulated and published technical suggestions for the Government of Japan in Aug.	➢ Compile **"Policy on Fuel Debris Retrieval"** - "Partial submersion / access from side method", from bottom of the PCV - Step-by-step approach (from a small scale)
ii) Fuel removal from SFP ✓ From the viewpoint of ensuring safety, newly required work has been clarified.	➢ Proceed carefully by **dealing with situations found out** and **ensuring/adding safety measures.** ➢ Optimize entire decommissioning processes, while improving environment around the building.
iii) Contaminated water management ✓ Preventive and multilayered measures (sub-drain, sea-side impermeable walls, frozen impermeable walls etc.) have made progress and the volume of water inflow into buildings has been drastically reduced.	➢ Maintain and manage properly the preventive and multilayered measures, and operate them certainly. ➢ **Reduce the amount of contaminated water generated, by** operating the frozen impermeable walls and sub-drain integrally. ➢ Handle liquid waste adheres to the current policy.
iv) Waste management ✓ NDF formulated and published technical suggestions on "Basic Principle" for the Government of Japan at the end of August.	➢ Compile **"Basic principles "** - Ensure safety (containment and isolation). - Select a precedent processing method in parallel with identifying the characteristics.
v) Communication ✓ More courteous information dissemination /communication is needed as people returns and reconstruction progresses.	➢ **Further strengthen communication.** ➢ **Enhance interactive communication** in addition to courteous information dissemination.

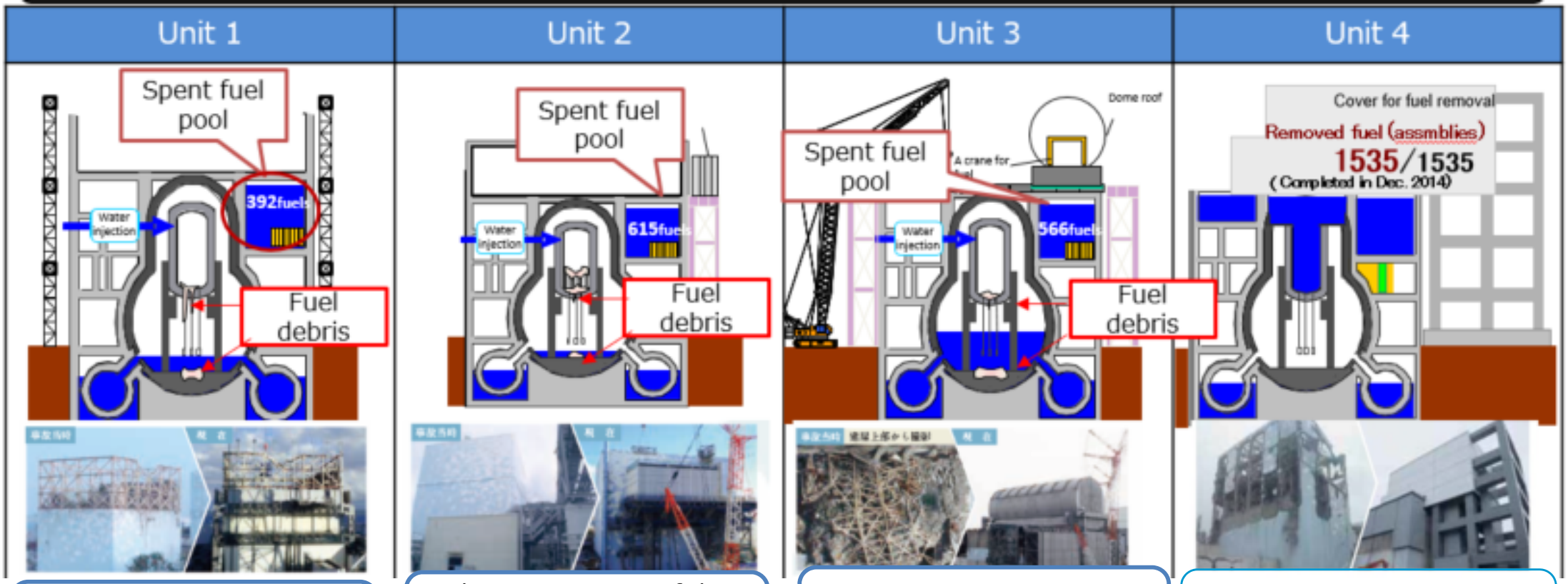
[Ref.] The scheme for the decommissioning of Fukushima Daiichi



[Ref.] Progress on Fukushima Daiichi Decommissioning (2018-2019)

" Japan has **made significant progress** since the accident in March 2011, **advancing from an emergency situation towards a stable situation** now. (IAEA review / Nov. 2018)

- Ordinary clothing can be worn at **96%** of the site (July 2018)
- Generation of Contaminated Water: 500m³/day (FY2014) → **180m³/day** (Apr-Dec. 2018)
- Progress towards the removal of spent fuel and debris retrieval (below)



The removal of the rubble on the operating floor started from January 2018

The investigation of the operating floor was conducted in July 2018.

Investigation of inside RPV was conducted in Feb. 2019.

A trial run of the crane stared in March 2019

Spent fuel removal: completed in Dec.2014

No fuel debris

[Ref.] Progress on Fukushima Daiichi Decommissioning in 3 years

<Contaminated Water Management>

- The construction of the Sea-side impermeable wall was completed in October, 2015.
- Replace of K-drainage was completed in March 2016.
- The frozen soil wall was almost completed in March 2018.

