Overview of Radioactive Waste Management in Japan And R&D Activities for Fukushima Daiichi

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Contents

- Classification and Disposal Concepts of Radioactive wastes in Japan
- Disposal Practice and Plan in Japan
- R&D of Fukushima Daiichi Radioactive Wastes

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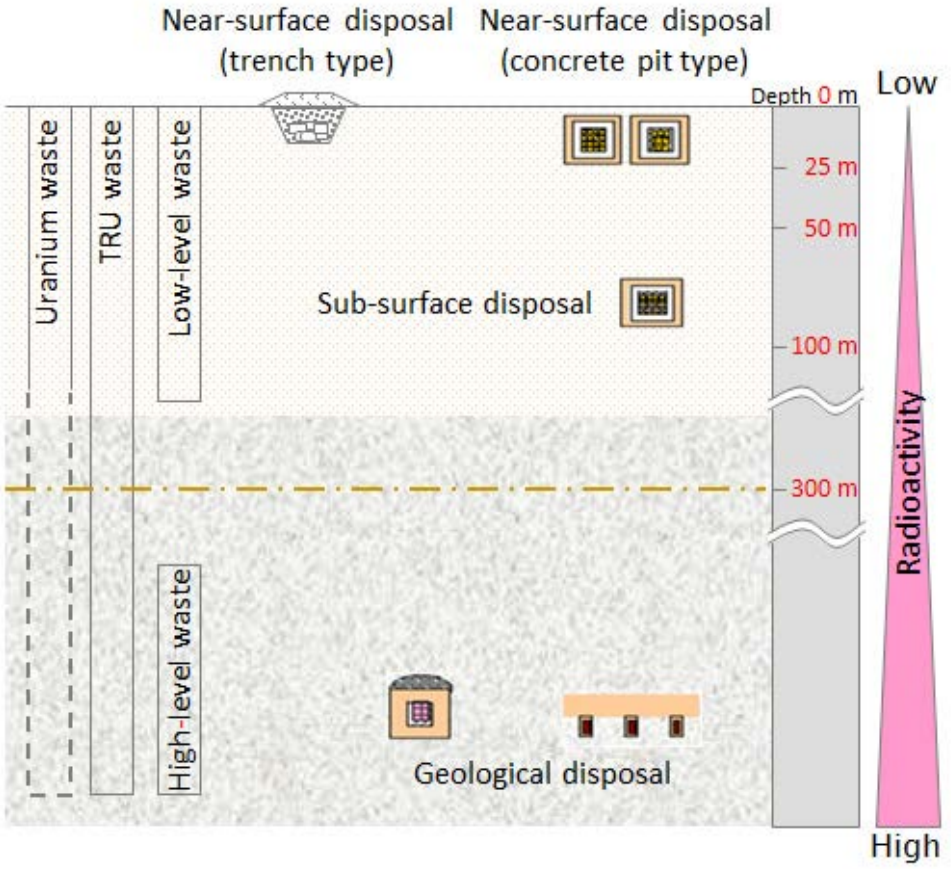
Classification of Radioactive Waste in Japan

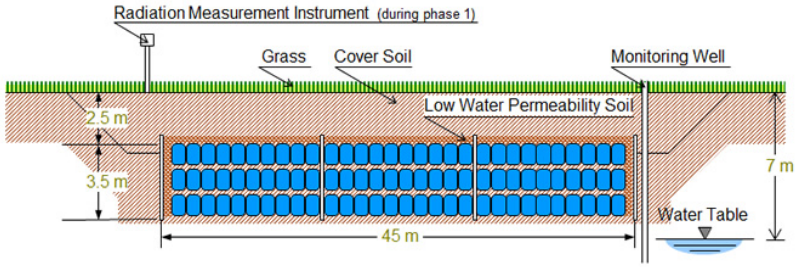
Classification			Example	Origin of Waste	Disposal (example)
High-level radioactive waste (HLW)			Canister	Reprocessing facilities	Geological
Low-level radio-active waste (LLW)	Waste from Power Reactors	Relatively High Radioactive Waste	Control Rods, Core Internals	Power Reactors	Sub-surface
		Relatively Lower Radioactive Waste	Liquid waste, Filters, Used Equipment, Expendables		Concrete Pit Type
		Very Low-Level Radioactive Waste	Concrete, Metals		Trench Type
	Waste Containing Transuranic Nuclides (TRU Waste)		Parts of Fuel Rod, Liquid waste, Filters	Reprocessing Facilities, MOX Fuel Manufacturing Facilities	Geological Sub-surface Concrete Pit Type
	Uranium Waste		Expendables, Sludge, Used Equipment	Enriched and Fuel Manufacturing Facilities	Sub-surface Concrete Pit Type Trench Type (or Geological)
Waste below the Clearance Level			Most Waste from Dismantling	Sources as shown in the above	Reuse Disposal as general wastes

