Approaches to the decommissioning and contaminated water management for Fukushima Daiichi Nuclear Power Station

1st International Forum on Decommissioning of
Fukushima Daiichi Nuclear Power Plant

April 10th, 2016

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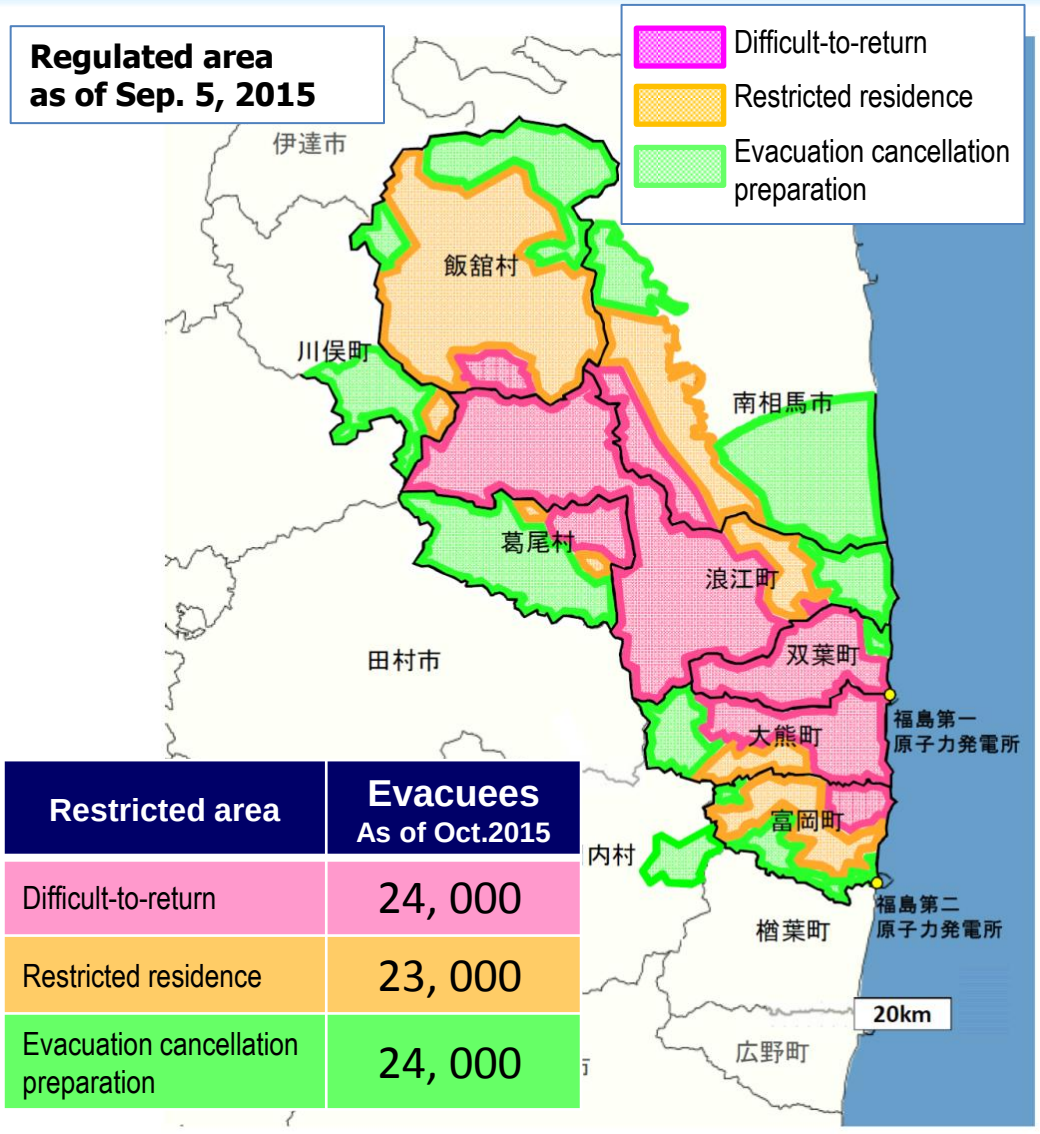
President, Nuclear Damage Compensation and
Decommissioning Facilitation Corporation

Review of the Fukushima Daiichi Nuclear Power Station Accident



Restricted area	Evacuees As of Oct.2015
Difficult-to-return	24, 000
Restricted residence	23, 000
Evacuation cancellation preparation	24, 000

Released radioactivity

Nuclide	Half-life	Chernobyl [1] PBq	Fukushima-Daiichi [2][3] PBq
Xe-133	5.25h	6, 500	14, 000
I-131	8.03d	1, 760	150
I-133	20.8h	910	146
Cs-134	2.07y	47	11.8
Cs-137	30.1y	85	12

[1] UNSCEAR (2008), [2] Chino et al. (2011, 2013),
[3] Steinhauser et al. (2014)

Changes in five years since the accident

2011 | 2012 | 2013 | 2014 | 2015

Government

Nuclear Emergency Response Headquarters 2011.03.11

Local nuclear emergency response headquarters 2011.03.11

Council for the Decommissioning of TEPCO's Fukushima Daiichi NPS 2013.09.03

Committee on Countermeasures for Contaminated Water Treatment 2013.04.19

Team for Countermeasures for Decommissioning and Contaminated Water Treatment 2013.09.10

