Revision of the Mid-term Risk Reduction Target

for TEPCO's Fukushima Daiichi Nuclear Power Station

August 6, 2018

Hiroshi YAMAGATA

Director-General for Emergency Response

The Secretariat of Nuclear Regulation Authority

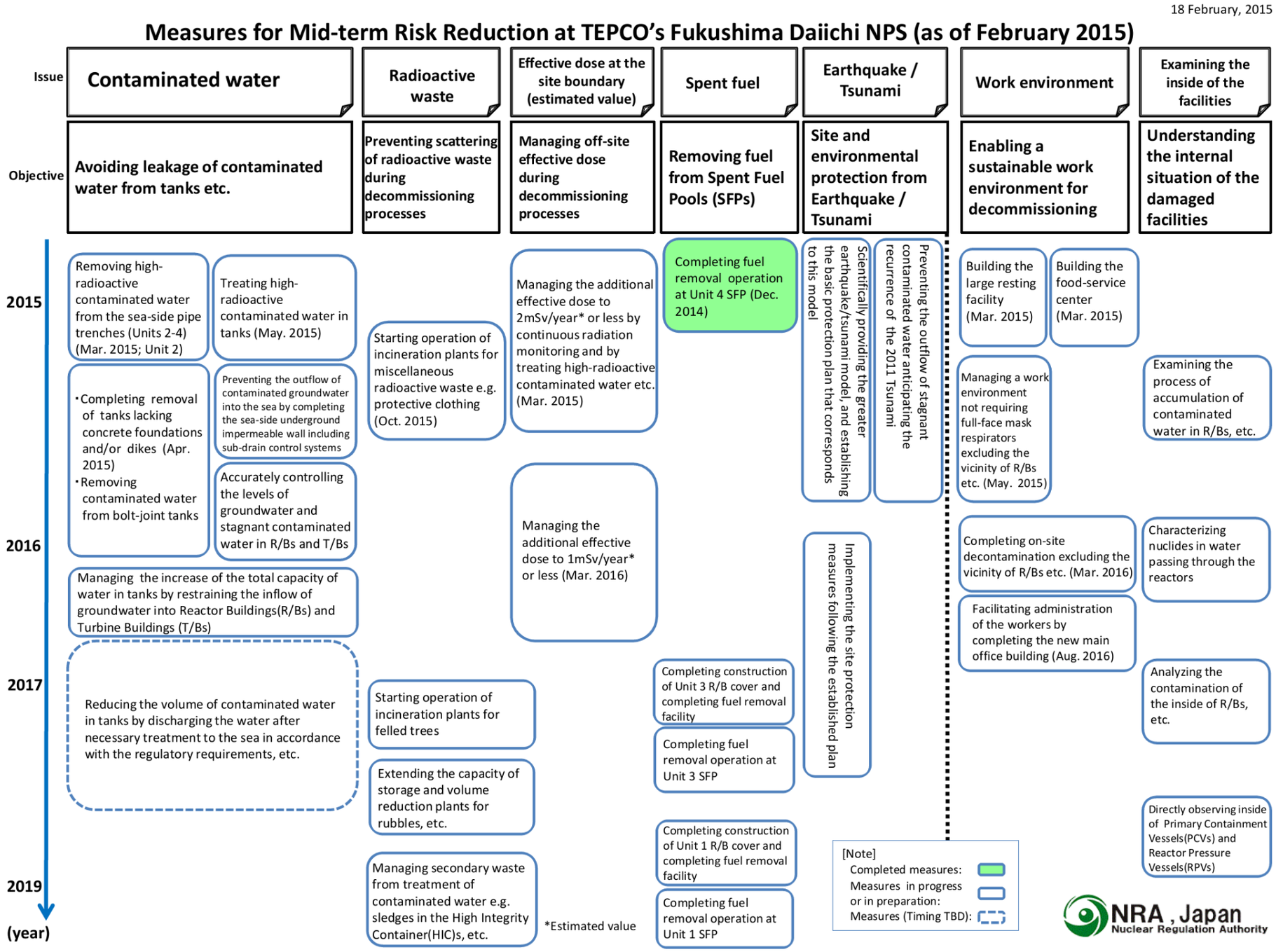
Contents

- What is Mid-term Risk Reduction Target?
- Concepts of the Revision of March 2018 Version
- Revision of the Mid-term Risk Reduction Target
- Priority Items
- Summary