Frozen soil wall

Sea-side impermeable wall

Unit1 : Removal of the cover was completed

Unit3
Dome roof was installed

<Removal of spent fuel>

- Unit1 : Removal of the building cover roof panel was completed in October 2015.
- Unit3 : Removal of the large rubbles in spent fuel pool was completed in November 2015.
- Unit1 : The removal of the wall panel of the building cover was completed in November 2016.
- Unit3 : Installation of the cover for fuel removal was completed in February 2018.

<Retrieval of fuel debris>

- Unit1 : Investigation inside PCV was done in March 2017.
- Unit2 : Contact investigation inside PCV was done in February 2019.
- Unit3 : Investigation inside PCV was done in July 2017.

Unit1 :
Snake shape robot

Unit2 :
Investigation unit

Unit3 :
Underwater ROV

<Waste management>

- The operation of the miscellaneous solid radioactive waste incineration facility was started in March 2016. (Measures for improving reliability was completed in June 2017)
- Solid waste storage facility (No9) was completed in February 2018.

Miscellaneous solid radioactive waste incineration facility

Solid waste storage facility(No9)

< Improvement of working environment >

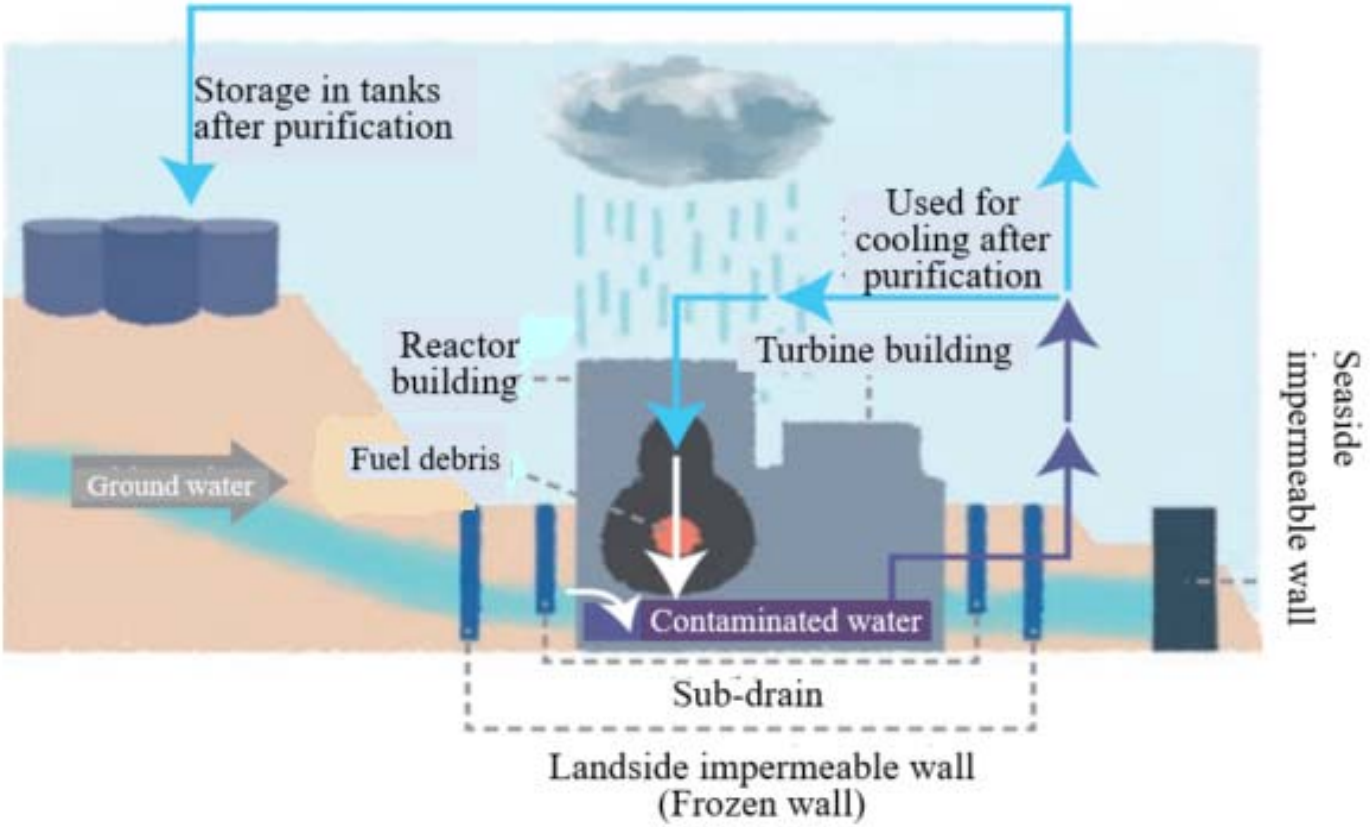
- A convenience store was opened at 2nd floor of large rest area in March 2016.
- Shower rooms were opened in the large rest area in April 2016.
- Operation of the new office building was started in October 2016.

Convenience store

New office building

Overview of Water Management
- Generation of contaminated water, purification and storage-

- In the reactor, cooling of fuel debris by water injection is continuing.
- In order to prevent flow out of the reactor building, the water level of the stagnant water is maintained lower than the groundwater level outside of the building.
- As a result, groundwater flows into the building and mixes with stagnant water, so that additional contaminated water is generated inside of the building.
- After processing by purification equipment such as ALPS, the water is stored in tanks. However, tritium cannot be removed by the purification equipment.