Roadmap

Roadmap 1st issue 2011.12.26

Roadmap 1st revision 2012.12.26

Roadmap 2nd revision 2013.06.27

Roadmap 3rd revision 2015.06.12

2011.03.11

Cold shutdown 2011.12.16

Strategic Plan

Strategic Plan2015 2015.04.30

Emerging entities

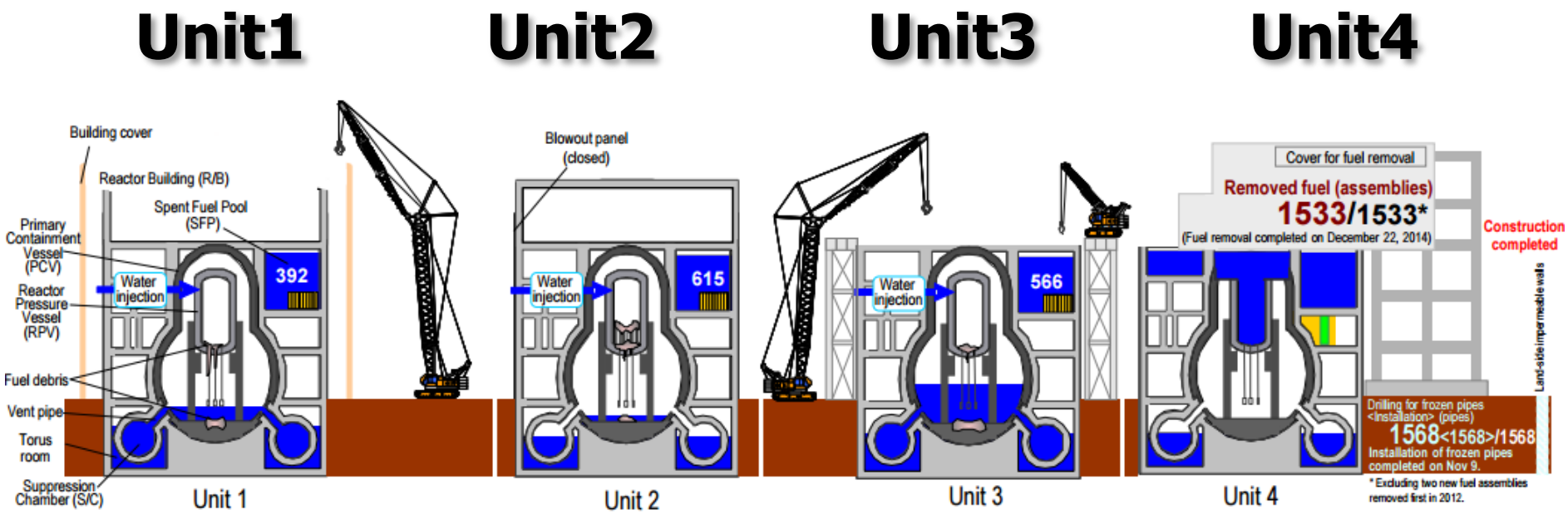
NDF 2014.08.18

IRID 2013.08.01

TEPCO D&D Co. 2014.04.01

NDF

Update of Units 1-4



Removal of last one roof panel

Policy decision for the overall disassembly of storage shed

During preparation of retrieval/decontamination

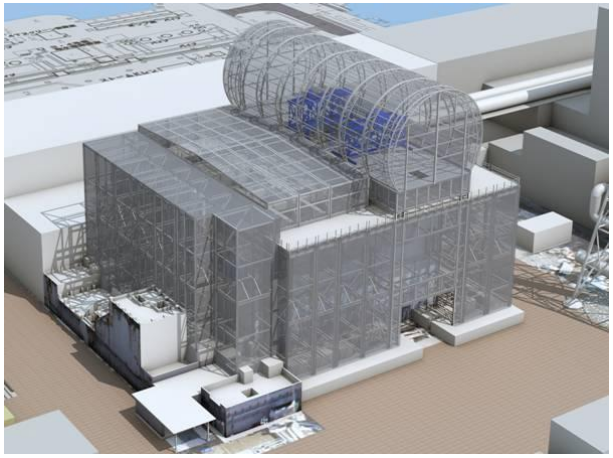
Completion of spent fuel

Source :Meeting material from Team for Countermeasures for Decommissioning and Contaminated Water Treatment

Retrieval of fuel debris from Unit3

- The removal of the spent fuels stored in the pools of Unit-1, 2, and 3 is urgently required operation.
- They are planned to be taken out after clearing off the radioactive rubbles existing on the operation floor.
- The decontamination and clearing off of the operation floor of Unit-3 has progressed, and the removal of rubbles fallen down into the pool has started.
- After the decontamination, a building cover will be installed to remove the fuels with newly installed Fuel Handling Machine.