Disposal Concept of Radioactive Waste in Japan

Several types of disposal facilities have been designed according to the radioactivity levels of the wastes.



Demonstration Test of Very Low-Level Concrete Waste Disposal (Trench Type) arising from decommissioning of JPDR (JAEA,Tokai)



Overview of the Disposal Facility Before Installation of the VLLW

Overview of the Disposal Facility Covered with Soil (1997)

http://www.jaea.go.jp/english/04/ntokai/backend/backend_01_04.html

http://www.jaea.go.jp/english/04/ntokai/backend/backend_01_04_01.html

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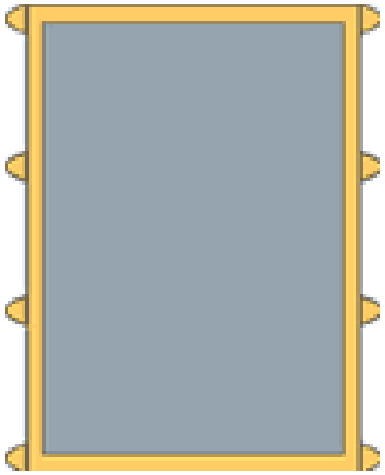
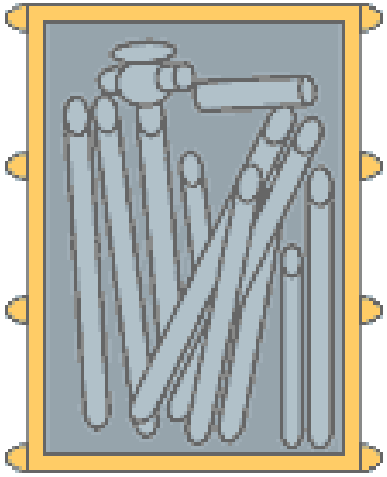
Disposal Facilities of Radioactive Waste from NPS

Japan Nuclear Fuel Limited
Low-level Radioactive Waste Disposal Center in Rokkasho, Aomori

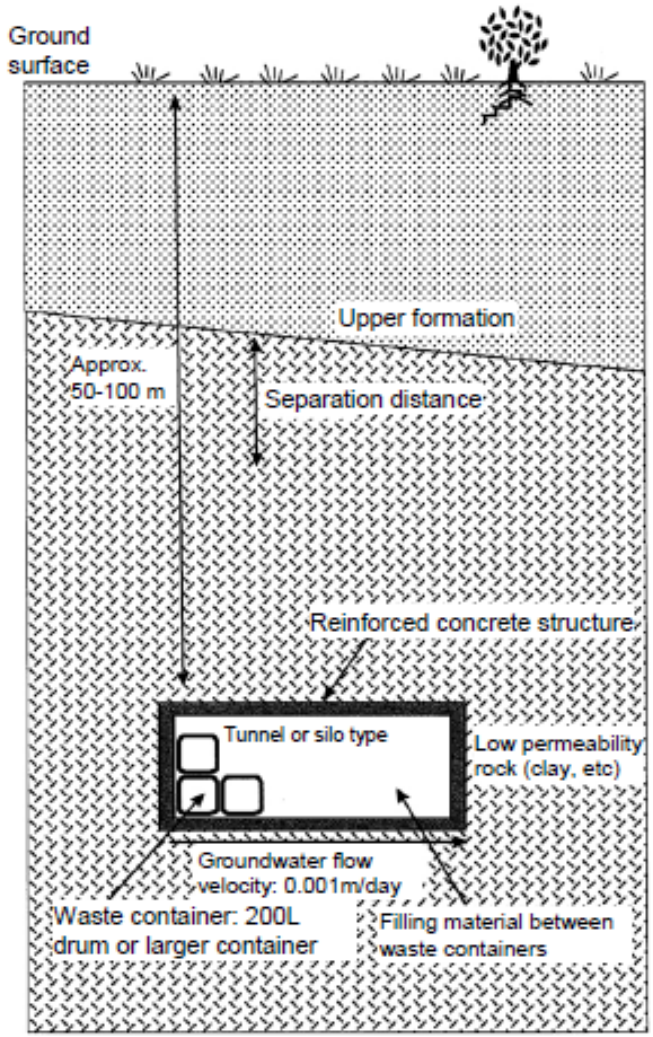
Total of 284,763 low-level waste drums has been received as of Jan.31, 2016.