Overview of Water Management
- Three Basic Principles -

Three Basic Principles for Water Management

1. "Isolating" groundwater from the contamination source

Measures are taken to reduce the generation of contaminated water. (①②③⑤)

500m³/day(FY2014)

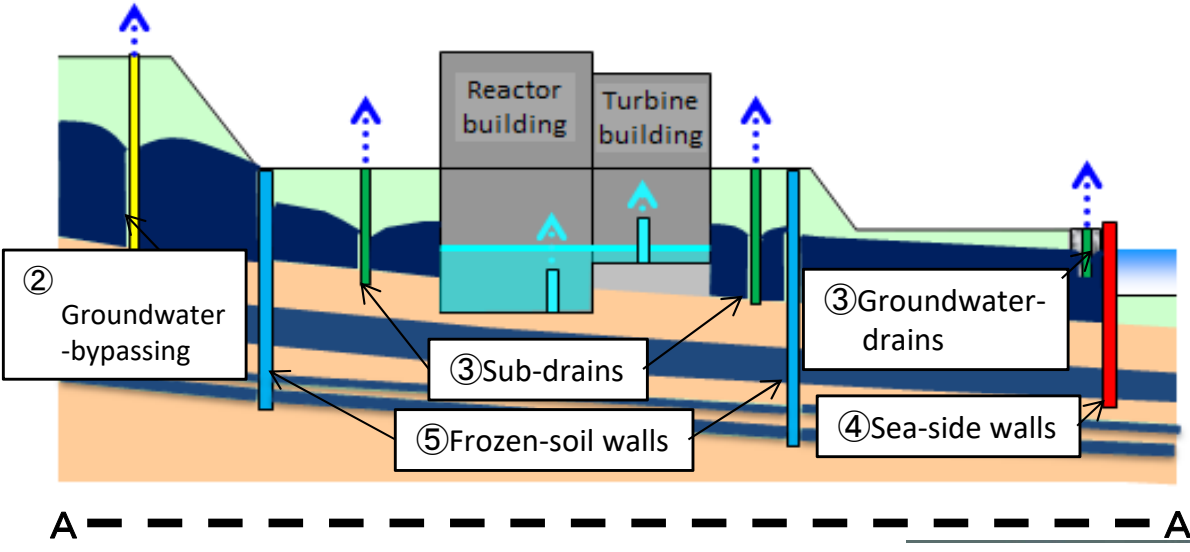
→ **180m³/day(Apr-Dec, 2018)**

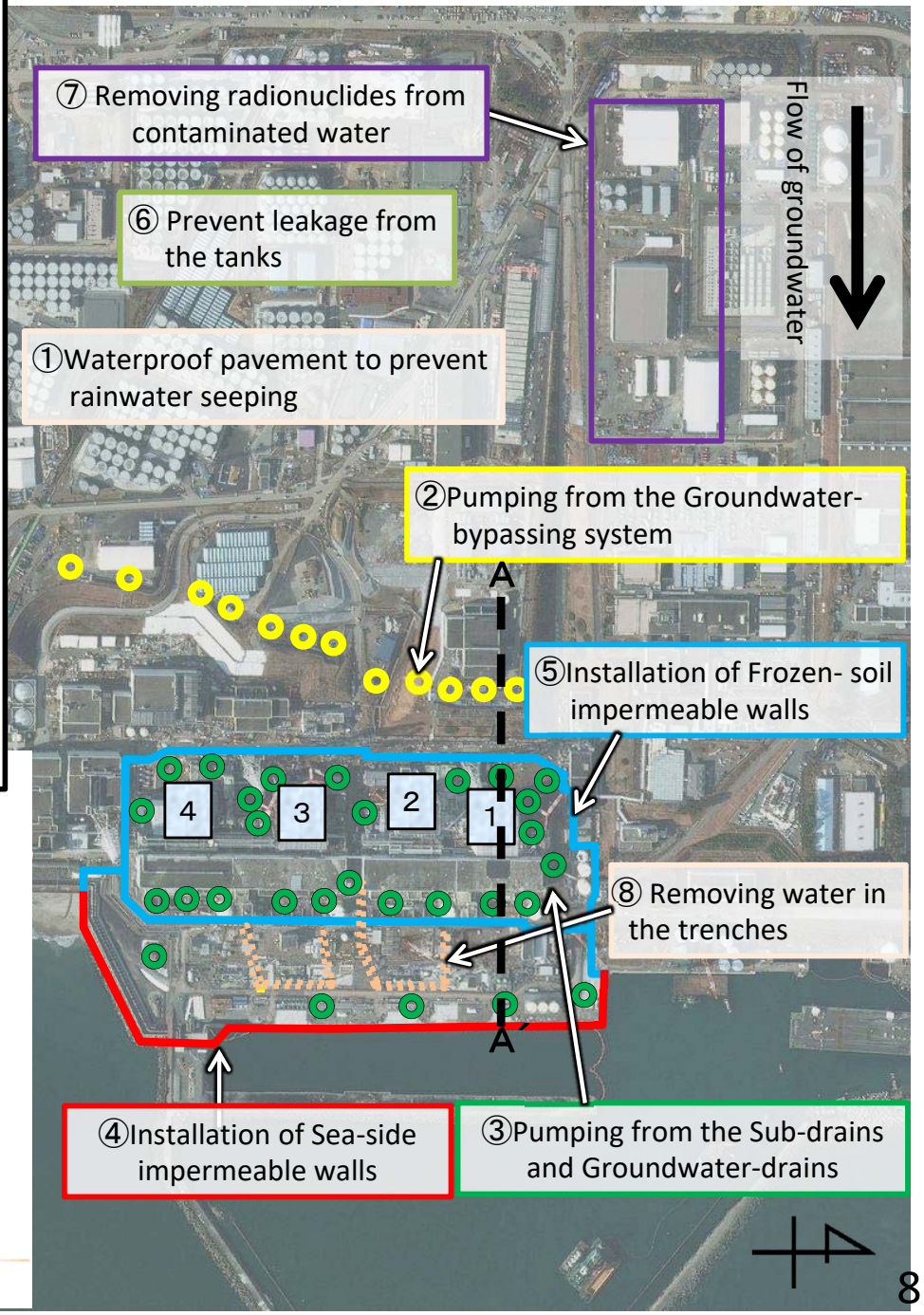
2. "Preventing leakage" of contaminated water