Removal of rubles from SF pool of U-3



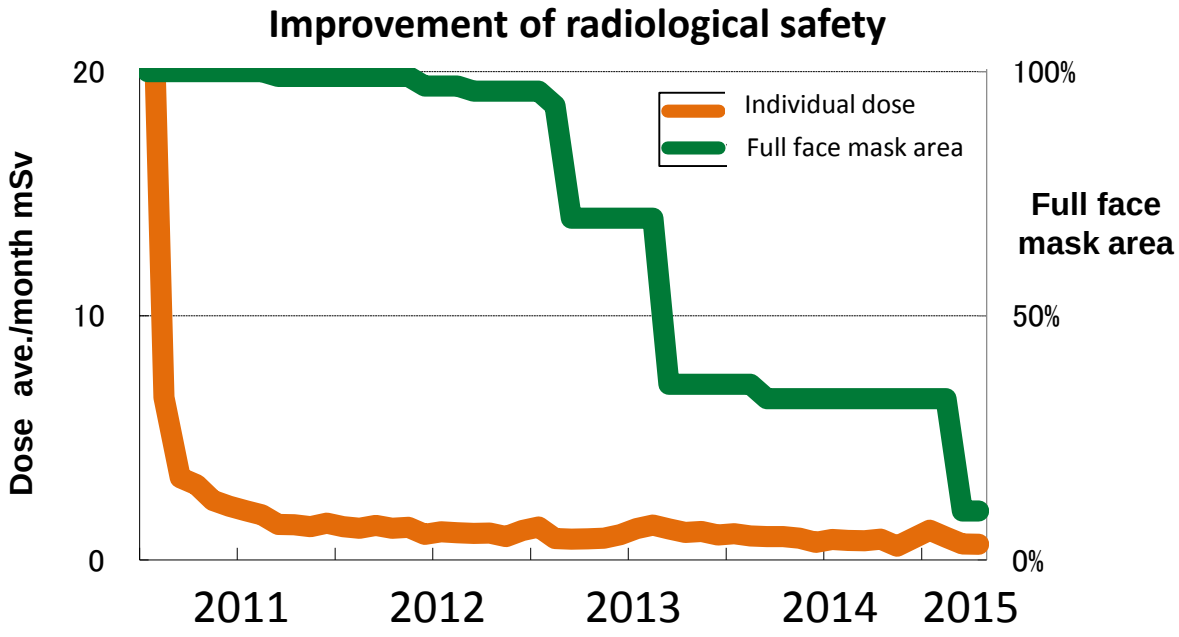
Building cover to be installed

Building covers under fabrication

Rubble removal operation

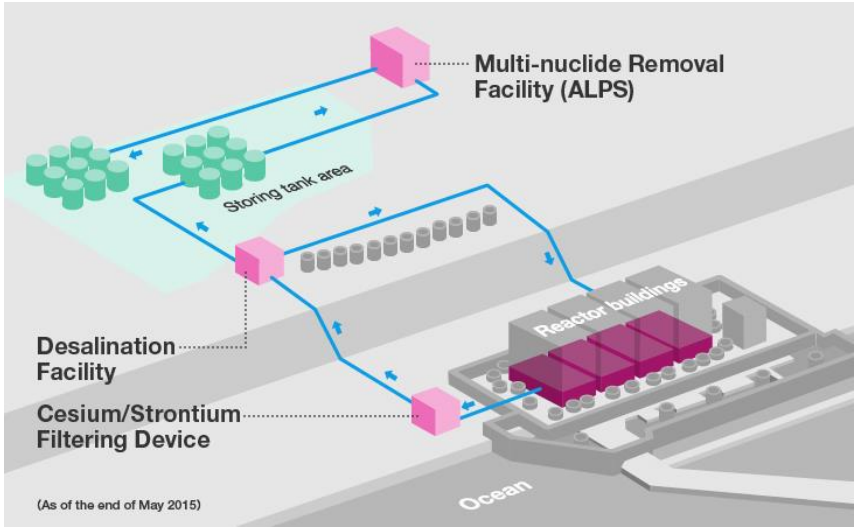
Source： TEPCO website and photo archive

Improvement of site condition

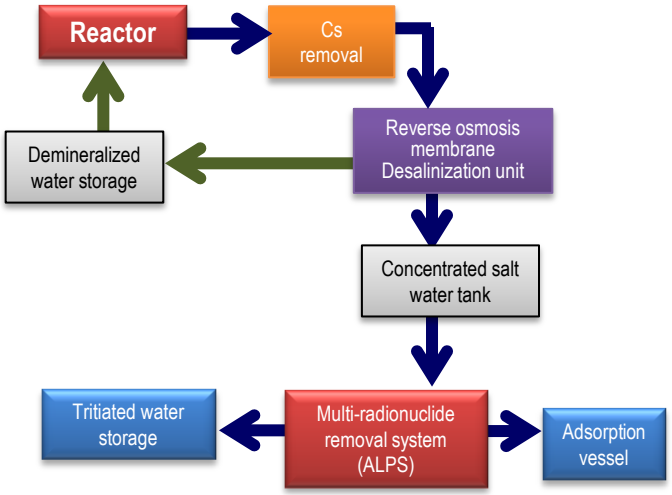


Source : Courtesy by TEPCO

Approaches to the contaminated water purification

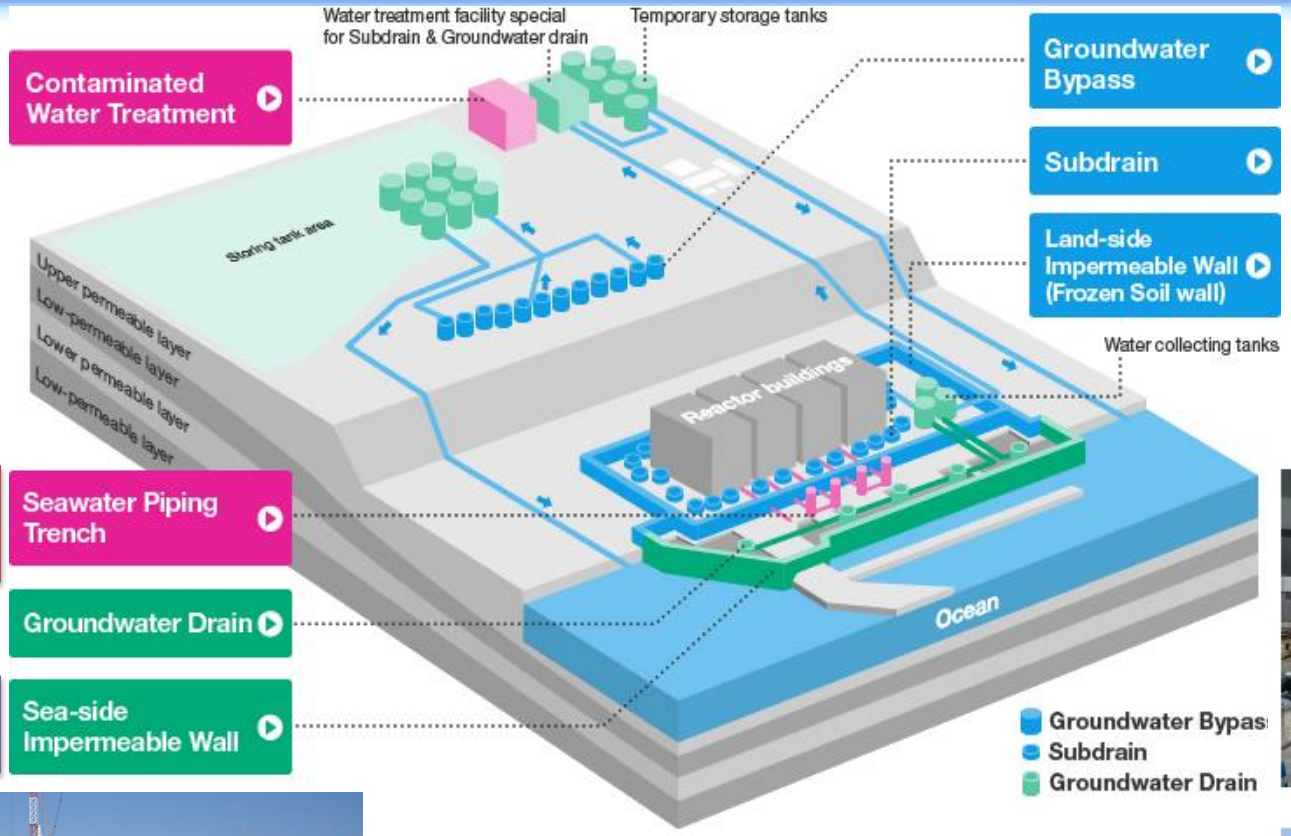


- Contaminated water is generated by the inflow of ground water into the reactor buildings. The total amount of the accumulated water exceeds 800 k m3 to date.
- It has been treated by using ALPS, Advanced Liquid Processing System, and Mobile Sr-Removal system to remove major radio-nuclides, and residual tritiated water is stored in tanks.



