The Future of the Fukushima Daiichi NPS Decommissioning

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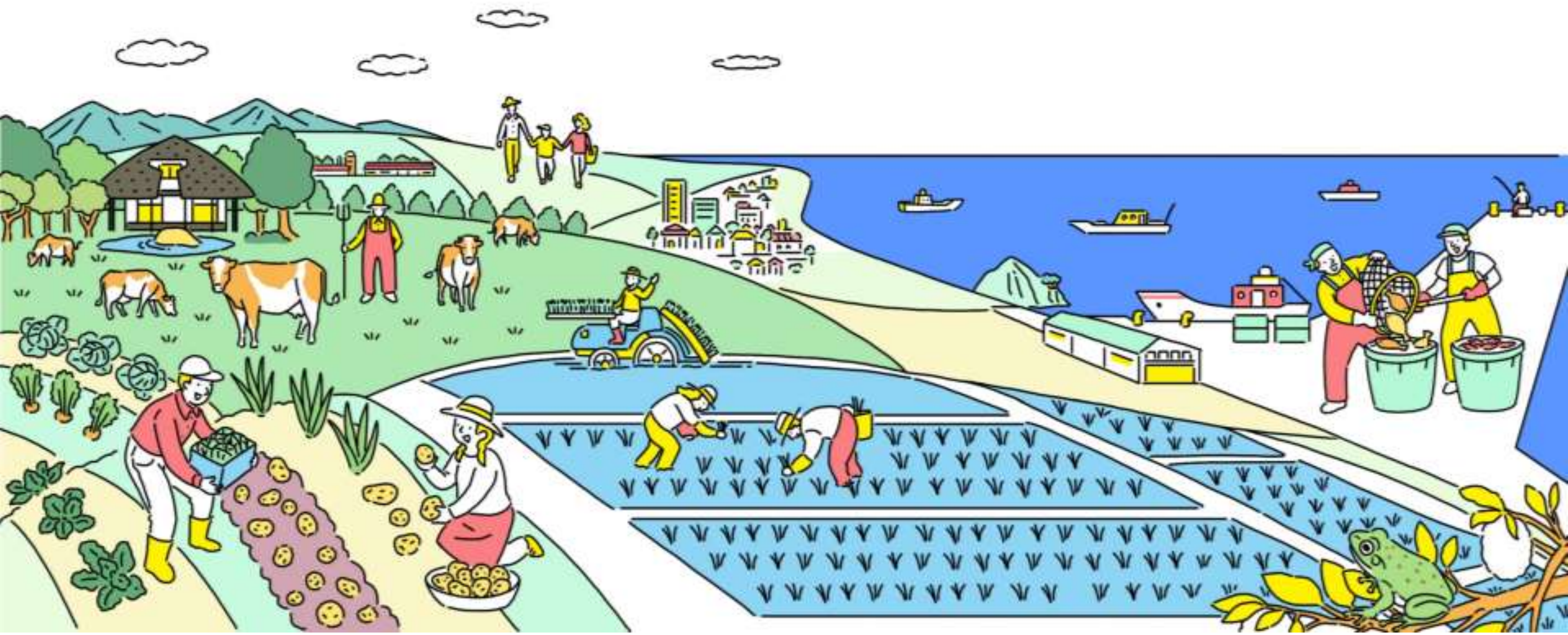
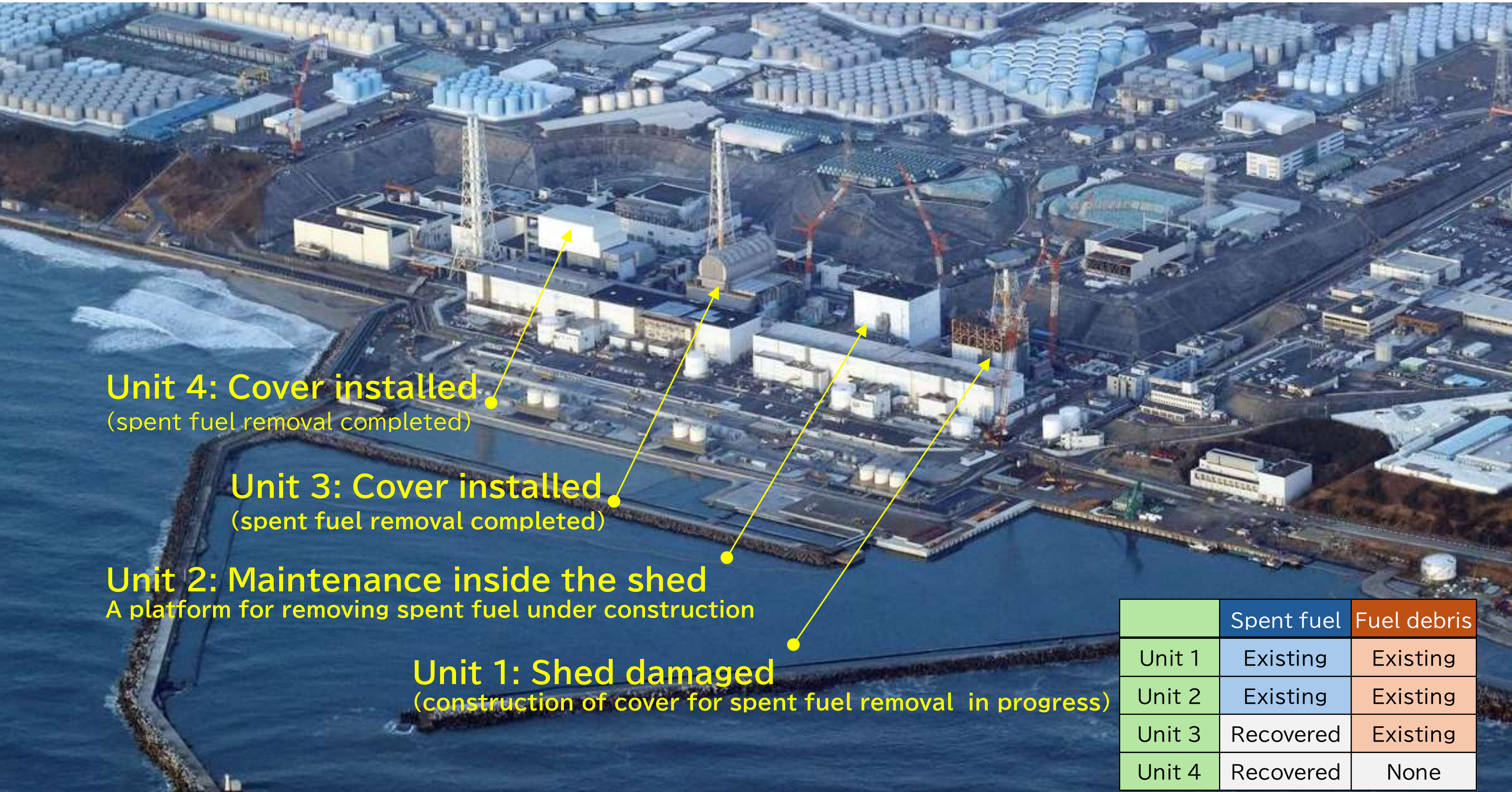