Mid-term Risk Reduction Target

- Nuclear Regulation Authority(NRA) formulated the “Mid-term Risk Reduction Target” in February 2015 to set out targets for risk reduction during the decommissioning of TEPCO’s Fukushima Daiichi Nuclear Power Station. It is reviewed regularly and the achievement statuses of the targets are evaluated.

18 February, 2015



Concepts of the Revision of March 2018 Version

- Characters of the risk reduction target:
  Focusing on presenting the residual risks, in addition that has the characters of the risk reduction work processes.

- Targets to be noted:
  In principle, targets with high risks concerning radioactive substances are noted, as well as targets of high interest for the completion of decommissioning.

- Target period:
  Approximately three years.

- Targets' position on the timeline:
  To be placed at the expected time of completion.

Revision of Mid-term Risk Reduction Target

➢ Based on concepts of the revision, the contents of the documents are as follows:

- Mid-term Risk Reduction Target for TEPCO's Fukushima Daiichi Nuclear Power Station (March 2018 version)

- Conceptual diagram of main risks, etc. for the beginning of FY2018 and the end of FY2020 [p. 6, 7]

- Specific processes for mid-term risk reduction of TEPCO's Fukushima Daiichi Nuclear Power Station [p. 8, 9]

Mid-term Risk Reduction Target for TEPCO's Fukushima Daiichi Nuclear Power Station (March 2018 version)

March 7, 2018
Nuclear Regulation Authority

Issue	Liquid radioactive waste	Solid radioactive waste	Spent fuel pool	Earthquake/ tsunami	Reduction of environmental impact	Decommissioning/ Facility investigation (*2)
Objective	Reducing the risk of leakage that occurs due to the accumulation of liquid radioactive waste	Restraining the risk of scattering and leakage of solid radioactive waste that is produced along with the progress of decommissioning work	Removing risks of spent fuel pools	Removing risks regarding the buildings, etc., which contain contaminated water and spent fuels	Reducing background radiation doses and scattering of radioactive dust that occurs during the decommissioning process	Steady progress in decommissioning work

2018

- ○ Treat accumulated contaminated water in buildings
  - Reduce the amount of radioactive substances to half or less
- ○ Restrain the inflow of groundwater into buildings
  - Increase pump capacity of the sub-drain
  - Increase treatment capacity of the sub-drain
- ○ Treat contaminated water with Sr in the flange-type tanks
- ○ Install the 9th Solid Waste Storage Facility (February 2018)
- ○ Install the large equipment decontamination facility
- ○ Install temporary storage facilities for contaminated soil
- ○ Install Unit 3 Building Cover and equipment removing spent fuels, etc. (February 2018)
- ○ Prevent the outflow of accumulated contaminated water in buildings with consideration of the 2011 Tsunami (max. 15.5 m)
  - Block the openings (Unit 3 Turbine Building, process main building)
- ● Reduce the total amount of stored liquid radioactive waste
  - Discharge water treated in the ALPS to the sea, etc. in accordance with the regulatory standards,