Source : Released material from TEPCO

Approaches to the contaminated water



2014/5
Discharge started

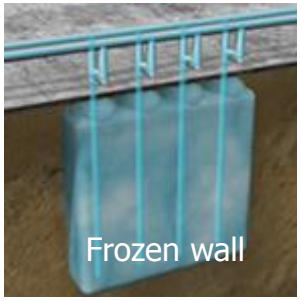
2015/9
Pumping-up started

2015/3
Operation started

2015/7
Water removal completed

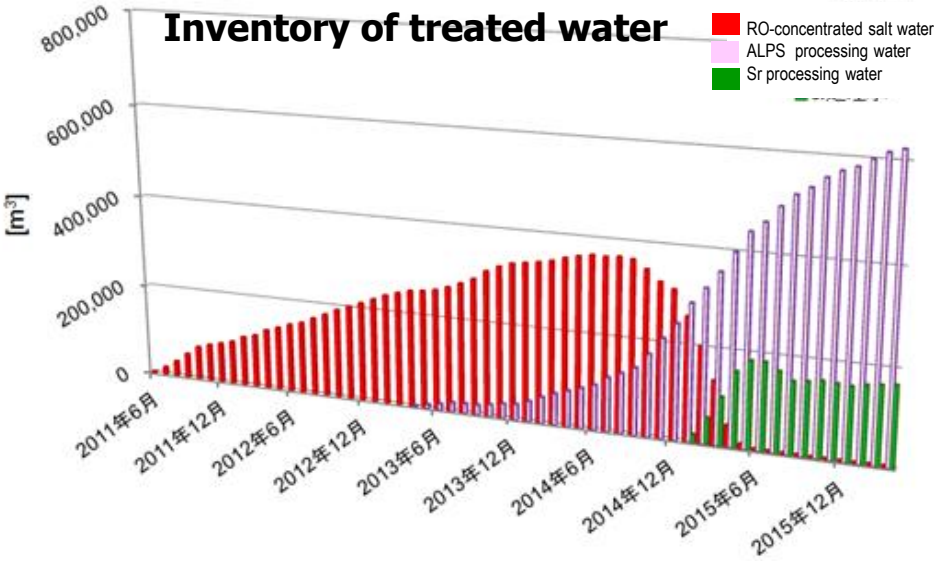
2016/2
Closing completed

Cooling pipe installation



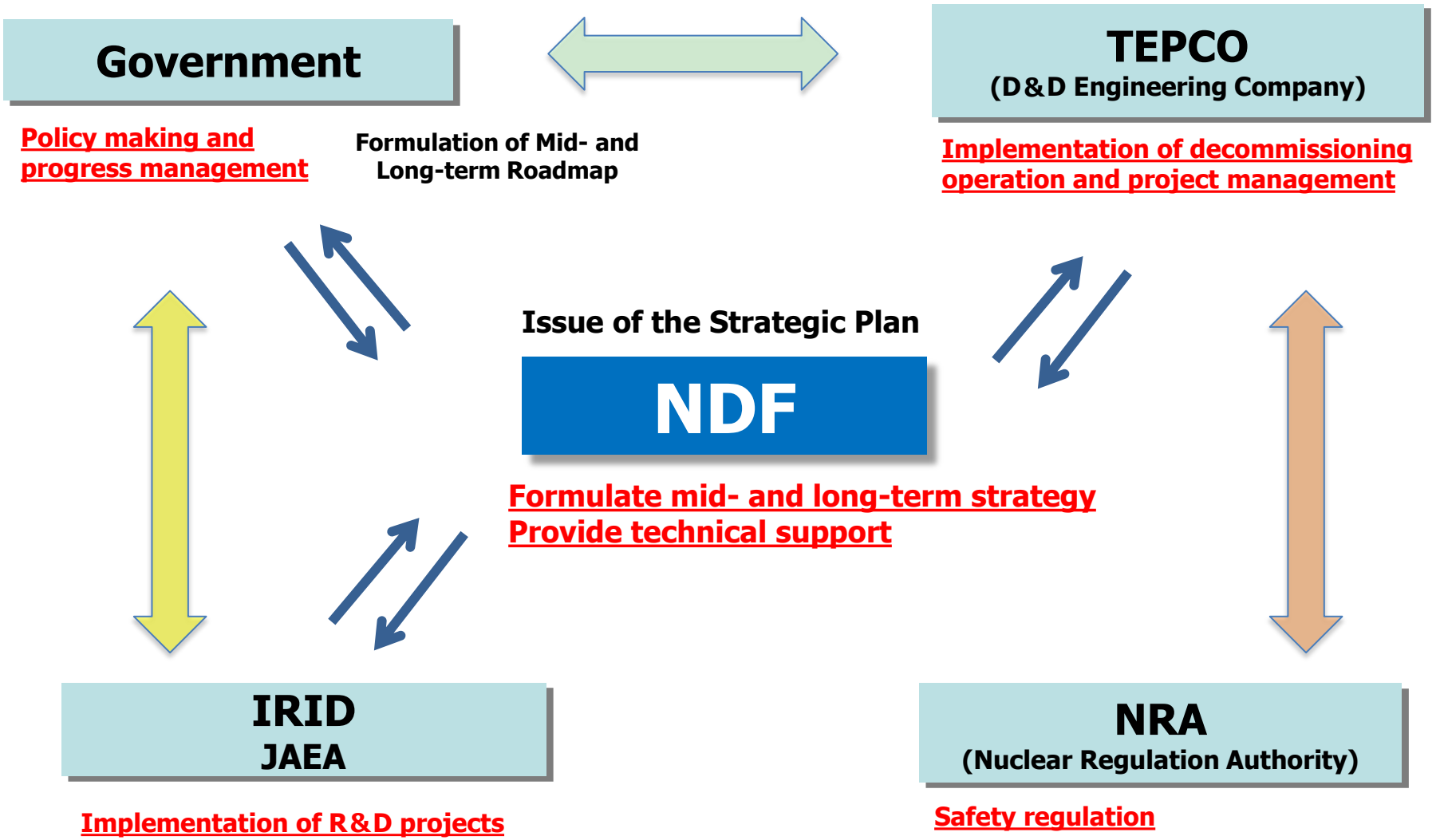
Source : TEPCO website and photo archive

