

# **Decommissioning of the Fukushima Daichi NPP - Fuel-Debris Retrieval and Future Prospect -**

**7th International Forum on the Decommissioning of the  
Fukushima Daichi Nuclear Power Station**

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# Current Situation of Fukushima Daiichi NPP



Photo : REUTER, May 19, 2022 (<https://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)

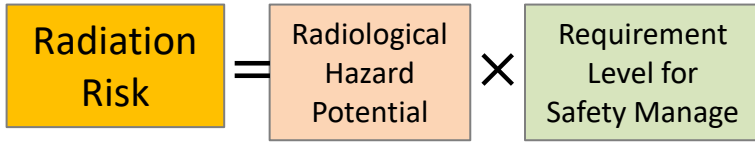
# 12-year Progress of the 1F Decommissioning

|                                      | 2011   | 2012  | 2013  | 2014   | 2015  | 2016                                      | 2017  | 2018                          | 2019  | 2020   | 2021                                  | 2022 | 2023  |
|--------------------------------------|--|---|---|--|---|---|---|-------------------------------|---|--|---------------------------------------|------|---|
| <b>Accident</b>                      | ●  |   |   |  |   |   |   |                               |   |  |                                       |      |   |
| <b>Contaminated Water Management</b> | ● Stopped leak from seawater trench<br>● KURION installed<br>● SARRY installed |   | ● ALPS treatment started                    |  | ● Highly contaminated water treatment completed |   |   | ● Frozen wall installed       |   |  |                                       |      |   |
| <b>ALPS-treated Water</b>            |  |   |   | The government published the basic policy to discharge |   |   |   |                               | ● Implementation Plan for discharging ALPS-treated water approved |  | ●                                     |      |   |
|                                      |  |   |   |  |   |   |   |                               |   |  |                                       |      | ● Facility installation for discharge completed                     |
| <b>In-Reactor Inspection</b>         |  | ● Camera inserted from penetration (Unit 2) | ● Camera inserted from penetration (Unit 1) |  | ● Observed with muon (Unit 1)                   |   | ● Camera inserted from penetration (Unit 3) | ● Observed with muon (Unit 2) | ● Investigation with underwater ROV (Unit 3)                      | ● Investigation with hanging camera (Unit 2) |                                       |      |   |
|                                      |  |   |   |  |   |   |   |                               |   |  |                                       |      | ● Investigation with underwater ROV (Unit1)                         |
| <b>Spent Fuel Removal</b>            |  |   |   |  | ● Unit 4 Spent fuel removal completed           |   |   |                               |   |  |                                       |      |   |
|                                      |  |   |   |  |   |   |   |                               |   |  | ● Unit 3 Spent fuel removal completed |      |   |
|                                      |  |   |   |  |   |   |   |                               |   |  |                                       |      | ● Construction of large structures for SF retrieval at U-1&2, start |
| <b>Waste Management</b>              |  |   |   |  |   | ● Misc. solid waste incinerator installed |   |                               |   |  |                                       |      |   |
|                                      |  |   |   |  |   |   |   |                               |   |  |                                       |      | ● Solid waste storage added   |
| <b>Organization Reform</b>           |  |   |   |  |   |   |   |                               |   |  |                                       |      |   |
|                                      |  | FDEC founded                                |   | ● Organizaion reform for project management            |   |   |   |                               |   |  |                                       |      | ●   |
|                                      |  |   |   |  |   |   |   |                               |   |  |                                       |      |   |