2019

- ○ Restrain the inflow of rainwater into buildings
  - Facings of ground level 2.5, 6, 8.5m, etc.
- ○ Restrain the inflow of rainwater into buildings
  - Restrain the inflow of rainwater into Waste Treatment Buildings of Unit 1 and 2
- ○ Restrain the inflow of rainwater into buildings
  - Restrain the inflow of rainwater into Unit 3 Turbine Building
- ○ Install large storage
- ○ Install additional incineration facilities (felled trees, flammables in rubble, etc.)
- ● Install Radioactive Substance Analysis Facility (building No. 1)
- ○ Install a stabilization equipment for ALPS slurry (HIC)
- ○ Install volume reduction facility (metal, concrete)
- ◎ Remove spent fuels, etc. from Unit 3 SFP
- ◎ Dismantle the upper part of the exhaust stack for Units 1 and 2
- ○ Take measures for Mega-Float
- ○ Implement and monitor enhanced countermeasures against scattering of dust
  - Implement and monitor countermeasures against scattering of dust during rubble removal on Unit 1 Operating Floor
- ○ Decrease the concentration of radioactive substances in the water of discharge channels
- ○ Remove rubble from around the buildings
- ○ Improve the environment of ground level 2.5 m
- ● Survey the contamination status inside the reactor buildings, etc. (nuclide analysis, etc.)
- ● Grasp the properties and characteristics of the cooling water after the reactors have cooled down (nuclide analysis, etc.)
- ● Analyze the flow of contaminated water, etc. inside the reactor buildings
- ● Directly observe inside the containment vessel and pressure vessel

2020

- ◎ Treat accumulated contaminated water in buildings
  - Treat accumulated contaminated water in buildings excluding those in Units 1 to 3 Reactor Buildings

2021 and onwards

- ○ Treat accumulated contaminated water in buildings
  - Treat accumulated contaminated water in the reactor buildings
- ○ Remove contaminated water in trenches, etc.
- ○ Remove underground cisterns
- ○ Restrain the inflow of rainwater into buildings
  - Facings around buildings, etc.
- ○ Install stabilization equipment for sludge of the decontamination facility (AREVA)
- ● Install Radioactive Substance Analysis Facility (building No. 2)
- ◎ Remove spent fuels, etc. from Unit 1 SFP
- ◎ Remove spent fuels, etc. from Unit 2 SFP
- ○ Remove used control rods
- ○ Take measures against deterioration of building structures
- ◎ Transfer sludge from decontamination instrument (AREVA)
- ○ Maintain dose level of less than 1 m Sv/year at the site boundary
- ○ Continuously improve the work environment

(Fiscal year)

Legend

Main risk reduction target:	◎
Target which corresponds to main risks:	○
Measures significant for decommissioning:	●
Completed measures:	
Measures underway as planned:	
Measures behind schedule:	
Measures (timing to be determined):	
Measures requiring evaluation, including decisions on whether to implement:	