http://www.jnfl.co.jp/business-cycle/llw/llw-center.html

Waste Packages to No. 1 & 2 Disposal Facility

	No.1 disposal facility	No.2 disposal facility
Content		
Waste	Concentrate, Spent IEX, etc.,	Metal, Plastic, etc.,
Binder	Cement, Bitumen, Plastic	Cement

Outline of Sub-surface Disposal



I. The waste is disposed of at a depth at which underground facilities can be constructed (e.g. about 50-100m from surface), taking underground conditions into consideration.

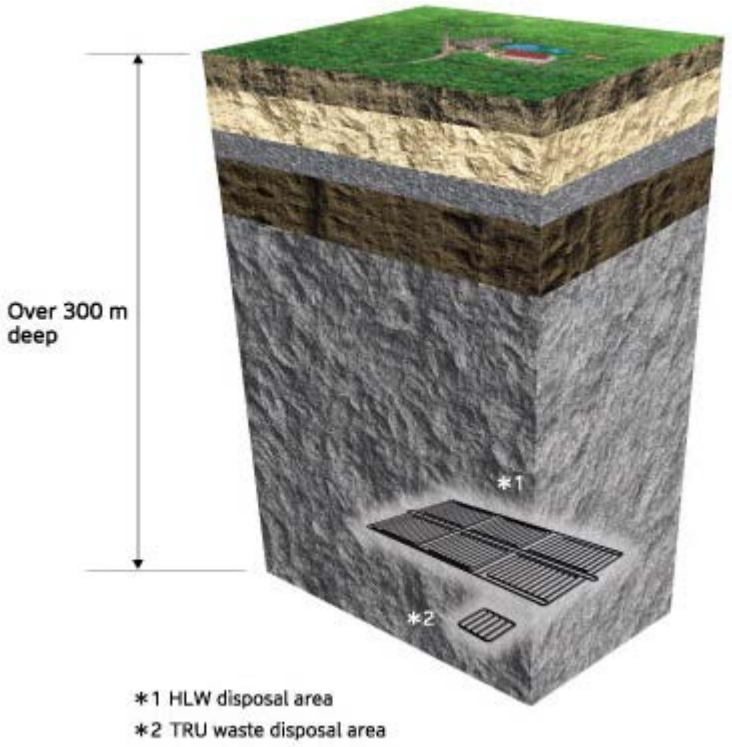
II. Rocks with the ability to prevent radionuclide transport are selected.

III. A disposal facility which has the ability to contain radionuclides, such as a concrete vault, is constructed.

IV. Considering the decrease in radionuclide concentrations due to decay, the disposal facility is managed for a period of several 100 years.

Second Progress Report on Research and Development for TRU Waste Disposal in Japan
- Repository Design, Safety Assessment and Means of Implementation in the Generic Phase -

Concept of Disposal Facility of HLW



http://www.numo.or.jp/en/jigyou/geological.html

Policy orientation responding to recommendations by Science Council of Japan (SCJ)

SCJ Recommendation to Japan Atomic Energy Commission (JAEC):

1. Social consensus on the nuclear energy policy should be pursued before talking about geological disposal of HLW;
2. The limitation of scientific and technological capability should be recognized and scientific autonomy for scientific deliberation should be secured;
3. A policy framework should be rebuilt centered on temporary storage and total volume control of the waste;
4. Socially acceptable procedures should be pursued, formulating policies based on the principle of fair burden-sharing;
5. Multi-step procedures should be pursued to build consensus by establishing venues for discussion and
6. Need for long-term tenacious efforts to solve the problems should be recognized.