Decommissioning of Units 1 to 4 and other nearby facilities is proceeding in various projects.



	Spent fuel	Fuel debris
Unit 1	Existing	Existing
Unit 2	Existing	Existing
Unit 3	Recovered	Existing
Unit 4	Recovered	None

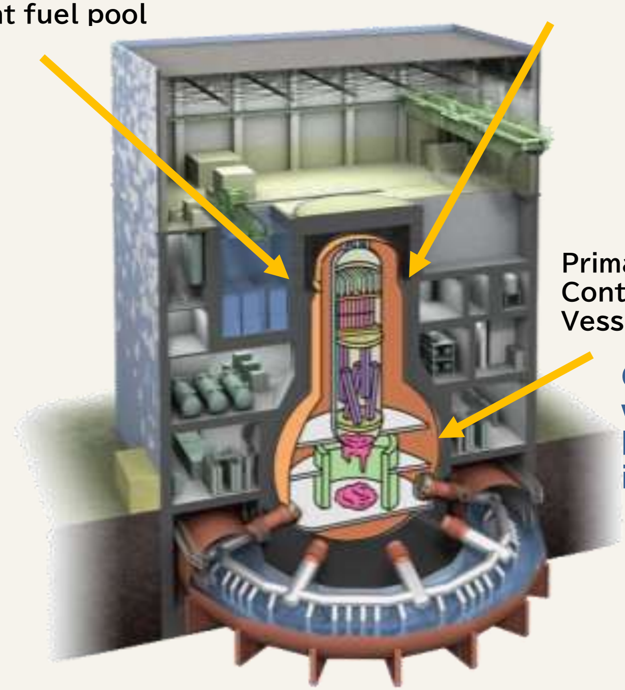
写真引用:REUTER, May 19, 2022 (ttps://www.reuters.com/world/asia-pacific/japan-nuclear-regulator-grants-initial-nod-fukushima-water-release-plan-2022-05-18/) (Originally taken by Kyodo on Mar 17, 2022)

Major radiation risk sources are **spent fuel, fuel debris, contaminated water, contamination inside buildings and solid waste**.