Measures are taken for preventing leakage of contaminated water to the sea. (④⑥)

3. "Removing" the contamination source

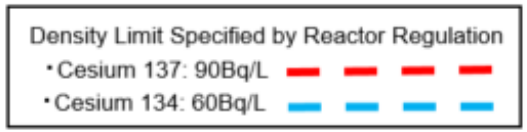
Measures are taken for removing the radioactive nuclides from the contaminated water in the tanks and in the trenches. (⑦⑧, etc.)

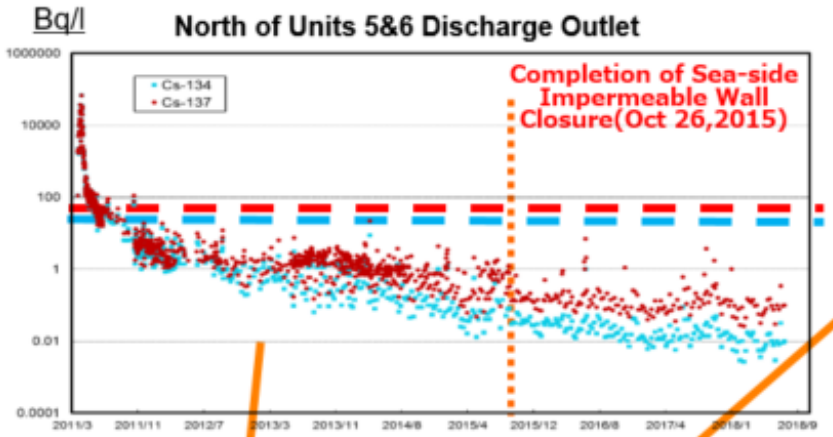


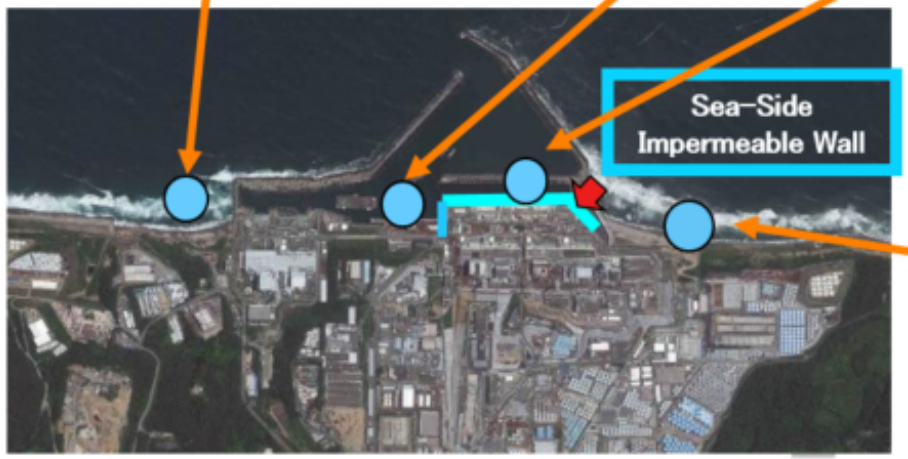


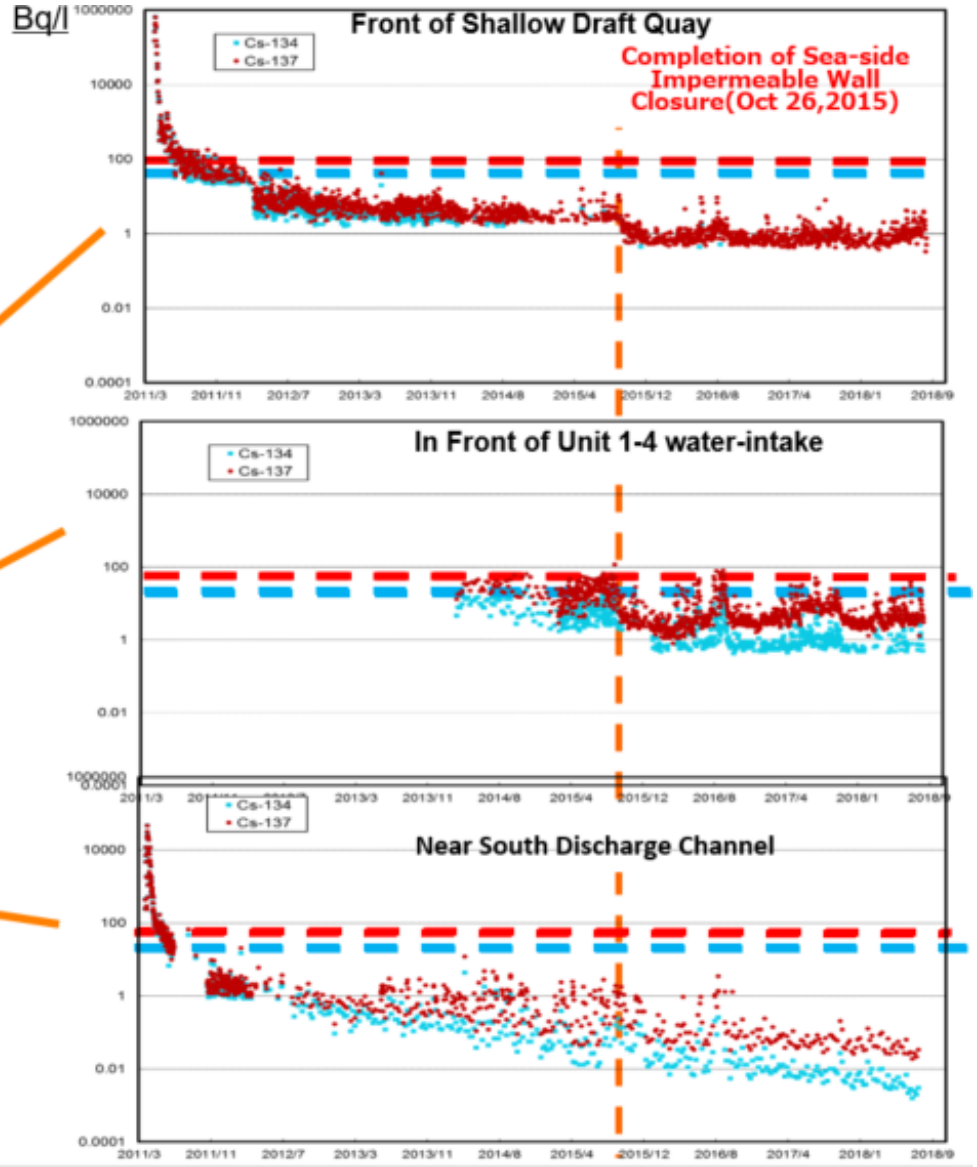
Overview of Water Management
- Density and quantity of contaminated water -