JAEC Recommendation to the Government:

1. To clarify the amount and nature of HLW in association with nuclear fuel cycle policies to be pursued in the post-Fukushima accident era, noting that one repository under planning will be sufficient for several decades of nuclear power generation;
2. To review the safety of geological disposal of HLW based on the latest knowledge of science and technology and geology in particular, and share the result with the public as well as learned societies;
3. To make it clear that its efforts to realize final disposal of HLW be promoted step-by-step, assuring reversibility and retrievability so that the course of action can be modified based on the result of consensus with the public and risk assessments to be emerged in the future;
4. To take initiative in sharing information and exchanging opinions with the public through regular meeting with citizens and municipalities.

Shunsuke Kondo, “Current Status of Program for Geological Disposal of high-level radioactive waste (HLW) in Japan”, Sep. 2014.

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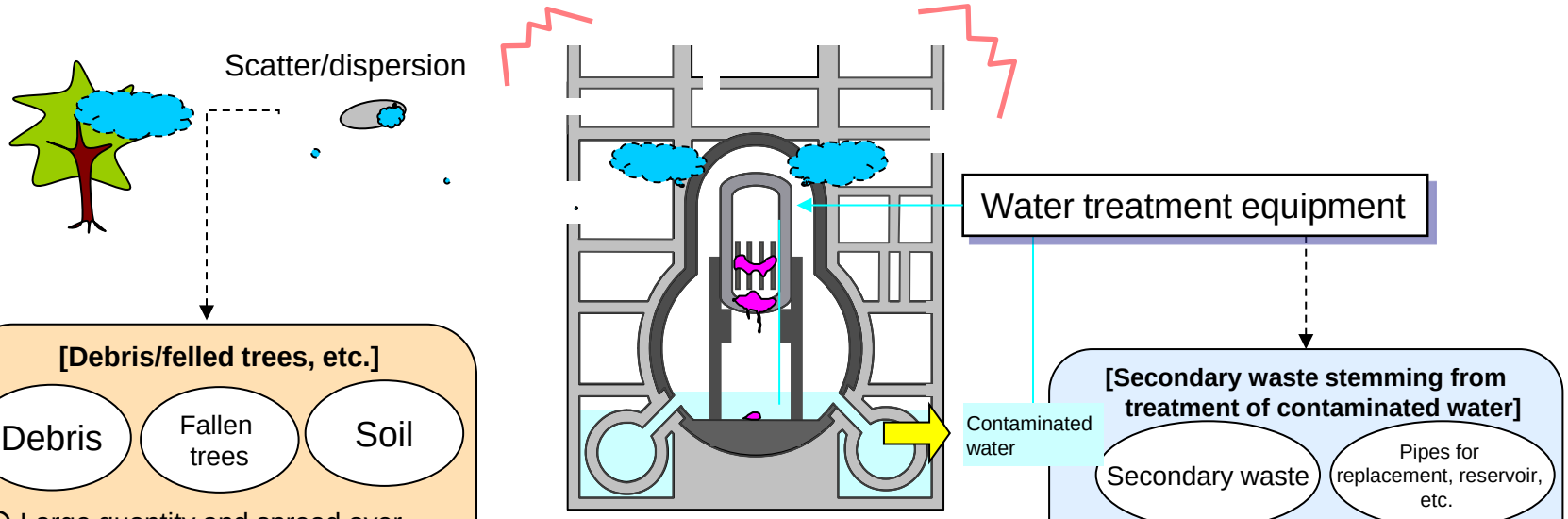
Waste Resulting from Accident at Fukushima Daiichi NPS(1)

	Radioactive waste from operation	Radioactive waste from accident
volume	Around 3% of whole decommissioning waste	Huge amount by internal and external contamination* of R/B and T/B



*: Contamination due to activation products and waste generated from operation may be included.