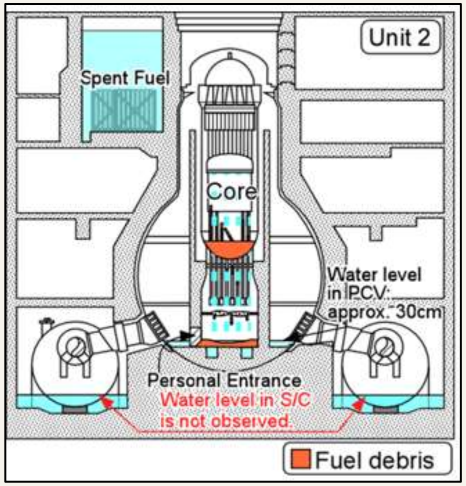
Radiation levels are very high inside the reactor

Spent fuel pool

Reactor Pressure Vessel(RPV)

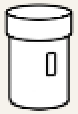


Primary Containment Vessel (PCV)



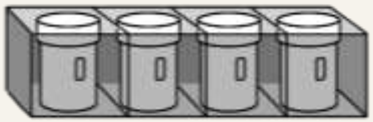
The bottom of the Unit 2 PCV (photo taken by remote-camera)

Contaminated water generated by groundwater inflow



Cesium removal equipment (SARRY)