# Risk characteristic by resources (Significance of fuel debris)

Origin: Technical Strategic Plan 2022



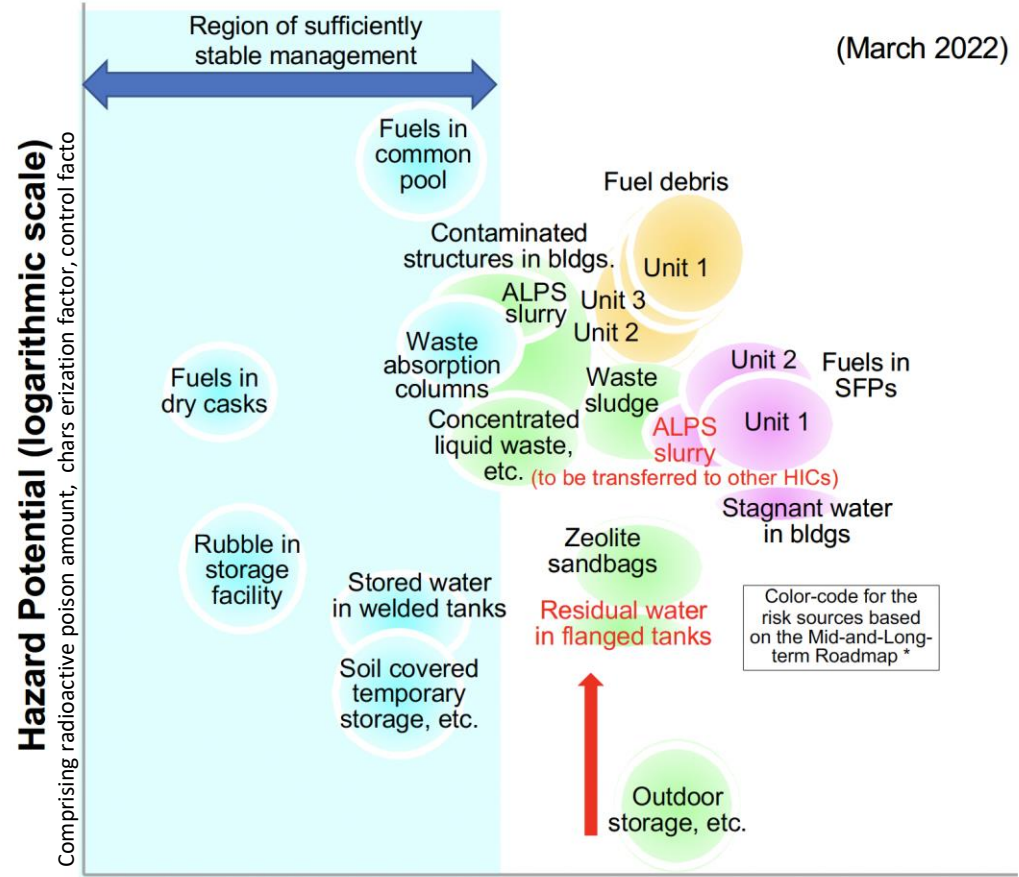
## Proactively reduce risk level at site

Reduce Radiological Hazard Potential (Convert into controllable form)

|                        |   |
|------------------------|---|
| Improve Form Factor    | Convert gas, liquid and powder into solid                         |
| Improve Control Factor | Reduce heat generation, corrosiveness, reactivity and criticality |

Improve Level for Safety Management

|   |   |
|---|---|
| Improve confinement                         | Enhance confinement performance   |
| Improve long-term stability of risk sources | Deactivation, stabilization, enhanced monitoring and facilitated handling |



## Safety Management (logarithmic scale)


Comprising facility containment fragility, long-term instability of risk sources

Fig. Risk Profile by SED

NDF Strategic Plan 2020

# NRA's instruction to reduce mid-term risks

- **NRA requested TEPCO's relevant actions by publicizing "Measures for Mid-term Risk Reduction at TEPCO's Fukushima Daiichi NPS"**