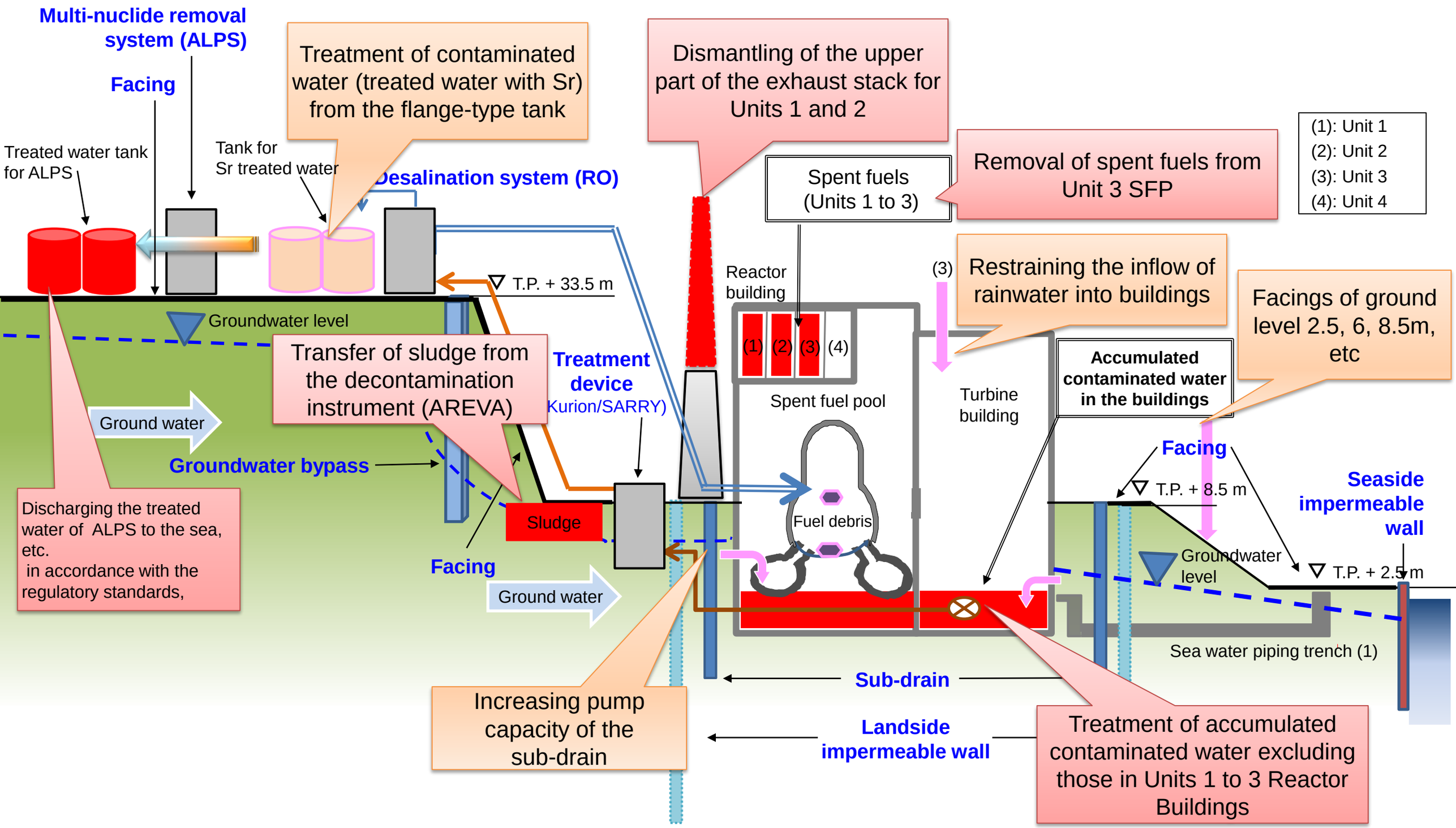
*1: Sr treated water: Water that has been reduced in concentration of cesium and strontium to some extent before purification treatment with the multi-nuclide removal system (ALPS).

*2: Targets of decommissioning/facility investigation are noted regardless of the implementation period.

(Note) Not all targets are listed, only the main ones.
The targets' position on the timeline indicates the expected time for completion.

Conceptual Diagram of Main Risks, etc. for the Beginning of FY2018 and the End of FY2020