- The concentration of radioactive material outside the port is sufficiently lower than the Regulatory Notification Limit.









Overview of Water Management
- Storage of ALPS treated water -

- Currently, tanks continue to increase. The installation area of the tanks occupy much of the southern half of the site.
- The current tank capacity per the construction plan is 1.37 million tons. The available site area for building new tanks is approaching the limit.
- (ref. northern half of the site is planned to be the solid radioactive waste storage facilities area)

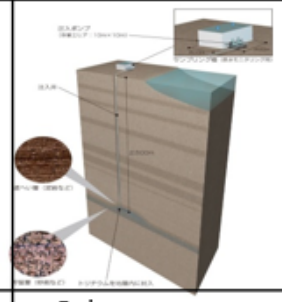
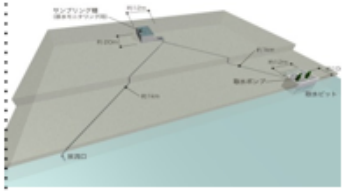
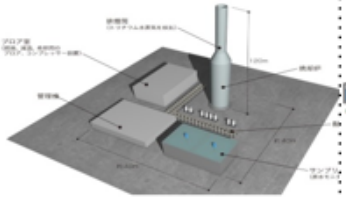
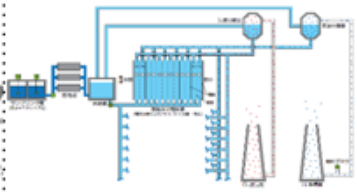
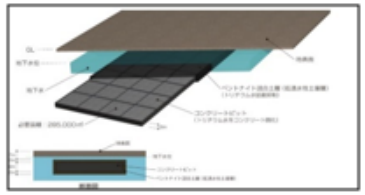
【ALPS treated water tanks spreading at 1F site】

Status of ALPS treated water	
Volume of water stored in tanks	About 1.12 million ton (as of January 2019)
Projected tank volume	About 1.37 million ton (end of 2020)
Generation rate of ALPS treated water	About 50,000-80,000 ton/year

Overview of Water Management
– Discussion at Task Force and subcommittiee -

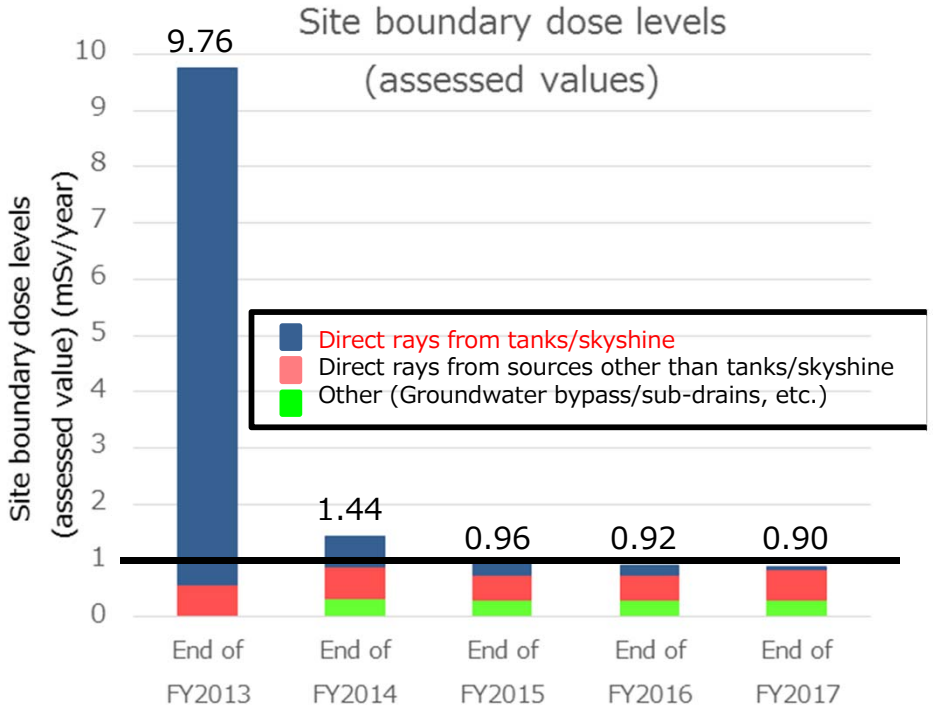
- METI's "The Tritiated Water Task Force" assessed the regulatory feasibility, technical feasibility (including monitoring to ensure safety), treatment period and cost of 5 disposal methods ; (1) geosphere injection, (2) offshore release, (3) vapor release, (4) hydrogen release, and (5) underground burial.
- All cases are examined on the premise that there is no scientific impact on the human habitant.
- The treatment of ALPS treated water has been discussed in "the subcommittee on handling ALPS treated water" as reputational damage can have a societal impact. For the purpose of listening the concerns on disposal methods and disposal itself from the public widely, we had held public hearing in Fukushima and in Tokyo in August, 2018.