Waste Resulting from Accident at Fukushima Daiichi NPS(2)

R&D items to minimize uncertainty in waste processing and disposal

- Generation of waste [quantity, type, period]
- Handling (collecting/classifying) [difficulty]
- Characterization [sufficiency of information, difficulty of sampling, representativeness of sample]
- Technologies for processing and packaging waste
- Burial and disposal methods and safety assessment

- Waste generated from operation has its own problem but is **fairly under control**.
  - Information on basic properties of waste, including quantity at present, future change, activity and chemical substances contained in individual waste is identified.
  - Both unprocessed and processed wastes are appropriately stored and managed in accordance with the current regulations.
  - Regulations and standards, as well as disposal method and safety assessment method, have been in place.
- Many uncertainties poses important technical problems in the disposal of wastes from the accident at Fukushima Daiichi. Solving these uncertainties and bringing the wastes under control are the major goals of technology development.

Strategy and Roadmap

Technical Strategic Plan 2015 for Decommissioning of the Fukushima Daiichi Nuclear Power Station of Tokyo Electric Power Company（formulated April, 2015）

- To provide a firm technical basis for the government's Mid-and-Long-Term Roadmap.
- To serve as an aid for smooth and steady implementation of decommissioning.

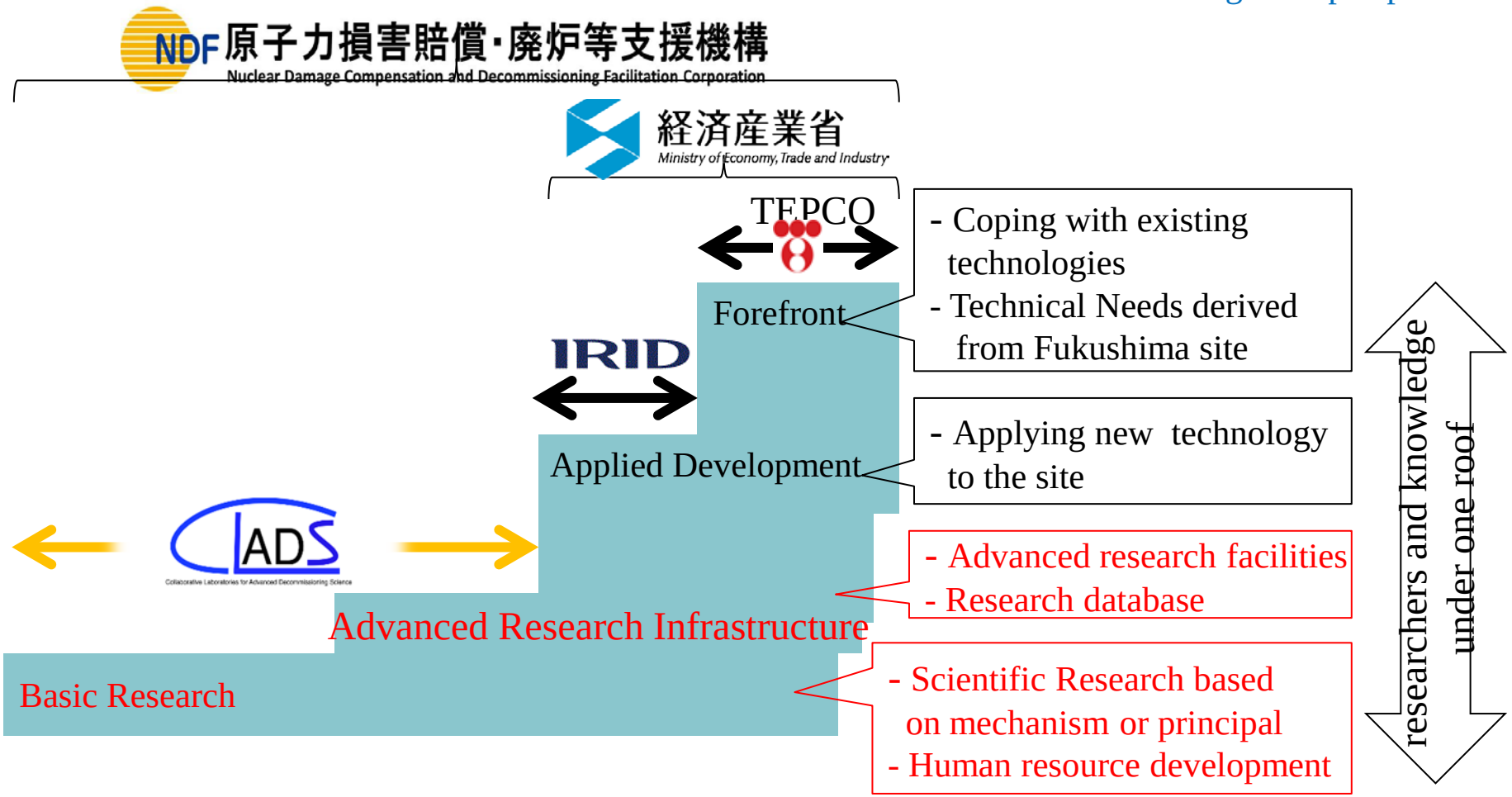
Mid-and-Long-Term Roadmap（revised June, 2015）