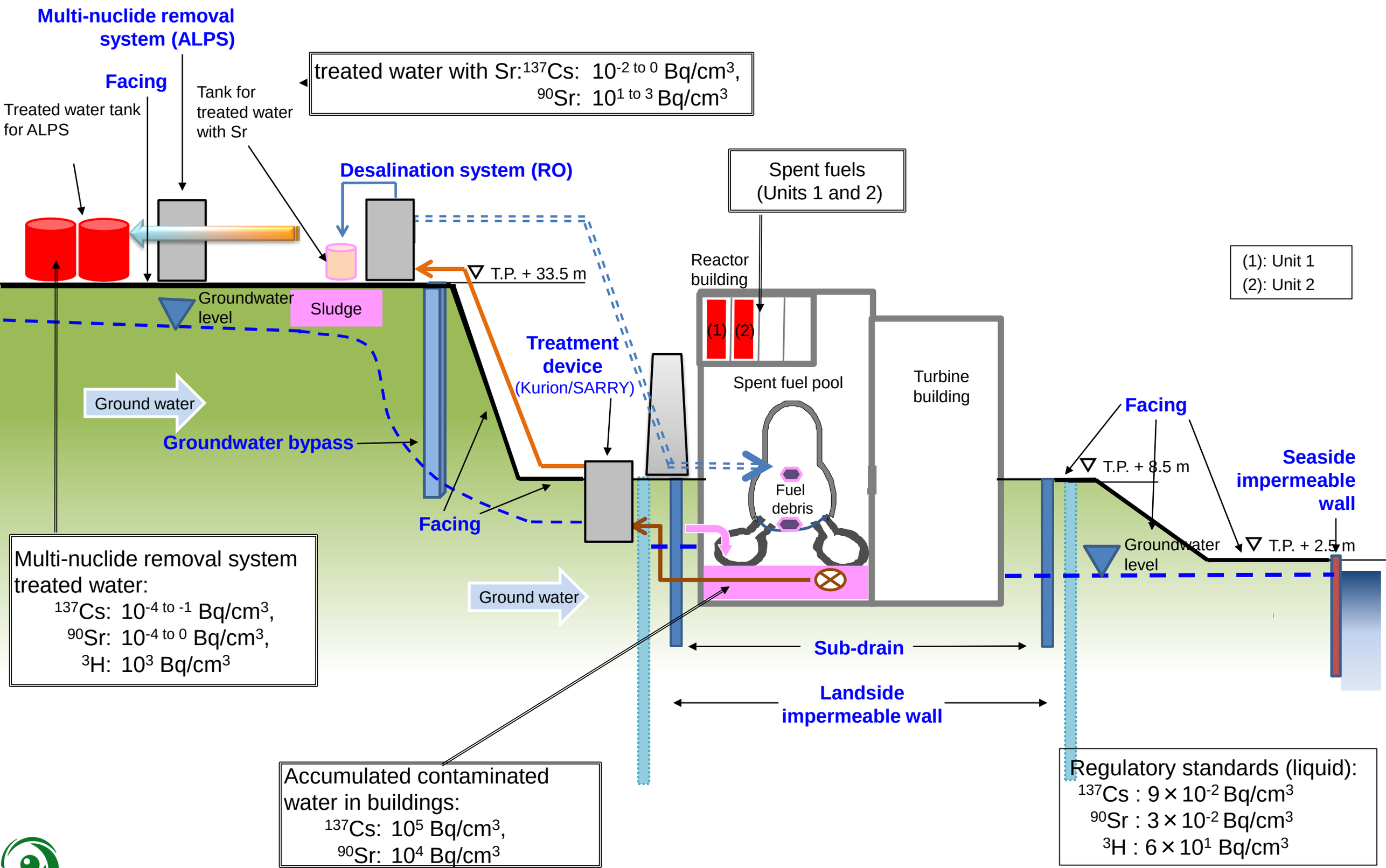
TEPCO's Fukushima Daiichi Nuclear Power Station
Beginning of FY2018



Conceptual Diagram of Main Risks, etc. for the Beginning of FY2018 and the End of FY2020

TEPCO's Fukushima Daiichi Nuclear Power Station

The End of FY2020



Specific Processes for Mid-term Risk Reduction for TEPCO's Fukushima Daiichi Nuclear Power Station (excerpt)