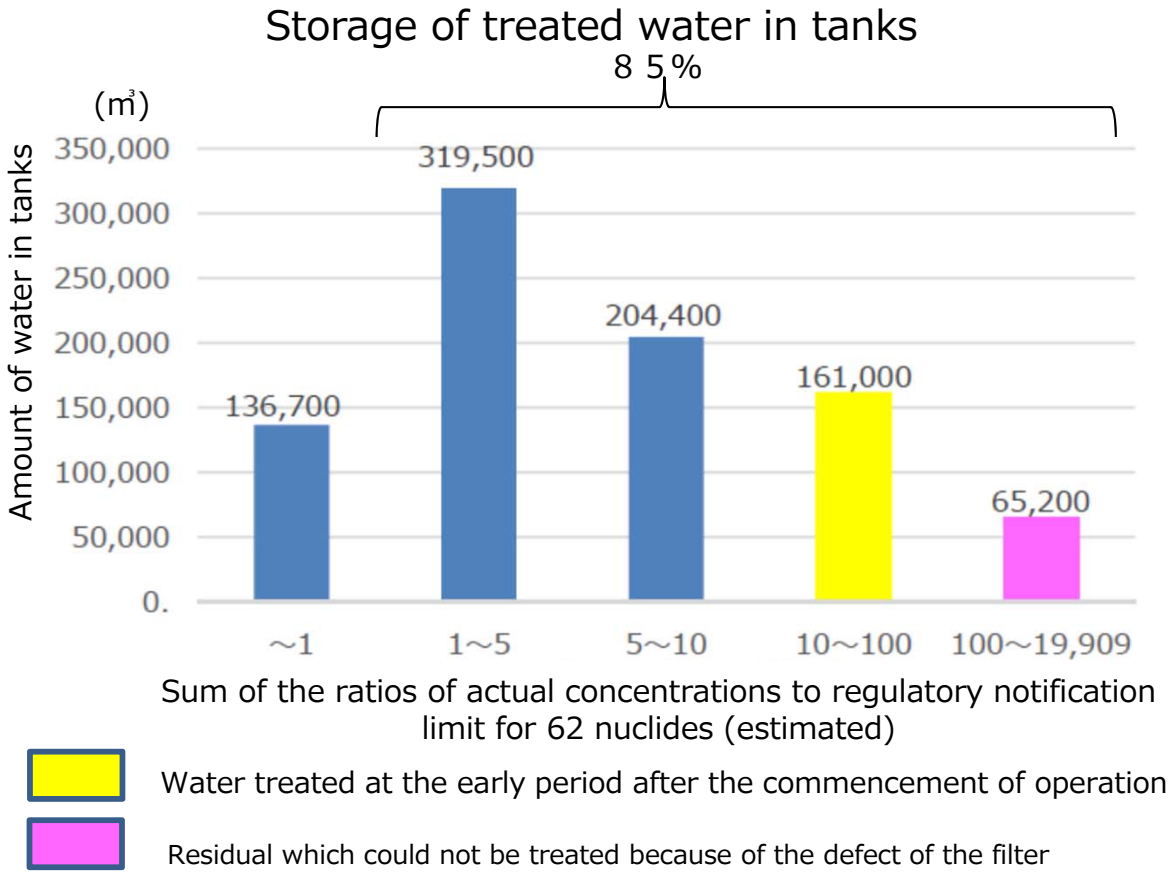
Table. Results of assessment of Tritiated water task force

Method of disposal	(1) geosphere injection	(2) offshore release	(3) vapor release	(4) hydrogen release	(5) underground burial
Image					
Regulatory feasibility	It is necessary to formulate new regulations and standards related to disposal concentration	Feasible (Precedent exists)	Feasible	Feasible	New standards might require to be formulated. (Similar examples exist)
Technical feasibility	Proper stratum is necessary	Feasible (Precedent exists)	Feasible (Precedent exists)	Research and development is necessary for pre-treatment and scale expansion	Feasible

Current characteristic of ALPS treated water

- The purpose of ALPS operation to keep site boundary dose levels to less than 1mSv/y, not to keep concentration of treated water to less than the Regulatory Notification Limit.
- Concentrations of ALPS treated water in the tanks vary since they depend on the concentration of contaminated water before treatment and operation management of ALPS, such as frequency of absorbent exchange. Now, the concentration of ALPS treated water is lower, because the performance of ALPS has improved.