Accumulated contaminated water



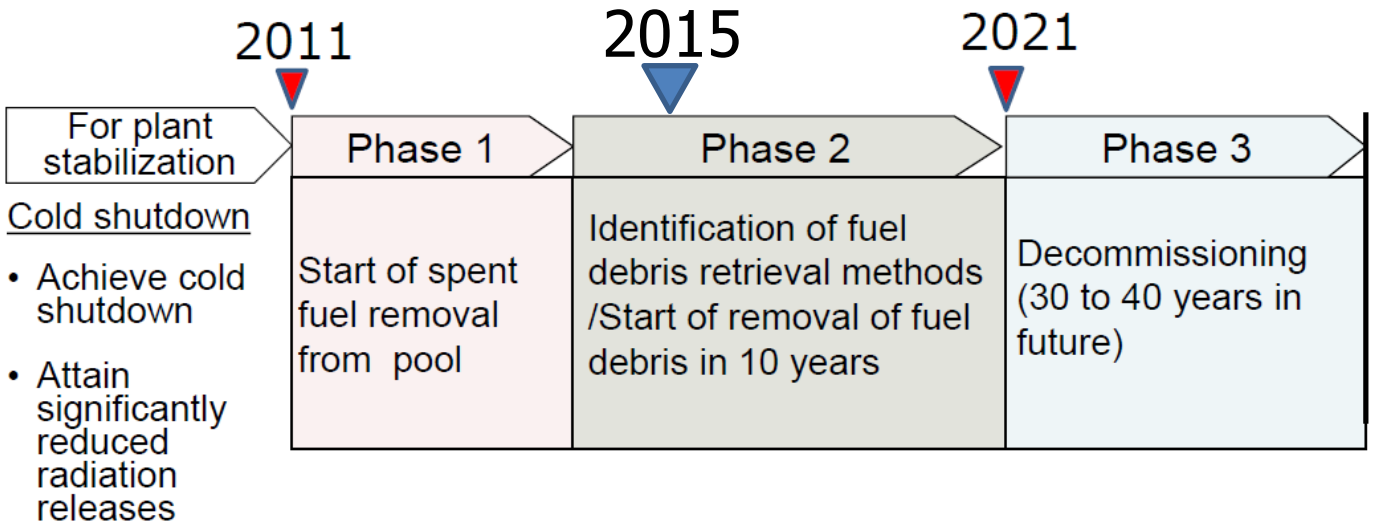
Source : TEPCO photo archive

Organizational structure for decommissioning of Fukushima Daiichi



Mid-and-long-term Roadmap and Technical Strategic Plan

Mid- and Long-term Roadmap by GOJ



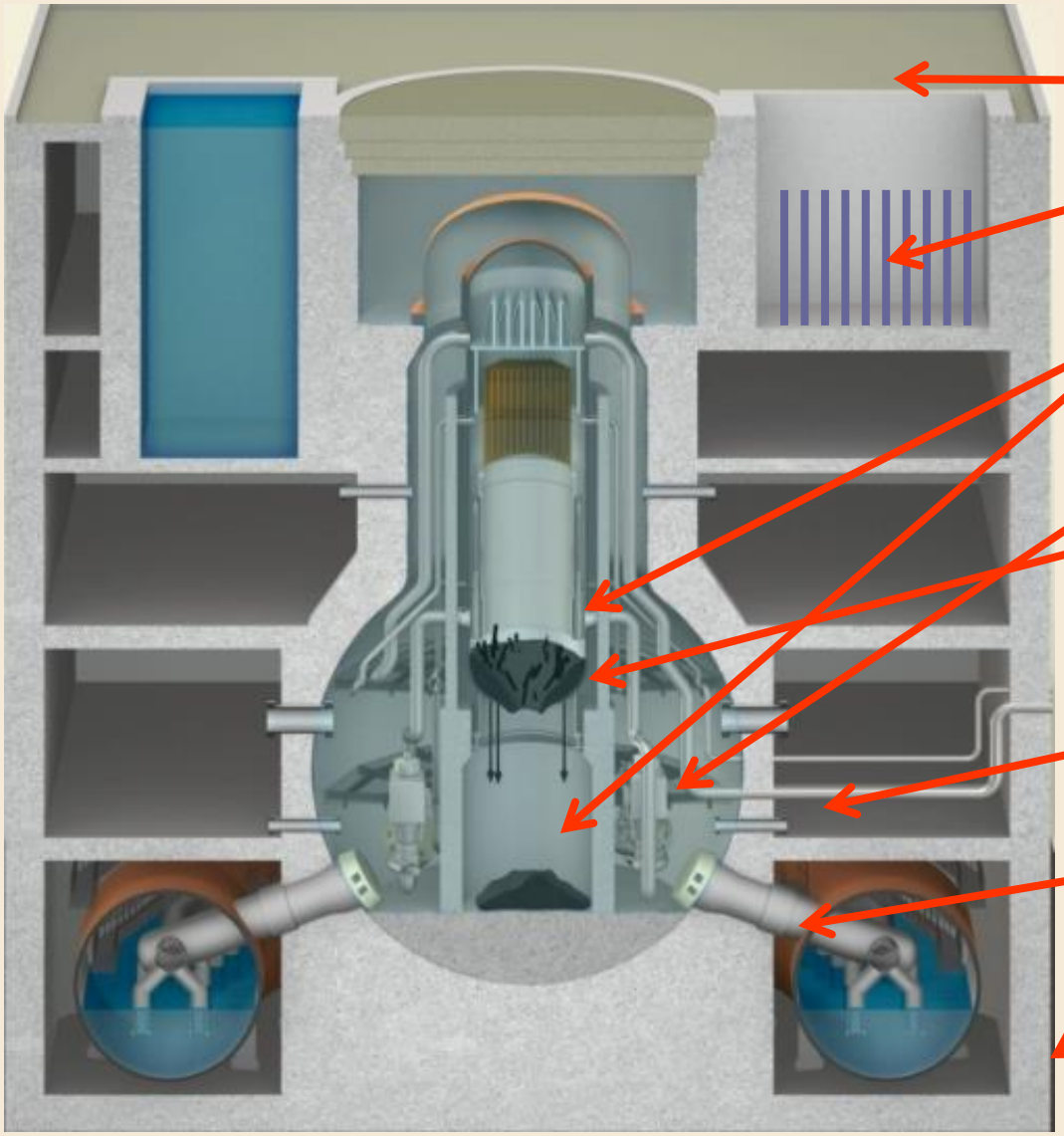
Strategic Plan by NDF

Strategic Plan 2015 : Issued on Apr. 30, 2015

Strategic Plan 2016: Scheduled for this summer

- ◆Discussion through the close dialogue and exchange of information between the Government and TEPCO.
- ◆Study mid-term technical strategy through the discussion with the experts from various technical fields while receiving the advise from Decommissioning Strategy Board, Expert Committee from multiple fields, International Special Advisors.
- ◆"Risk reduction strategy" regarding mid- and long-term decommissioning
- ◆In vessel inspection and study of the technical strategy for the fuel debris retrieval method.