Unit 3

Main category	Sub-category	Completed measure	Schedule (fiscal year) 2018 – 2019 – 2020 – 2021 – 2022
Liquid radioactive waste	Treatment of accumulated contaminated water	• Treatment accumulated contaminated water of inside the condenser (December 2017)	Decide on the strategy of fuel debris cooling; Adopt air cooling for fuel debris; Treat accumulated contaminated water of inside the reactor building (R/B); Treat accumulated contaminated water inside the turbine building (T/B) and waste treatment building (Rw/B) [until the first half of FY2020]
	No additional accumulated contaminated water (restraining the inflow of groundwater, rainwater, cooling water, and work-use water)		Adopt full circulation of fuel debris cooling water; Restrain the inflow of ground water into the turbine building [until the first half of FY2020]; Repair the roof of the waste treatment building; Restrain the inflow of groundwater after completing the treatment of accumulated contaminated water, excluding Units 1 to 3
Spent fuel pool	Removal of spent fuels	• Installation of cover (February 2018)	Train staff, remove small rubble, etc. [until around the middle of FY2018]; Remove spent fuels [from the middle of FY2018 to the end of FY2020]; Remove used control rods; Drain water
Earthquake/ tsunami	Earthquake		Decide upon the strategy on the seismic motion for review (observing the status of containment vessels, such as suppression chambers)
	Tsunami		Block the openings of Unit 3 Turbine Building [until the first half of FY2018]
Decommissioning/ facility investigation	Facility investigation	• Investigation inside the containment vessel (October 2015) • Investigation inside the pedestal (July 2017)	Investigate inside the containment vessel

Specific Processes for Mid-term Risk Reduction for TEPCO's Fukushima Daiichi Nuclear Power Station (excerpt)

Common

Main category	Sub-category	Completed measure	Schedule (fiscal year) 2018	2019	2020	2021	2022	2023
Liquid radioactive waste	Treatment of accumulated contaminated water	• Restraint of the outflow of accumulated contaminated water inside the buildings	Reduce the amount of radioactive substances to half or less					
	Restraint of water contamination		Increase pump capacity of the sub-drain [until January 2018] → [until June 2018] Increas treatment capacity of the sub-drain (1,500 m^3/day) [until September 2017] → [until March 2018]	Facings of ground level 2.5, 6, 8.5m, etc.	Restrain the inflow of groundwater after completing the treatment of accumulated contaminated water, excluding Units 1 to 3 Reactor Buildings	Facings around the buildings, etc.		
	Treatment of accumulated contaminated water in tanks	• Removal of horizontal tanks (December 2014) • Removal of accumulated contaminated water (RO concentrated water) from flange-type tanks (May 2015)	Treat accumulated contaminated water (Sr treated water) in flange-type tanks [until October 2018]					
	Removal of accumulated water			Remove accumulated contaminated water on the premises, etc.		Remove underground cisterns		
Earthquake/ tsunami	Earthquake			Dismantle the upper part of the exhaust stack on Units 1 and 2 [until the second half of FY2019] Decide upon the strategy on the seismic vibration for review (observing the status of containment vessels, such as suppression chambers)		Take measures against the deterioration of building structures		
	Tsunami	• Installation of temporary seawalls (June 2011) • Blocking openings Common pool (September 2013); Units 1 and 2 Turbine Buildings, high-temp. incinerator (October 2014)	Block openings of the process main building [until the first half of FY2018]	Decide on the strategy of measures for Mega-Float	Transfer sludge from decontamination instruments (AREVA) [until the second half of FY2020]	Take measures for Mega-Float		

Priority Targets
(Treatment of Accumulated Contaminated Water)

- **NRA recognizes that, in order to reduce the risk of accumulated contaminated water in buildings, which is high concentration liquid radioactive waste, flowing out, the treatment of accumulated contaminated water must be conducted promptly.**

- **Complete the treatment of accumulated contaminated water in buildings, excluding the reactor buildings, within 2020.**
  - In the 12th Extraordinary Meeting of NRA held in May 2018, the president of Fukushima Daiichi Decontamination & Decommissioning Engineering Company Mr. Ono stated that he “will achieve this goal at any cost.”
  - As the amount of accumulated contaminated water in buildings is treatable within approximately one month if the currently installed multi-nuclide removal systems are operated at full capacity, the treatment should be conducted immediately.