Remove radioactive cesium from contaminated water



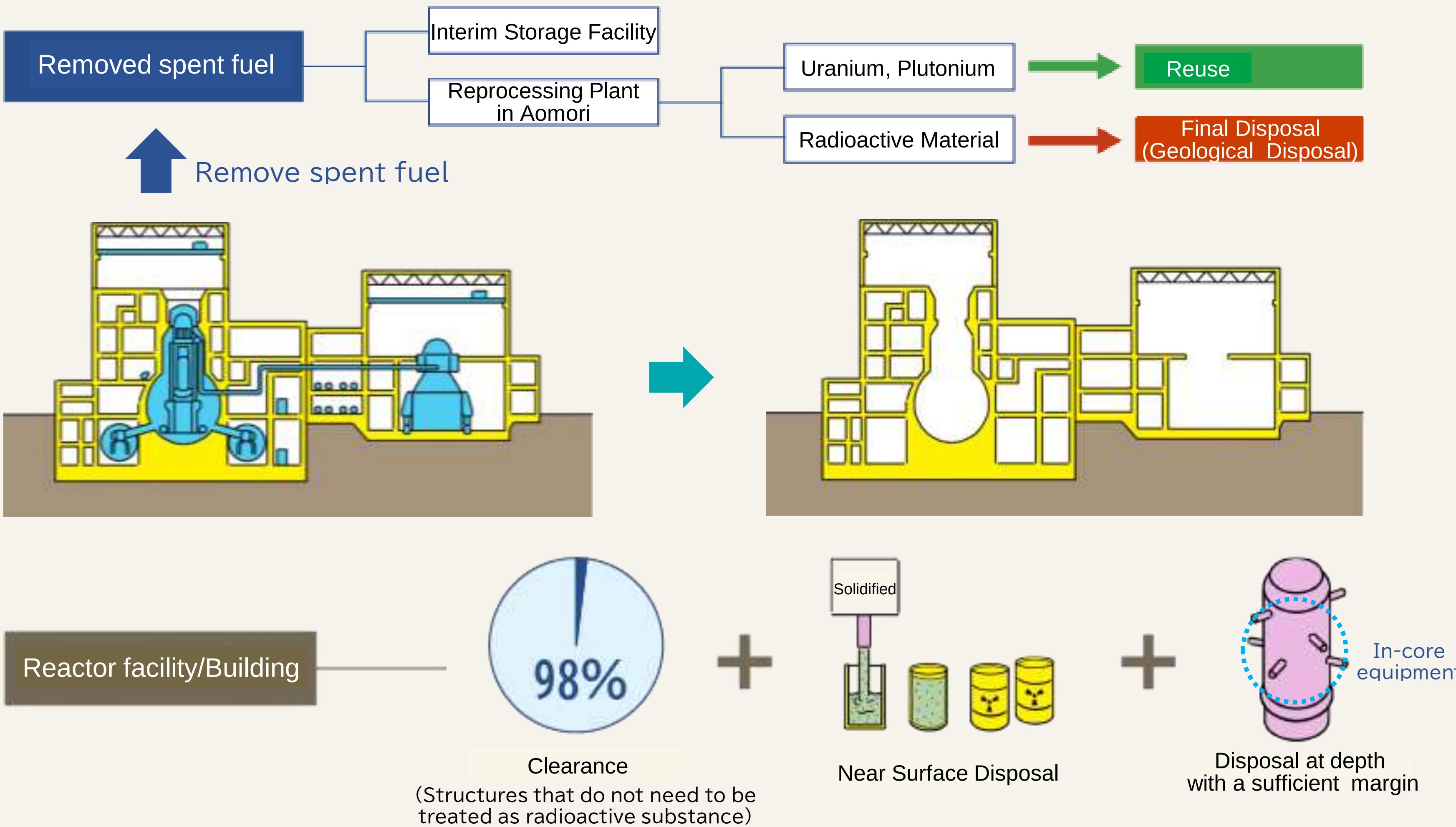
ALPS

Remove almost all radionuclides

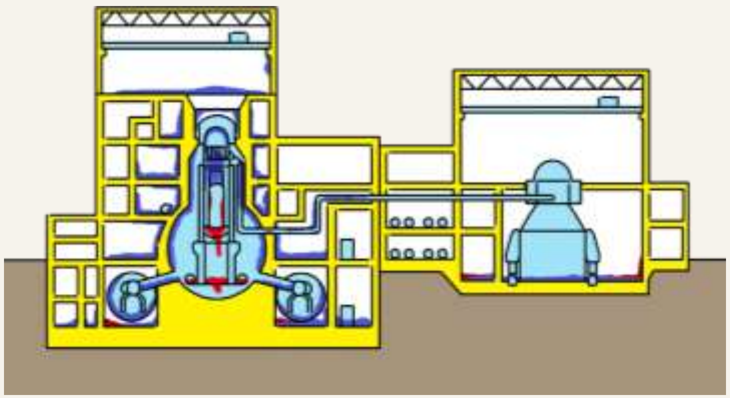
Tanks

ALPS-treated water (tritiated water)

Decommissioning starts after removing spent nuclear fuel in a normally operated reactor



At the Fukushima Daiichi Nuclear Power Station, spent fuel was damaged and could not be easily removed. Careful preparation and various devices are required.



① Nuclear fuel because fuel debris scattering around the reactor and it is difficult to recover .

② Reactor buildings and reactor structures are contaminated with nuclear fuel and cesium, all of which is treated as radioactive waste.

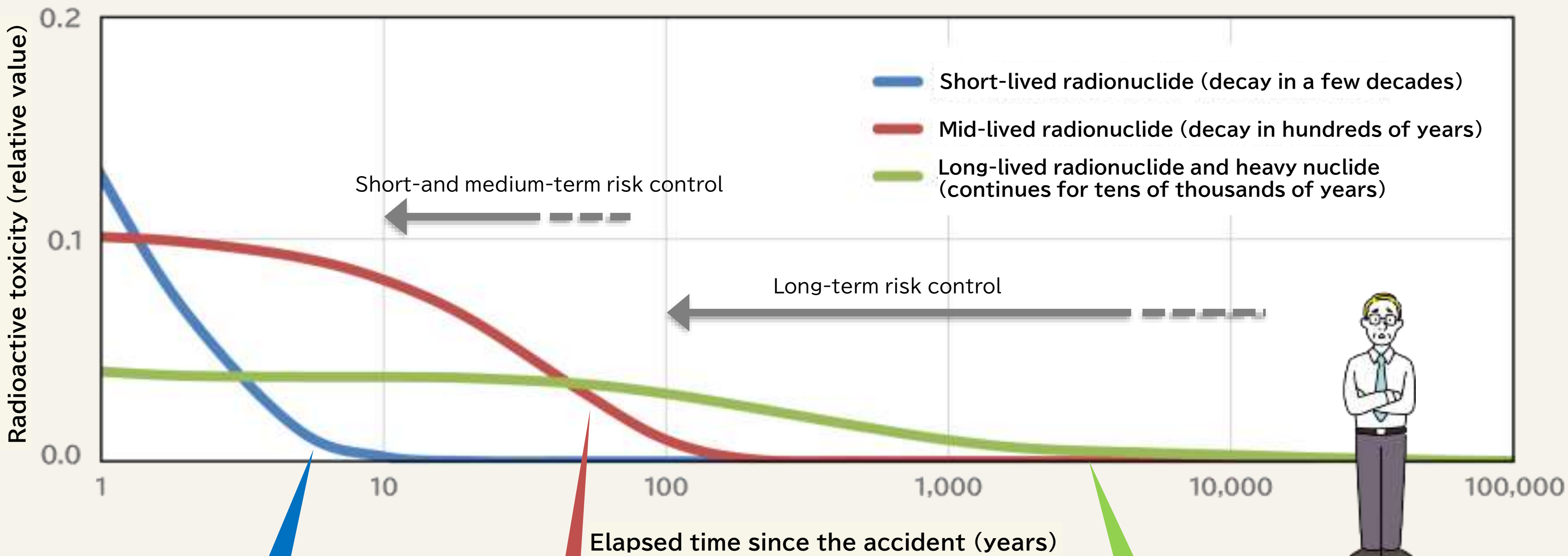
③ The buildings are broken, and it is difficult to remove the spent fuel.