- ◆Develop an optimum technical strategy based on the Five Guiding Principles. " Safe, Proven, Efficient, Timely and Field-oriented"

Fuel debris retrieval



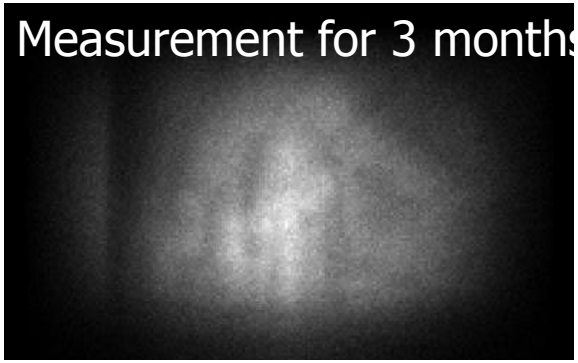
- Operation floor largely damaged.
  High dose rate
- Spent fuels stored in Unit1, 2 and 3
- Fuel debris dispersed in both RPV and PCV
  Properties unknown
- High radiation inside PCV
  Inside PCV gradually known.
- Cooldown by water injection required.
- Building highly contaminated with high radiation (battle with decontamination)
- Leakage from PCV.
  Generation of contaminated water.
- Leakage from the building.
  Penetration of groundwater.
  Needs of contaminated water leakage prevention

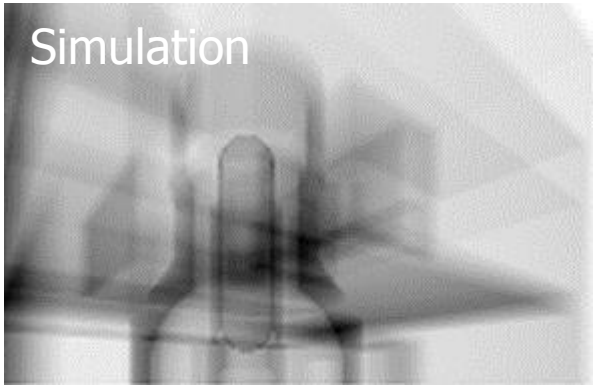
Source : Courtesy of IRID

Internal inspection for reactor containment vessel

- Internal inspection for reactor containment vessel using robots and other remote techniques are the keys to determine the fuel debris removal method.