    The amount of accumulated contaminated water as of July 2018: Approx. 50,000 m^3 ÷ ALPS total capacity: 2,000 m^3/day = 25 days?

    (Existing: 750 m^3/day, additional: 750 m^3/day, high performance: 500 m^3/day)
  - TEPCO should consider operating the currently stopped high performance multi-nuclide removal systems and moving up the schedule so that the treatment can be completed prior to 2020.

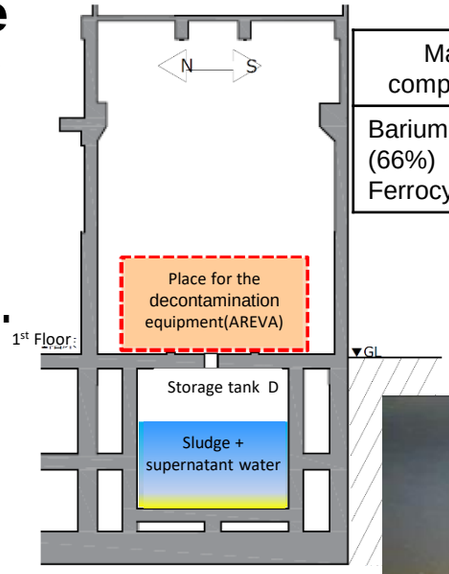
- **Complete the treatment of treated water with Sr contained in the flange-type tank by November 2018.**
  - The treatment plan for treated water with Sr is approximately one month behind schedule. To avoid further delays, TEPCO should establish backup systems to prevent unexpected events from affecting the treatment plan.

    The amount of treated water with Sr stored in the flange-type tank as of June 2018: Approx. 50,000 m^3

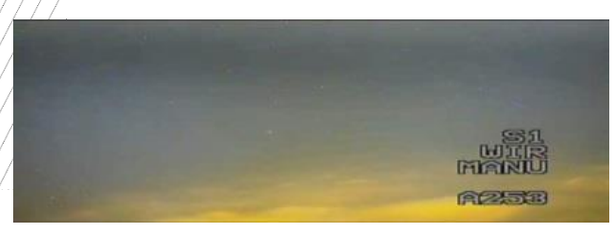
Priority Targets (Liquid Radioactive Waste)

- **NRA recognizes that, in order to avoid the risk of leakage of high concentration liquid radioactive waste caused by Tsunami, the waste must be transferred to a higher ground and stabilized promptly.**

- **Complete the transfer of AREVA sludge to higher ground.**
  - Although the transfer is scheduled to be completed within FY2020, TEPCO should consider completing the transfer as early as possible from the perspective of countermeasures against Tsunami.



Main component	Concentration of major nuclide	Generation rate
Barium sulfate (66%) Ferrocyanide	^{90}Sr : Approx. 3×10^8 Bq/cm^3	37 m^3



- **Install a stabilization system for AREVA sludge.**
  - While the research and development of stabilization treatment has been underway, the installation plan for the stabilization system must be formulated at an early stage, and the timing at which the operation can be started must be clarified.

- **Install a stabilization system for ALPS slurry (HIC), etc.**
  - Preparation, such as moving up the schedule to prevent delay in the start of operation of the treatment system, must be done steadily, so that the approval of changes on the implementation plan can be requested at an early stage.