No facility or disposal method was not envisaged to receive such waste.

The time base to be addressed varies according to the lifetime of the radionuclide. It is important to secure both the safety of the current generation and the environment of the next generation.

Completely contain medium-lived and long-lived radionuclides to keep reactors safe during decommissioning period.

After a few decades, mid-lived and long-lived radionuclides are isolated from the social environment for long periods of time.



Short-lived nuclides (e.g. iodine)

Almost finished decaying

Medium-lived nuclides (e.g. Cesium)

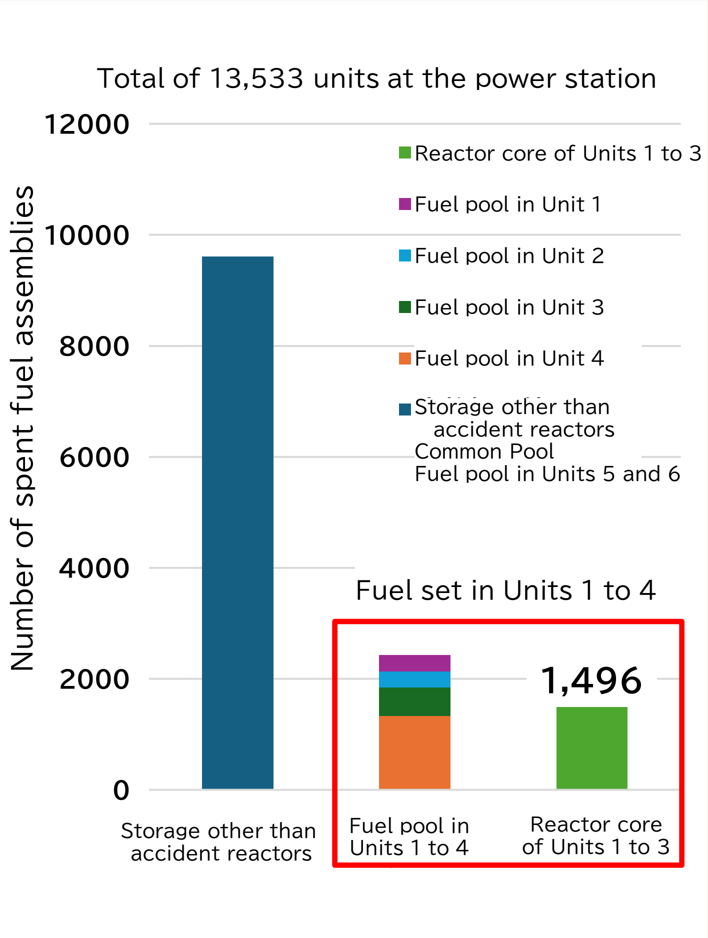
Spent fuel and fuel debris, buildings, rubbles and sorbents for contaminated water treatment

Long-lived nuclides (e.g. Plutonium)

Mostly spent fuel and fuel debris

Handling of spent fuel at the Fukushima Daiichi is the focus of attention in the nationwide spent fuel issue.