Muon-tomography adopted to Unit-1



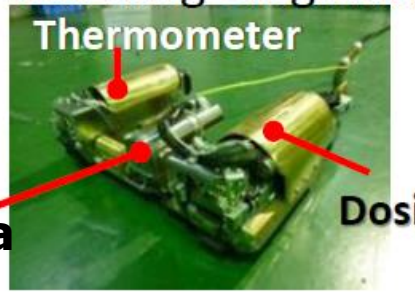


Shape-changing crawler robot

Traveling through piping

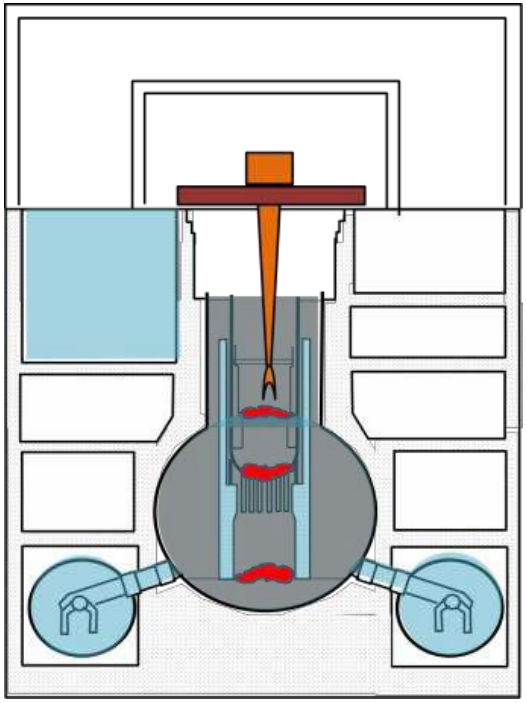
Transformation

Traveling on grating



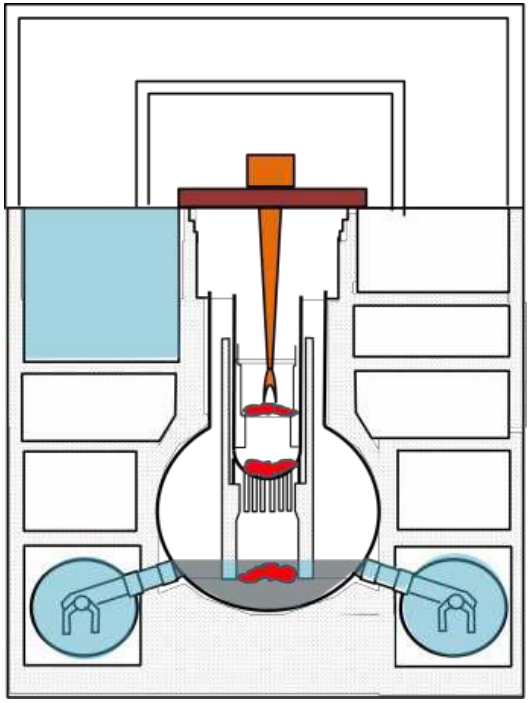
Source: Published materials by TEPCO and IRID

Fuel debris retrieval method



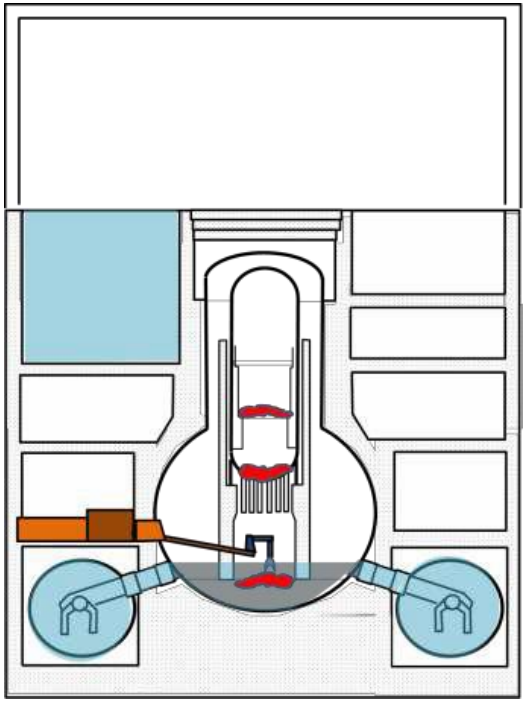
Submersion - Top entry method

Assuming the in-core structures above the fuel debris are removed



Partial submersion - Top entry method

Assuming that the in-core structures above the fuel debris are removed



Partial submersion - Side entry method

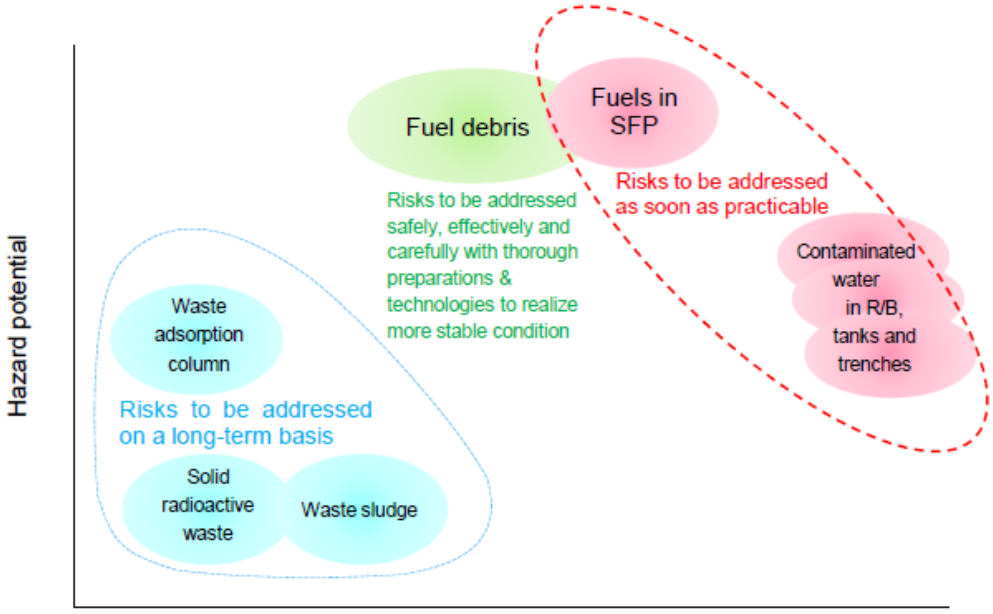
Assuming that the equipment and other objects outside RPV pedestal in PCV are removed