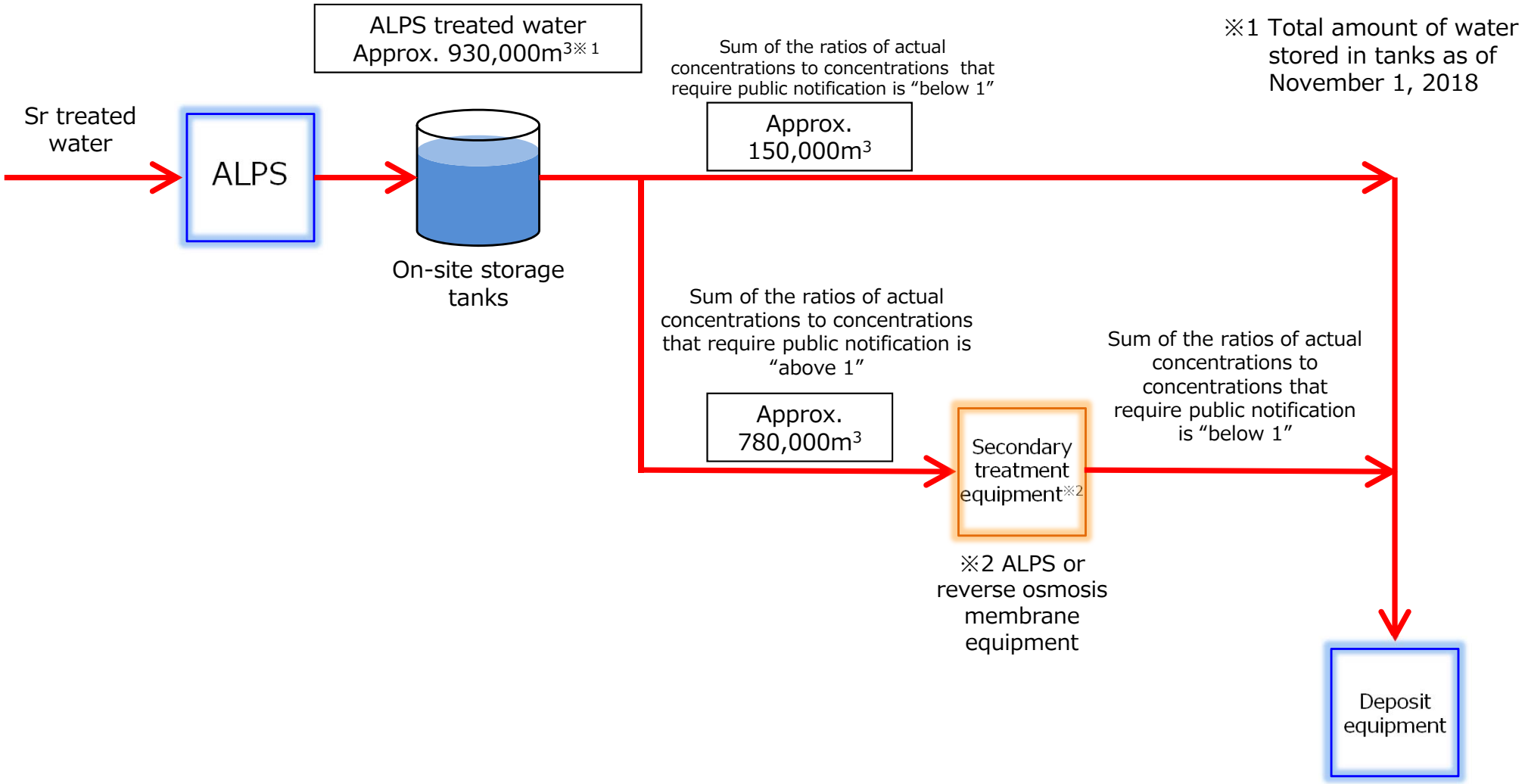




* Quoted from "Subcommittee on handling ALPS treated water" (10th and 11th) , updated as of Nov. 2018

Secondary treatment of ALPS treated water

- Disposal of ALPS treated water needs to satisfy the regulatory limit after dilution. However, considering its societal impact, TEPCO plans to repurify ALPS treated water with secondary treatment, to meet the regulatory limit before dilution.
- Whether to use ALPS or reverse osmosis membrane equipment for secondary treatment is being deliberated.



Summary of the 4th IAEA Review (1)
- 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.

Summary of the 4th IAEA Review (2)
- 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

[IAEA website:] Press release (January 31, 2019)

IAEA Issues Final Report on Fourth Review of Fukushima Decommissioning

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

Cooperation with International Communities

International Organizations

IAEA International Atomic Energy Agency

- Peer Review Missions (April, 2013 -)
- Expert Visits
- Expert Meetings
- Comprehensive information on the website (December, 2013 -)
- “The Fukushima Daiichi Accident” (September, 2015) (Reported by the Director General)
- Side Event in the General Conference since 2015

OECD BETTER POLICIES FOR BETTER LIVES / NEA NUCLEAR ENERGY AGENCY

- PreADES
  (Preparatory Study for Analysis of Fuel Debris)
- CDLM
  (Committee on Nuclear Decommissioning & Legacy Management)
- EGCUL
  (Expert Group on Characterisation Methodology of Unconventional and Legacy Waste)
- Policy dialog on decommissioning industry cluster development

Bilateral Frameworks

U.S.-Japan Bilateral Commission on Civil Nuclear Cooperation

- Decommissioning and Environmental Management Working Group
- Civil Nuclear Energy R&D Working Group

UK-Japan Nuclear Dialogue

- Decommissioning Working Group

Japan-France Nuclear Committee

Japan-Russia Nuclear Energy Working Group

International Forum on Decommissioning of Fukushima Daiichi NPS 2019

August 4, 2019 (Sun)