FY 2017
- Basic concept of processing and disposal for solid radioactive wastes.

FY 2021
- Prospects of a processing/disposal method and a technology related to its safety.

Whole Structure of R&D for Decommission of Fukushima

MEXT promotes basic research and provides advanced research infrastructures in order to
- realize technical breakthroughs with scientific knowledge based on mechanisms or principals;
- establish an under-one-roof research hub, with advanced research facilities, where industry, academia and government cooperate with each other;
- facilitate human resource development beyond the field of nuclear science in a long-term perspective



Flow Chart and Research Items on Disposal of Radioactive Waste

Characterization
- Analysis on concentrations of radioactive nuclide
- Physical properties and chemical composition

Long term storage
- Assessment of safety on long term storage
  - Safety of hydrogen gas
  - Corrosion of container
  - Stability of waste

Conditioning（processing for disposal package）
- Technical research on conditioning
- Basic test for technical assessment
  - Vitrification
  - Geopolymer solidification

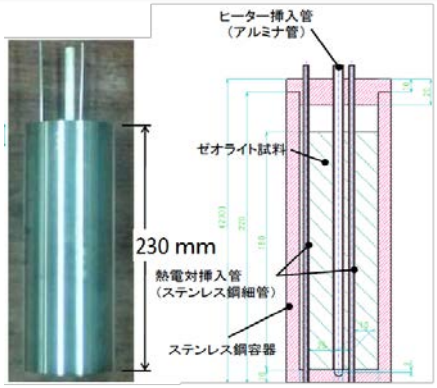
Disposal
- Investigating disposal concept
- Disposal safety assessment
  - Domestic and international research on disposal concept and safety assessment techniques, and their applicability

Analysis on radioactive nuclide in waste

JAEA staff collecting rubble near 4th reactor

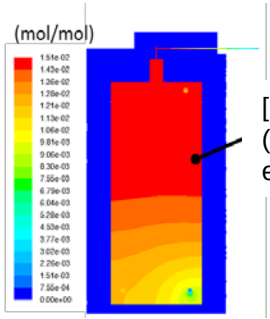
Analytical work on ^{3}H, ^{14}C

Measurement of thermal conductivity of waste



Measurement of effective thermal conductivity of zeolite layer

Hydrogen generation from the waste



$[H_2]$ ≤1.51% (less than explosive limit)