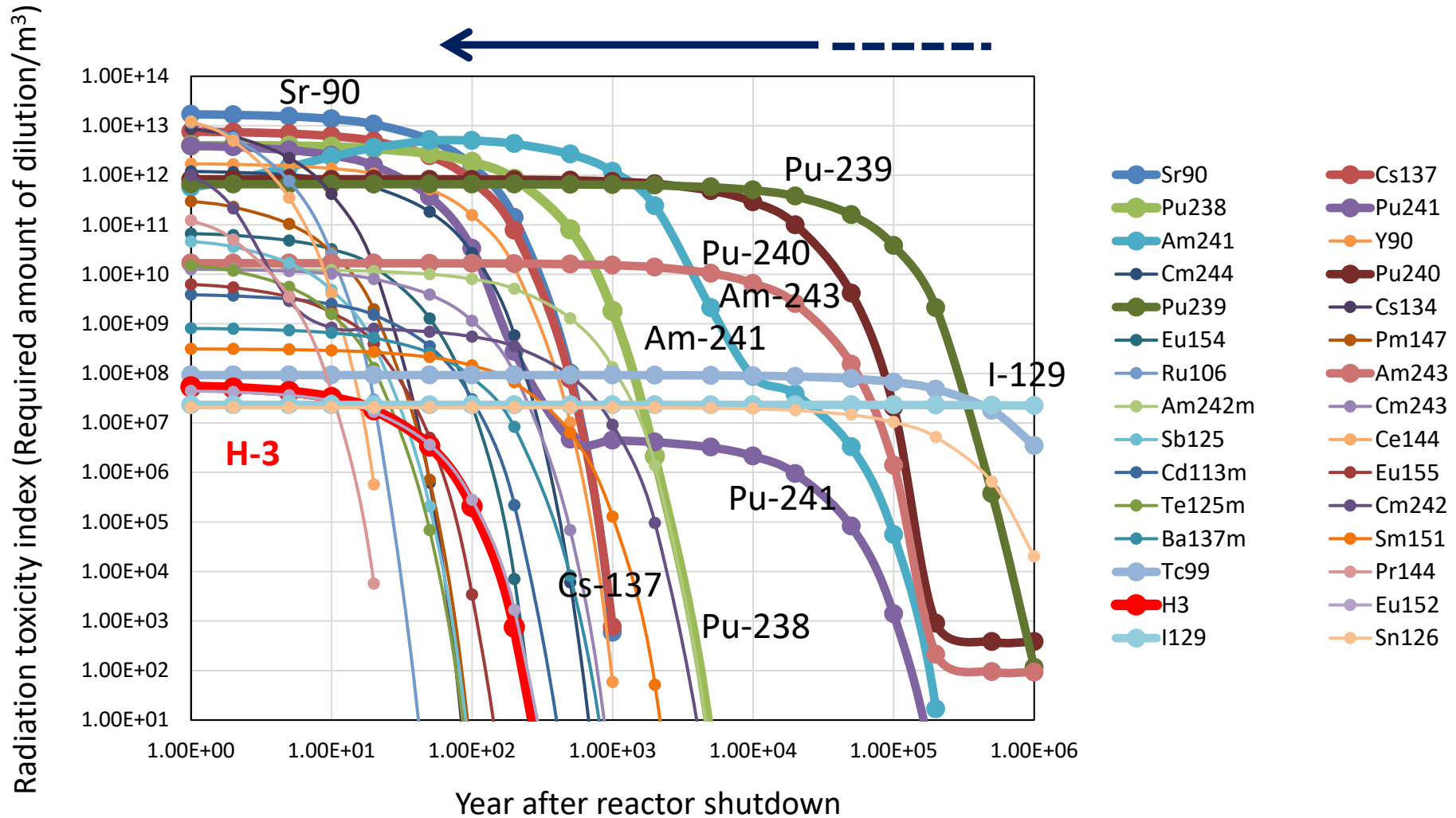
|   | 2023~2025   | Future goal(2026~34)   |
|---|---|---|
| Solid radioactive material:<br>Risk reduction area with high priority (except fuel debris (FD) ) Risk | <ul style="list-style-type: none"> <li>• Water treatment (unstable)</li> <li>• Buildings dismantled(future)</li> <li>• Rubbles etc.(through past decommissioning work)</li> <li>• Nuclide analysis</li> </ul> | <ul style="list-style-type: none"> <li>→ Further stabilization</li> <li>→ Classification and storage/management</li> <li>→ Appropriate storage and management</li> <li>→ Analytical facility and capacity</li> </ul>  |
| Major goals other than solid radioactive material   | <ul style="list-style-type: none"> <li>• Liquid radioactive material</li> <li>• SF</li> <li>• External events</li> <li>• Critical for D&amp;D work</li> </ul>   | <ul style="list-style-type: none"> <li>→ Process full amount of liquid material</li> <li>→ Dry storage of whole SF</li> <li>→ Measures for building ageing and damages</li> <li>→ Planned discharge of treated water</li> <li>→ Safe storage of FD</li> </ul> |