Source: Strategic Plan 2015, NDF

Decommissioning as risk reduction

Risk defined in the Technical Strategic Plan 2015 by NDF, Japan

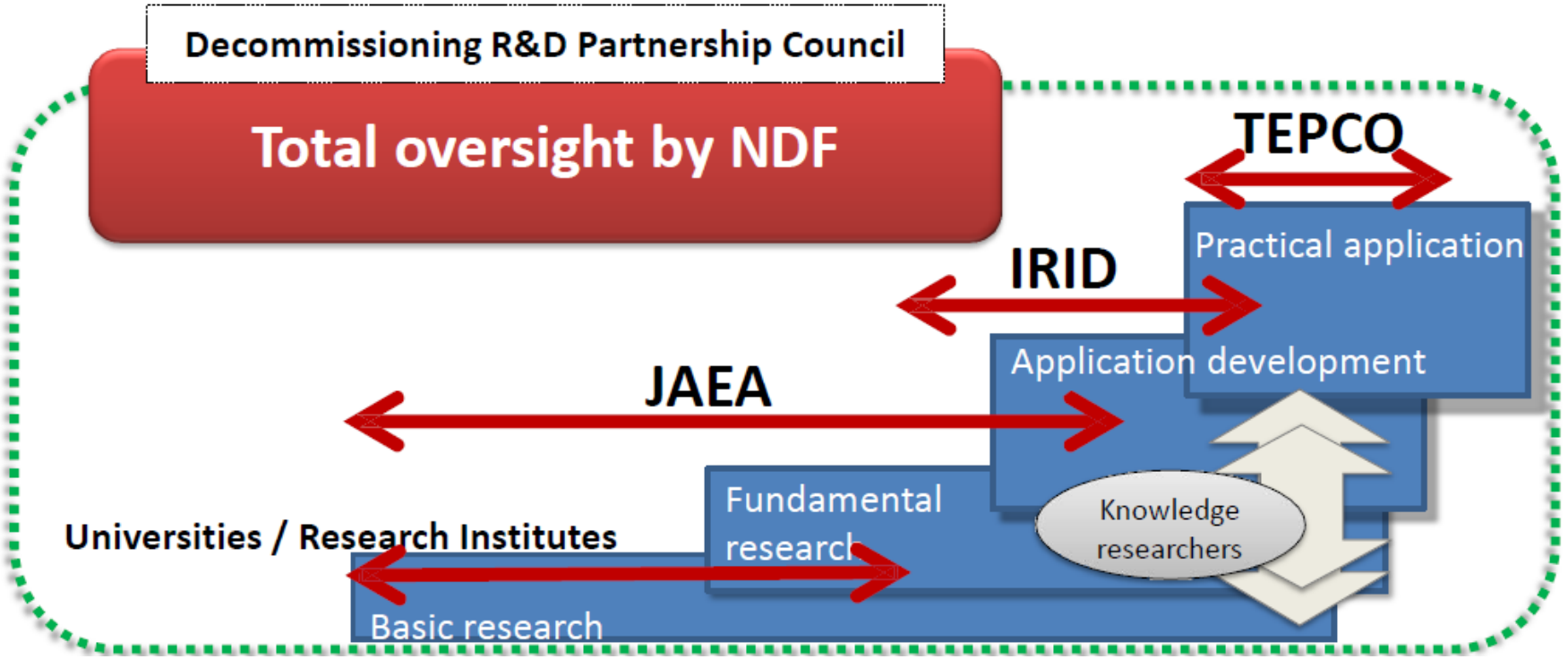
Fig. 3-5 shows the levels of risks for major risk sources in the Fukushima Daiichi NPS based on the "hazard potential" and "likelihood of loss of containment function"



Source: Strategic Plan 2015, NDF

Integration from basic research to practical application

- It is important to facilitate interaction among researchers and engineers involved in R&D initiatives.
- The Decommissioning R&D Partnership Council integrates management from fundamental research to practical application.



Approaches to the decommissioning

- While accelerating the stabilization of the contaminated water management, risks which mat be exposed in a short period of time should be eliminated as quickly as possible , such as removal of spent fuels.
- Realize the stable state where the risks would not be exposed by promoting the fuel debris retrieval and other "cleanup after the accident" and removing a shot- and mid-term risk derived from the reactor building.
  Study final decommissioning while continuing the inspection and monitor of the inside of the reactor.
- Securing the "Low risk state" that dose not have impact on the residents and environment and developing reasonable decommissioning strategy so that the people in Fukushima can make their all effort to the restoration of hometown.

Reference：Concept of decommissioning defined by IAEA

Source：IAEA Nuclear Energy Series NW-T-2.7
"Experiences and lessons learned worldwide in the cleanup and decommissioning of nuclear facilities in the aftermath of accidents"

Thank you for your Attention!

Source: TEPCO photo archive