Status of spent fuel before the accident



Nuclear power plants nationwide
Cumulative amount of spent fuel stored: approx. 118,000 units (equivalent)

Fukushima Daiichi NPS
Total amount of spent fuel: 13,533 units
Of these damage in the accident: 1,496 units (fuel debris)

- The amount of fuel debris in Fukushima Daiichi is only about 1% of the total amount of spent fuel stored in Japan.
- The spent fuel (9,613 units) stored in the areas other than the accident reactors are the same sound spent fuel as in the rest of Japan.
- The spent fuel recovered from Units 1 to 4 may be treated as sound spent fuel, and it is important to carefully examine for this purpose.
- Fuel debris can be safely treated according to the same concept as spent fuel and high-level radioactive waste if it is recovered from the accident reactor and treated appropriately.

Due to the long-term uncertainty of the reactor facilities, recover fuel debris and other materials and transfer to safe storage conditions

Internal factors

Possibility of aging degradation of the PCV and building

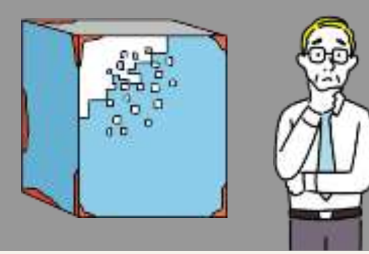
Changes in fuel debris and the situation inside the PCV

Wear damage on equipment that is difficult to maintain

Take proactive measures to ensure containment, including monitoring and inspections, against possible degradation, and prevent external impacts.

Present

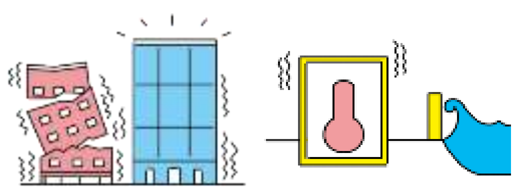
It is difficult to guarantee integrity over the long-term future, and the longer the period, the greater the uncertainty.



Future

External factors

Natural disasters such as earthquakes and tsunamis

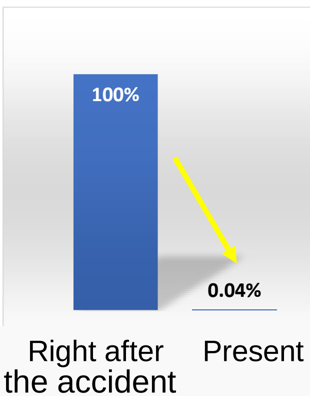


Verify that the buildings can withstand the expected natural disasters and implement reinforcement measures as necessary.

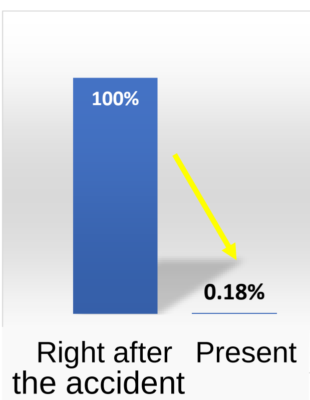
Actively recover fuel debris and spent fuel from damaged buildings and bring them into secure storage conditions.

Virtually there is no possibility of a destructive event like in 2011 during decommissioning work.

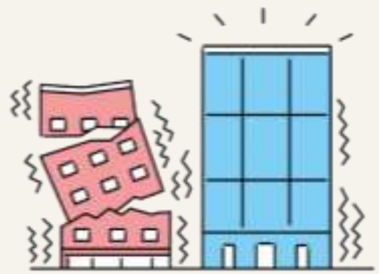
Heating value of the reactor



Radioactivity of the reactor

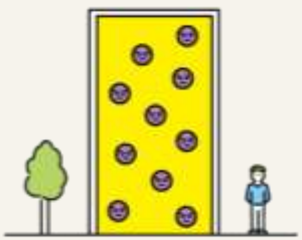


Earthquake



Sufficient seismic resistance to withstand large earthquakes

Containment

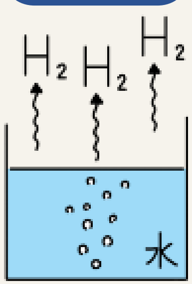


Mechanisms to prevent leakage of radioactive materials

Workers

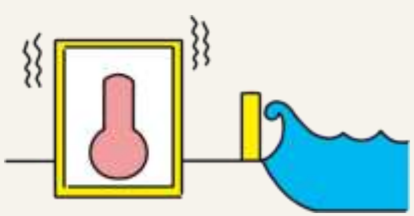
Taking all possible measures to control workers’ radiation exposure