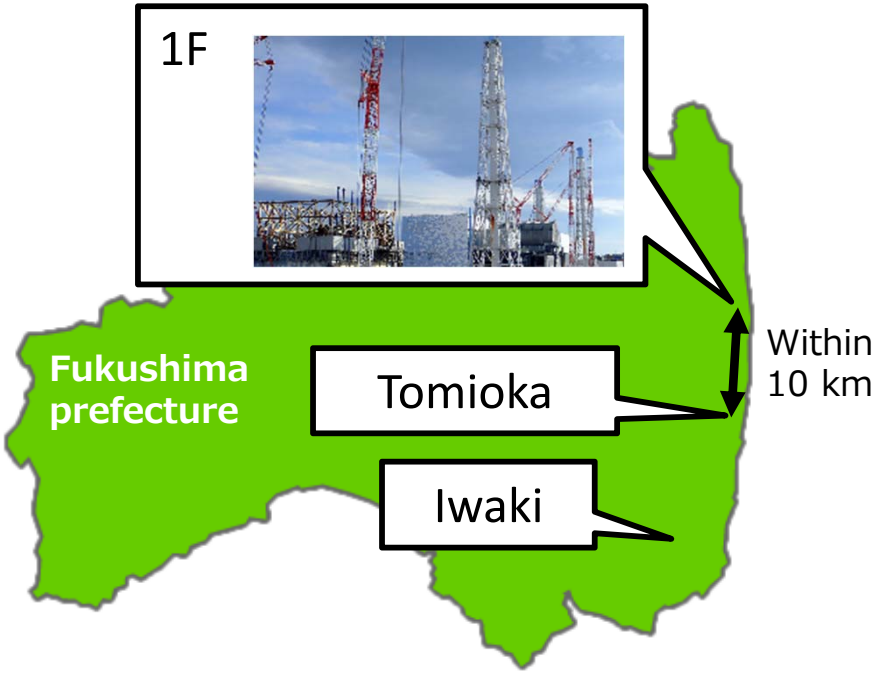
Program Day1 Tomioka Town

Open Dialogue with local Communities and Student Session

August 5, 2019 (Mon)

Program Day2 Iwaki City

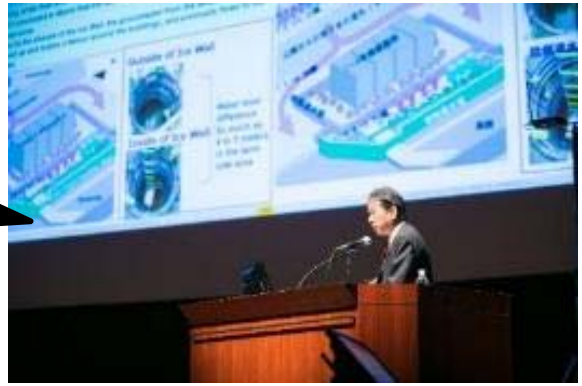
Discussion by the technical experts and Technical Poster Session



Open & Visual

Workshop by All participants

Generation of The future



Cutting-edge Technology

(tentative)

For more information
Tel:03-5545-7106 E-mail: forum@ndf.go.jp

International Forum on Decommissioning of Fukushima Daiichi NPS (2016-2018)

Evolving social & technological communication through open dialogue in Fukushima.

Archive data open to public at the website http://www.ndf-forum.com/en

1FD-Forum I

"The day, whole world would like to know about Fukushima"

Total Participants (cumulative)
641

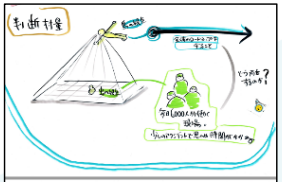
Technical Poster Session
37 organizations

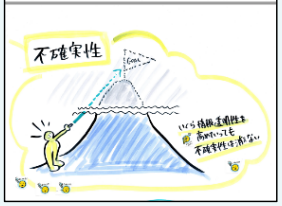
>28 Presentations on
Overseas experience of D&D
Communication with local community
Risk assessment
Fuel Debris Retrieval
Waste management

2016

1FD-Forum Ⅱ

"Moving forward together"





Total Participants (cumulative)
1,055

Technical Poster Session
89 organizations

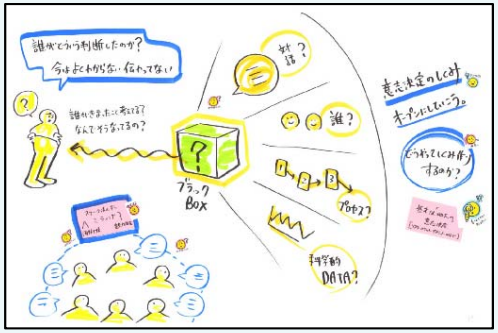
DAY1 Program for local community
>Lecture & workshop by all participants
>Open dialogue by D&D implementing organizations and local panel

DAY2 Program for Technical experts
>14 Presentations on Fuel debris, Risk analysis, Waste management

2017

1FD-Forum Ⅲ

"Make your voice heard for 1F decommissioning"



Total Participants (cumulative)
1,264

Technical Poster Session
123 organizations

DAY1
Open Dialogue with local Communities
>Lecture & workshop by all participants
>Open dialogue by D&D implementing organizations and local panel

DAY2
Discussion on the technical details
>10 Presentations on Remote handling technology in USA, UK and France and US Space industry

Student Session
>31 high school students attended
> 8 presentations and workshop

2018

Related Links

◆ ANRE, METI

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

http://www.meti.go.jp/english/earthquake/nuclear/decommissioning/index.html#links

◆ Film (METI)

Fukushima Today 2018 -Efforts to Decommission and Reconstruction

https://www.youtube.com/watch?v=TZV2HRKNvao

◆ The 3rd International Forum on the Decommissioning of the Fukushima Daiichi Nuclear Power Station

http://ndf-forum.com/en/