**In line with these Main Goals, "FD retrieval and storage" and "Management and disposal of radioactive waste has to be steadily and full-fledged challenged for suppressing short-and-mid term risk and reducing long-term risk**

edited from NRA 2023/02/01

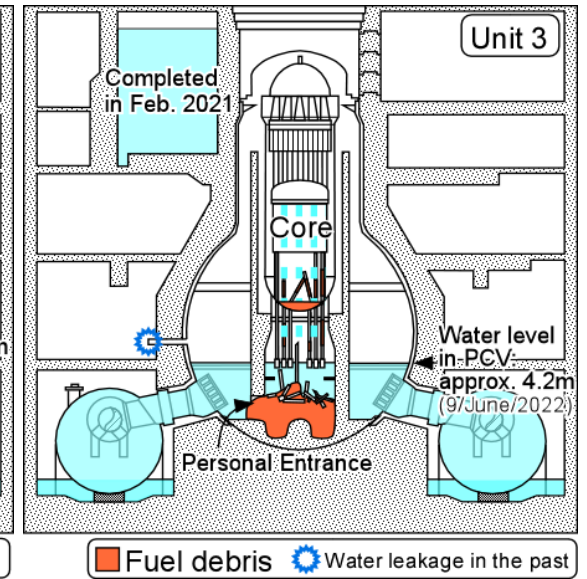
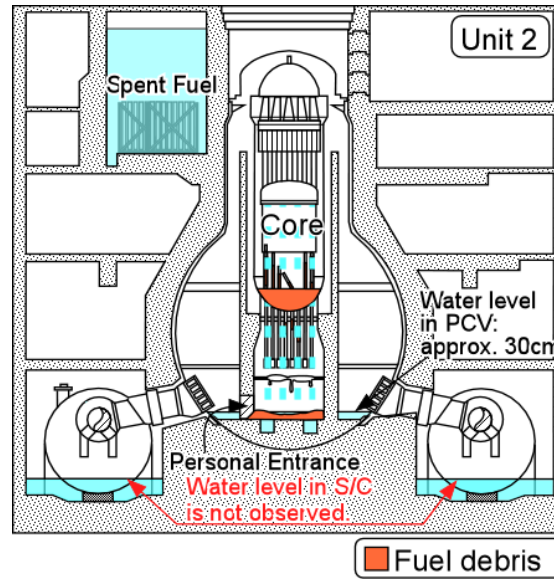
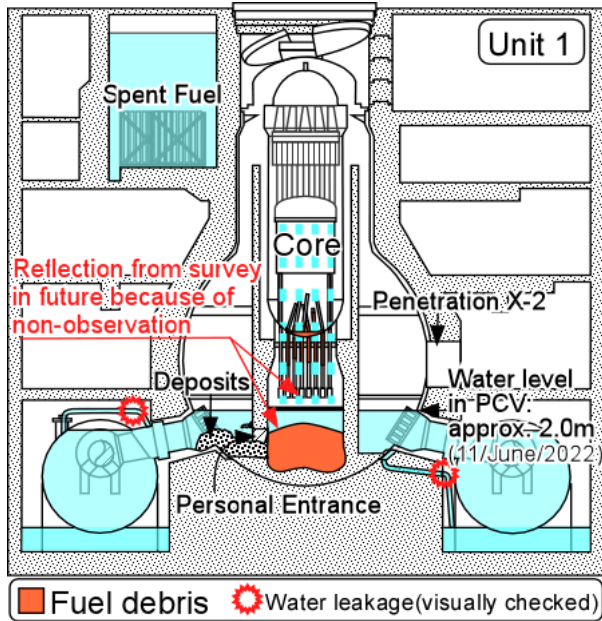
# Time transition of radioactive poison with Spent Fuel

Conduct FD retrieval and isolation In pursuit of future "passive low risk"



Produced from JAEA-Data/Code 2012-018 (K. Nishihara et al.)