Hydrogen



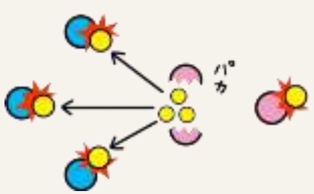
Measures to prevent increase of hydrogen concentration

tsunami



Block tsunami with breakwaters and watertight doors

Criticality

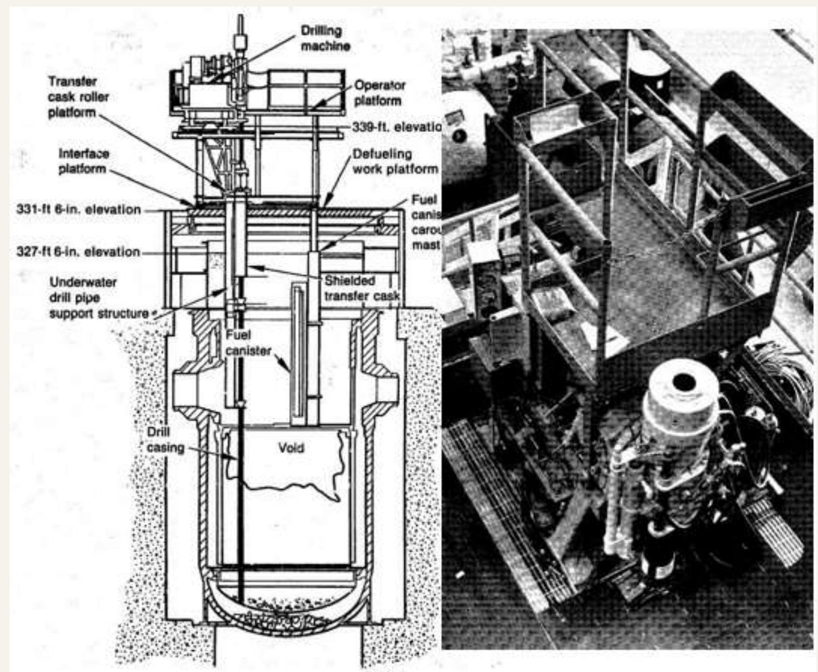


Sufficient measures to prevent the onset of criticality

At Three Mile Island Unit 2 (1979), **most of the fuel debris was recovered about 10 years after the accident**.

Work over the reactor core

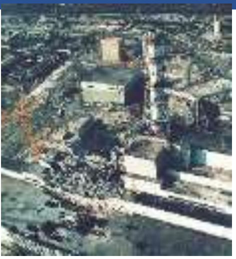
Core boring equipment



At Three Mile Island Unit 2 (1979), the recovered fuel debris was transported to the national laboratory and is still being stored for a long period of time.

Transfer of recovered fuel debris to the Idaho National Laboratory

Recovered fuel debris is stored at the Idaho National Laboratory



In the Chornobyl Unit 4 accident (1986),
the entire reactor building was damaged on a large scale.
Currently, it is covered with a metal shelter.

Reactor building immediately after the accident

Source: European Bank for Reconstruction and Development (EBRD)

Old stone coffin (sarcophagus)

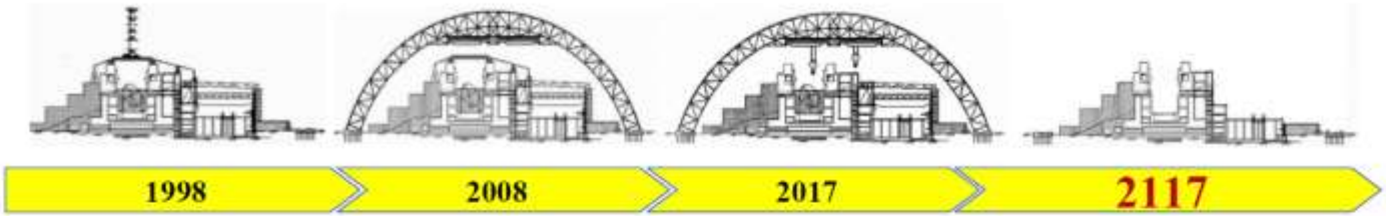
SSE ChNPP

In the Chornobyl Unit 4 accident (1986), nearly 100 years of decommissioning programs are planned inside the metal shelter.