Calculated result on hydrogen concentration

Basic test for technical assessment on conditioning

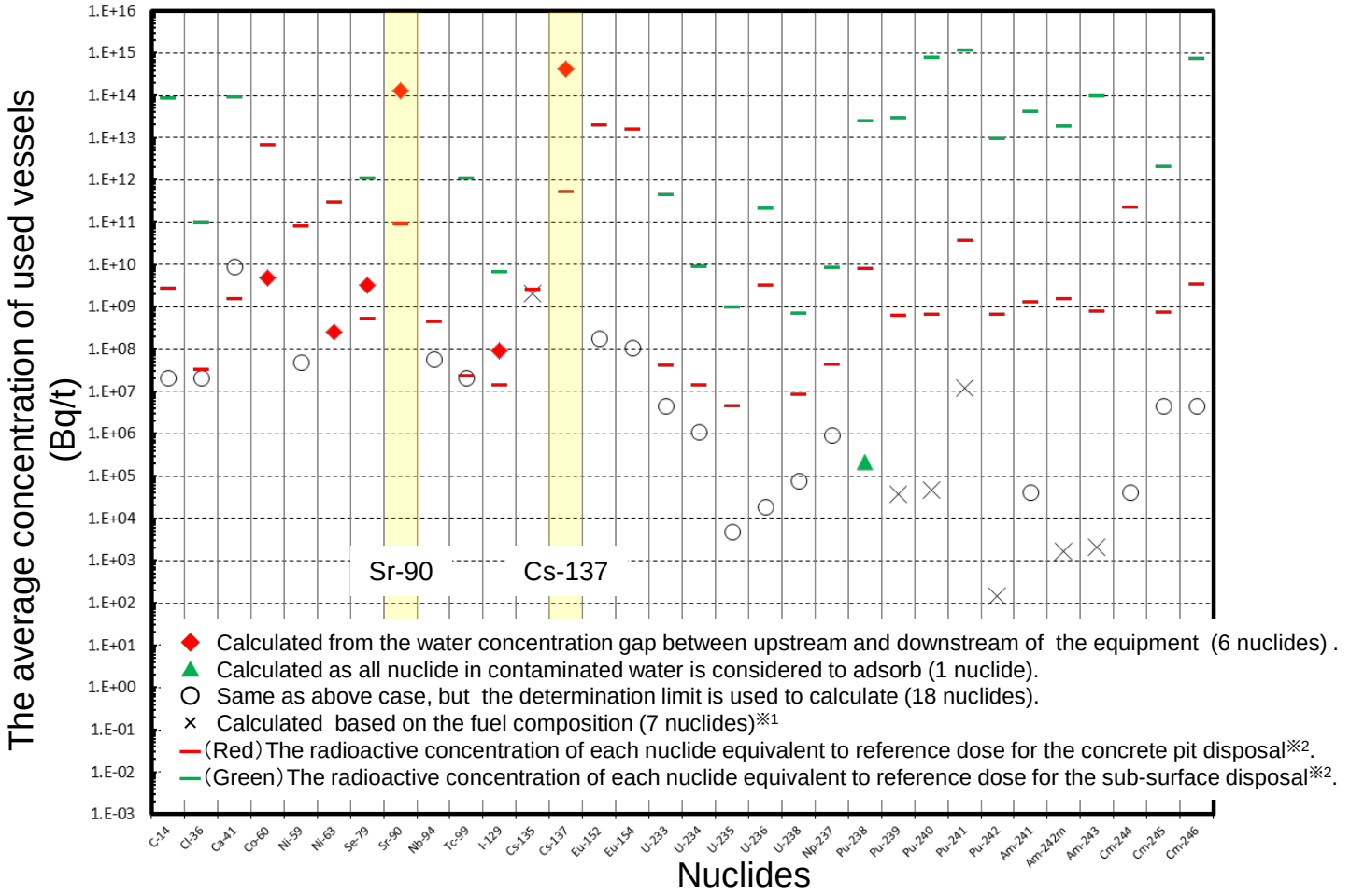
Vitrification

Geopolymer solidification

Inventory estimation based on analytical results

The inventory of a secondary waste generated from contaminated water treatment is estimated using the analytical data of the contaminated water between upstream and downstream of the equipment.