# Status of Fuel Debris (Estimate and Observation)



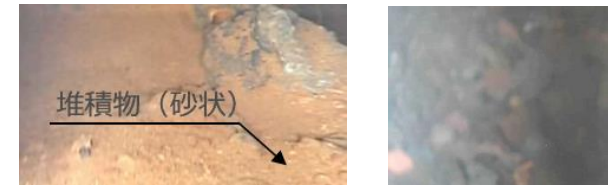
Inside U1 PCV Pedestal (2022-2023)



Inside U2 PCV Pedestal (2018)



Inside U3 PCV Pedestal (2017)



Accident Progress Analysis (MAAP) (2015)

|            |                      |          |
|------------|----------------------|----------|
| RPV inside | Core (t)             | 0        |
|            | RPV bottom (t)       | 15       |
| PCV inside | Pedestal inside (t)  | 109 (78) |
|            | Pedestal outside (t) | 33 (52)  |
| Total (t)  |                      | 287      |

|            |                      |         |
|------------|----------------------|---------|
| RPV inside | Core (t)             | 0       |
|            | RPV bottom (t)       | 25      |
| PCV inside | Pedestal inside (t)  | 92 (37) |
|            | Pedestal outside (t) | 102 (4) |
| Total (t)  |                      | 260     |

|            |                      |          |
|------------|----------------------|----------|
| RPV inside | Core (t)             | 0        |
|            | RPV bottom (t)       | 25       |
| PCV inside | Pedestal inside (t)  | 103 (51) |
|            | Pedestal outside (t) | 96 (6)   |
| Total (t)  |                      | 281      |

# Mid-and-Long-Term Roadmap towards the Decommissioning of TEPCO's Fukushima Daiichi Nuclear Power Station

Edited from RM(2019)

2011 ————— 2020 ————— 2030 ————— within 30~40 years —————>

Stabilized after Accident



Complete SF removal:  
ca 2030

Waste storage • SF removal • Contaminated water • Reactor research • Technical Dev.



Preparation for FD retrieval (Stepwise expansion from experimental retrieval)



Full-fledged FD retrieval

Dismantling of bid.



Waste research • Technical research • Storage • Volume reduction • Management and Disposal



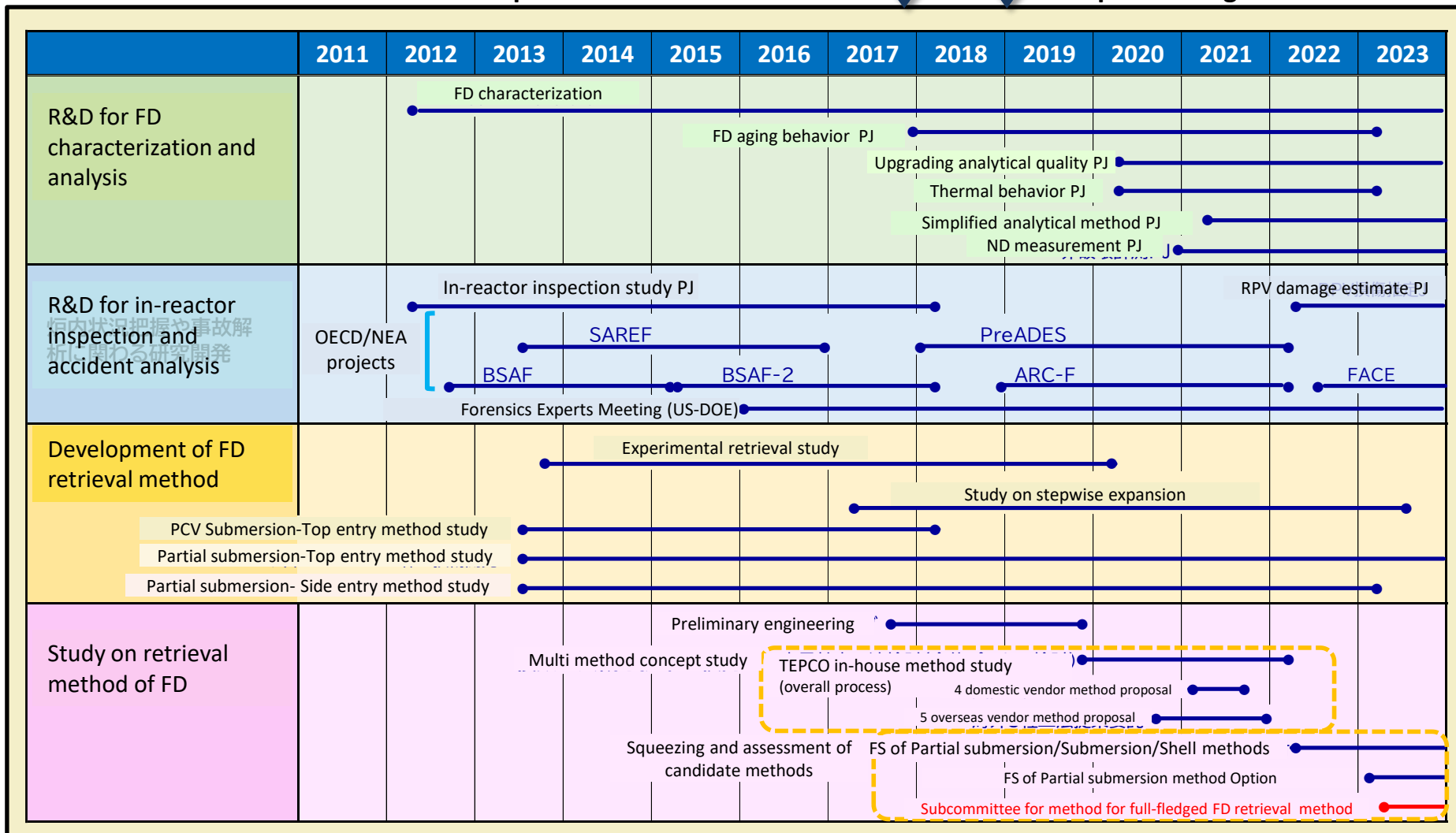
- ✓ Start of SF removal at Unit 1: FY 2027~2028
- ✓ Start of SF removal at Unit 2: FY 2024~2026
- ✓ FD retrieval: Start within 2021  
(later half of FY 2023 due to COVID 19 and safety consideration )
- ✓ Halve stagnant water in RB end of 2020: FY 2022~2024