New shelter (installed November 2016)

Old sarcophagus in the new shelter

Strategy of Shelter object Transformation into environmentally safe system



Phase 1 : stabilization of existing object status

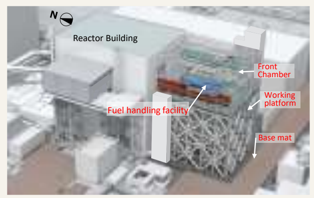
Phase 2 : creation of the additional protective barriers

Phase 3 : Fuel Containing Materials and Long Lived RAW retrieval from SO

Decommissioning projects (fuel debris retrieval, waste management) will gradually get into full swing in the Mid-and-long-term Roadmap.

2011 — 2024 — 2030 — Aiming to complete the project in 30 to 40 years

Phase 3



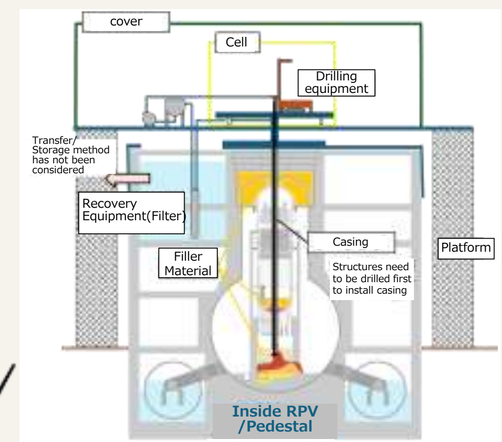
Spent fuel removal from Unit 2

Full-scale retrieval of fuel debris
Radioactive waste processing and storage

Sub-Committee for the Evaluation of fuel debris retrieval methods

Phase 3-[1]

Trial retrieval of fuel debris
Gradual expansion of fuel debris retrieval
Removal of spent fuel completed (Units 1,2,5 and 6))
Reduction of contaminated water generated (150m³ /day or less)
Elimination of temporary storage of radioactive waste



For example, the combination of partial submersion method filling and solidification method

Phase 2

Improvement of waste storage
Improvement of radiation environment
Spent fuel recovery (Units 3 and 4)
Reduction of stagnant water in buildings
Internal investigation of rectors
Research and Development

Discharge of treated water started in summer 2023

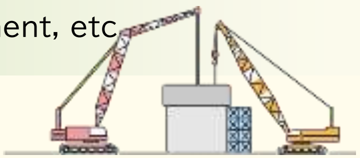
Phase 1

Stabilization of the post-accident condition

Ensure that safe storage conditions are achieved while actively mitigating the risks at the site, then aim for **final risk isolation.**

Development of the decommissioning work

Reduction of contaminated water and discharge of treated water
Stable storage and characterization of solid waste
Strengthening and maintaining radioactive containment
Improvement of radiation environment, etc



Recovery of fuel debris and spent fuel
Storage and processing of radioactive waste, etc

Thorough operations and controls to ensure site safety

Note) At present, it is difficult to clearly foresee this future zone because the properties of fuel debris and waste, damages to the accident facilities, and the design of the retrieval work, etc. are not sufficiently developed.

Building demolition and disposal of radioactive waste

We will strive to minimize the impact on workers and the environment and work to eliminate various sources of risk through proactive safety management and facility maintenance.

Achievement of safe storage conditions
Achieve sufficiently low risk level

Achievement of final isolation status
Achieve extremely low risk levels

The future and final form of the decommissioning should be examined in close coordination with the technical considerations of decommissioning and the future visions of the local communities.

- Decommissioning project will move into the Phase III this year, and the retrieval of fuel debris and the handling of radioactive waste will enter the full-scale stage.
- The transition to Phase III does not mean that the processing/disposal measures of fuel debris and waste and the entire picture of decommissioning will be immediately clear. Technical studies are continued while analyzing samples and assessing the situation, and gradually make it more specific.
- It is essential to examine the final form of the decommissioning process in a way that is consistent not only with the technical aspects but also with the future vision of the region. It is important to work with the local community to consider the final form of decommissioning that will bring the most benefits to the local community while proceeding with the decommissioning work with full efforts.
- It is necessary for the technical and local sides to think together about the final form of Fukushima Daiichi, which will create economic vitality and ensure secure-life in the local community in the future.
- To this end, it is necessary to promote the provision of information from the decommissioning implementer side and to continue to have sufficient dialogues with local residents.

For today, tomorrow, and the future