HIC

Storage condition

Main component		Concentration of major nuclide	Generation rate
Existing ALPS	Iron co-precipitation slurry: $FeO(OH) / H_2O$ (75%)	^{90}Sr: Approx. 1×10^6 Bq/cm^3	386 HIC units 1,008 m^3
Existing ALPS Additional ALPS	Carbonate slurry: $CaCO_3$, $Mg(OH)_2$	^{90}Sr: Approx. 4×10^7 Bq/cm^3	971 HIC units 2,535 m^3 1121 HIC units 2,926 m^3

Priority Targets
(Treated Water by Multi-nuclide Removal System)

- **NRA recognizes that a decision on discharging treated water that contains tritium to the sea, etc. in accordance with the regulatory standards must be made as soon as possible for the decommissioning work.**

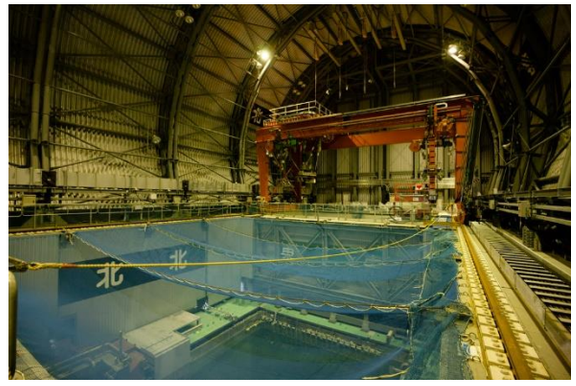
- **As for the long-term storage of tritium-containing treated water in several hundred tanks (approx. 900 units), the possibility of leakage to the environment due to earthquakes, etc. cannot be ruled out. The environmental impact of it leaking into the environment is small; however, economic damage may be incurred as a result of rumors.**

- **TEPCO should consider all the possibilities and take countermeasures.**
  TEPCO should immediately address specific countermeasures for handling treated water that contains tritium.

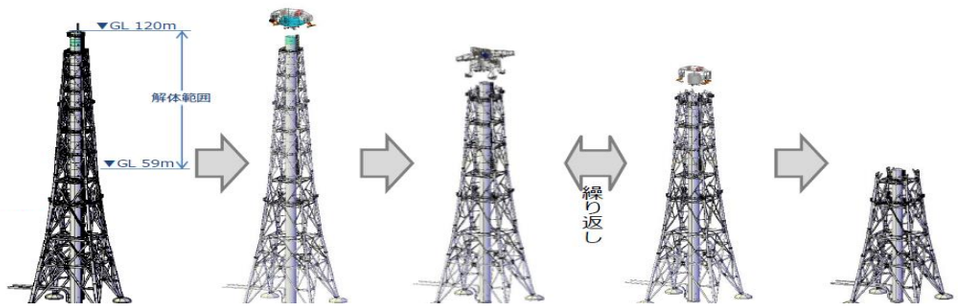
- **TEPCO should have awareness as the responsible body and proactively make the decision to progress the decommissioning work.**

Priority Targets (Others)

- **Start the removal of spent fuels from Unit 3 from the November 2018.**
  - Although the malfunction of the crane of the fuel handling machine is said to have affected the schedule for removal of spent fuels, removal must be started in November 2018 as planned.



- **Complete the dismantling of the upper part of the exhaust stack for Units 1 and 2 by the second half of FY2019.**
  - As for the exhaust stacks to which damage due to earthquakes has been confirmed, dismantling work must be started in December 2018 and carried out as planned.



- **Evaluate the seismic resistance of the containment vessels (suppression chambers, etc.) using the earthquake for review.**
  - The evaluation of earthquake resistance must be conducted immediately, since the suppression chamber is currently filled with contaminated water and considering the damage caused by earthquakes and corrosion, there is a safety concern in the event of occurrence of earthquakes of the same level as the 3.11 earthquake.

Summary

- ✓ TEPCO needs to implement the items indicated in the Mid-term Risk Reduction Target in a planned and steady manner.

- ✓ The Nuclear Regulation Authority will continue to monitor and evaluate that risk reduction is implemented without delay.

- ✓ In particular, move up the schedules for the treatment of accumulated contaminated water in buildings, transfer of AREVA sludge, and removal of spent fuels in Unit 3.
  Decisions on handling the treated water, such as discharging water treated in the multi-nuclide removal systems to the sea, etc. in accordance with the regulatory standards, should be made as soon as possible.