# History of FD retrieval study

NDF proposed to focusing on the partial submersion methods. ▼

RM decided U2 as the first implementing Unit ▼



## IAEA GSR (General Safety Requirement) Part 6 (Decommissioning of Facilities)

Many of the requirements established in this publication [can also be applied to decommissioning after an accident has occurred or a situation has arisen that has resulted in serious damage to, or the contamination of, a facility, or simply after the premature shutdown of a facility.](#)

### **Requirement 1: Optimization of protection and safety in decommissioning**

Exposure during decommissioning shall be considered to be a planned exposure situation and the relevant requirements of the Basic Safety Standards shall be applied accordingly during decommissioning.

### **Requirement 2: [Graded approach](#) in decommissioning**

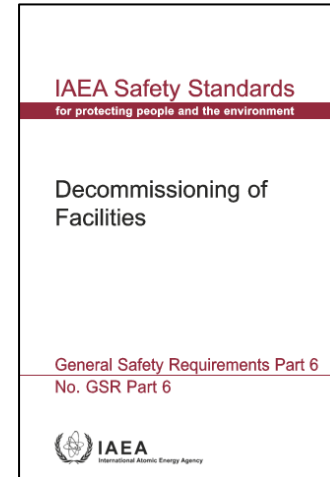
A graded approach shall be applied in all aspects of decommissioning in determining the scope and level of detail for any particular facility, consistent with the [magnitude of the possible radiation risks arising from the decommissioning.](#)

### **Requirement 3: Assessment of safety for decommissioning**

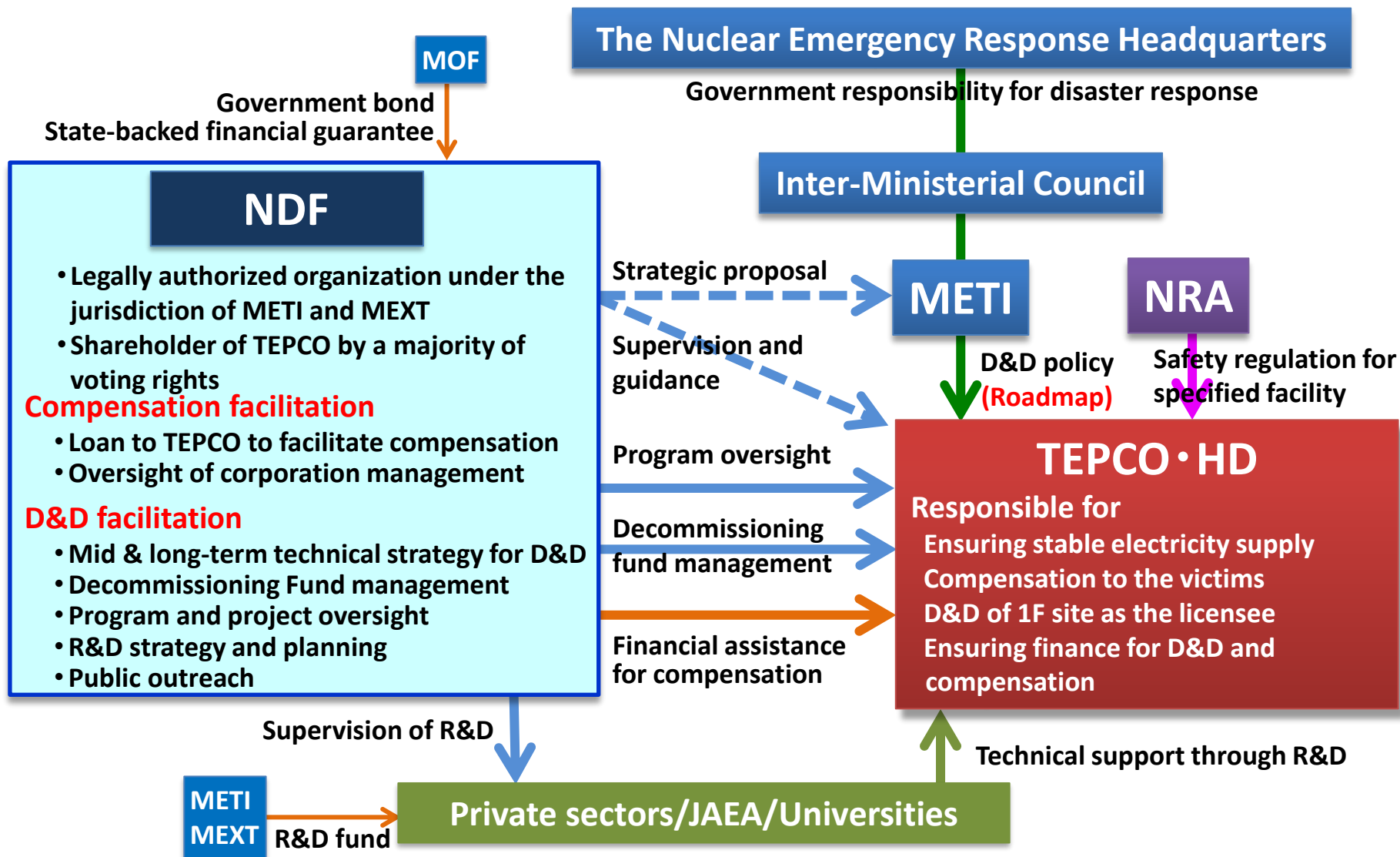
Safety shall be assessed for all facilities for which decommissioning is planned and for all facilities undergoing decommissioning.

Currently no Guidance exists indicating the approach ensuring the safety for the features of 1F D&D (Uncertain level/status of radioactivity, radioactive environment, work plan etc.) Consequently, to share the information and to get on the same page between the regular and operator incorporating following angles is keenly expected.

- Balance between the short-term risk and long-term risk to be suppressed in terms of time-axis
- Application of risk informed approach such as graded-approach
- Balance between the increase of workers' risk and deduction of public risk
- Maintain D&D work as long-term challenge, respect of public perception etc.



# Organizational alliance with the full support by the government



- Full-fledged fuel debris removal at around 2030 is planned in line with the policy in the Mid-and-Long Term Roadmap following from the experimental removal at the First Unit.
- While priority is being placed on the operations to maintain the site stability and to reduce the short and mid-term risk at the site, it is required to embody full-pledged "Fuel Debris Removal" for the reduction of the long-term risk.
- On the background of the accumulated achievement of R&D works and the result of various implementations over the past 12 years, it's been started by TEPCO and NDF to assess and select the full-fledged fuel debris retrieval methods.
- It is expected that TEPCO's engineering work would go forward under the cooperative frame of multiple committed organizations with the full support by the government.
- As for fuel debris retrieval, it is essential for TEPCO to look for the methods with assured safety through the careful preparation such as engineering and designing etc. To assist this, sharing the information and same recognition by the regulator and operator is keenly expected.