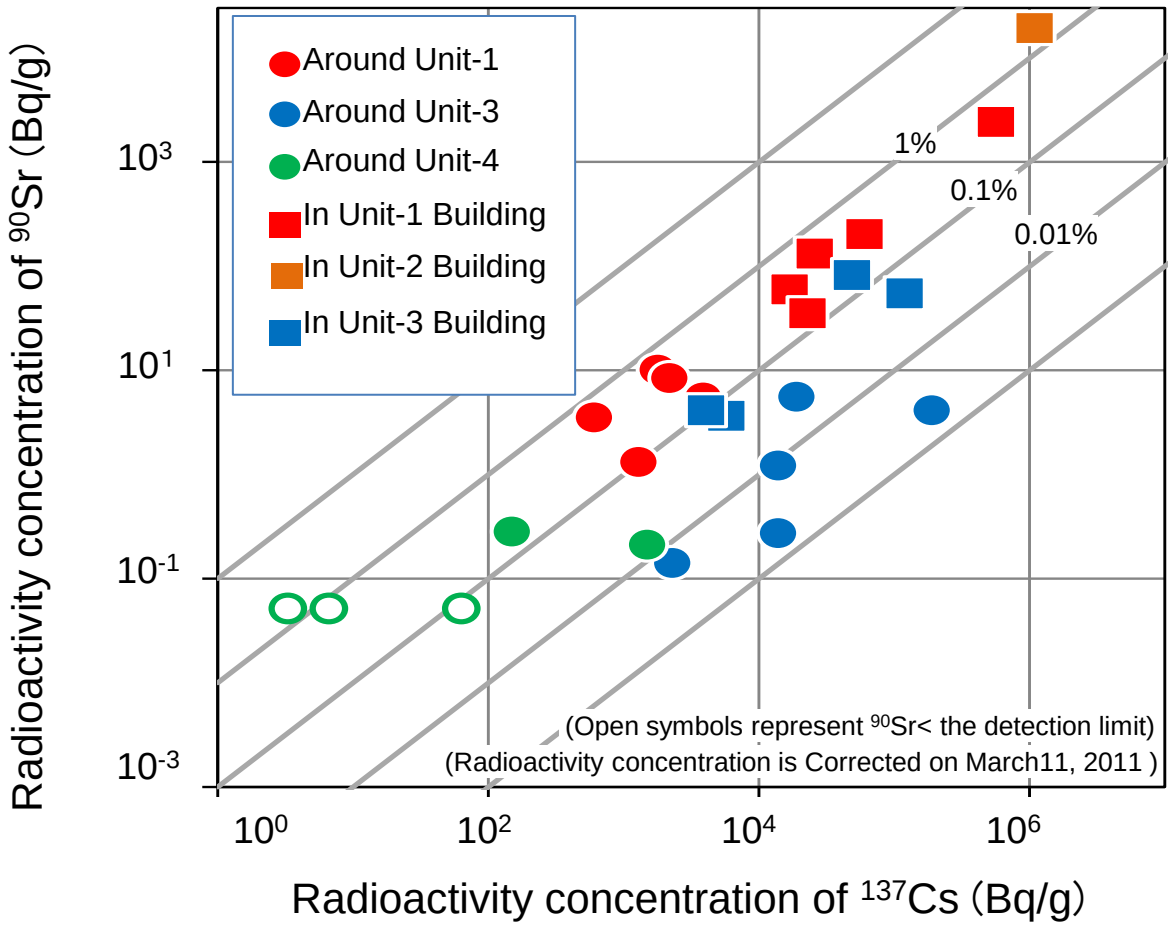
- **The inventory of the cesium adsorption vessel is estimated using analytical data of the contaminated water.**
- **The inventory of the undetected nuclide at the inlet of the equipment is calculated on the presumption that the detection limit of the nuclide is considered the upstream concentration.**
- **They can be compared with radioactive concentration of each nuclide equivalent to reference dose in an examination of the disposal concept.**



※1 The value calculated by the rate of nuclide composition in the fuel (JAEA-Data/Code 2012-018).
※2 Nuclear Safety Commission, "Upper Bounds of Radioactive Concentration in Burial of Low-Level Radioactive Solid Waste (in Japanese)", May 2007.

This figure includes the results of "Development of technology for treatment and disposal of accident waste" subsidized to JAEA and IRID by the Agency for Natural Resources and Energy.

Radioactivity of ^{137}Cs vs ^{90}Sr for rubbles at Fukushima Daiichi NPS



Radioactivity concentration for rubbles sampled around each Unit and in the building of each Unit

Correlation of Radioactivity of ^{137}Cs vs ^{90}Sr was found.

This figure includes the results of "Development of technology for treatment and disposal of accident waste" entrusted to JAEA and IRID by the Agency for Natural Resources and Energy.

International Collaboration

- Collaboration research and information exchange with international organization and research institutes in many countries

International organization and countries	Institutes
International Organization	OECD/NEA、IAEA
United States of America	DOE、NRC、ANL、INL、LANL、LBNL、ORNL
Europa	England : NNL、 France : CEA、IRSN、 Germany : KIT、 Finland : VTT、 Czech Republic : NRI/CVR、 Sweden : KTH、 Europa : ITU、 Ukraine : ISP-NPP

1st CLADS Decommissioning Workshop and Seminar
-International Collaboration towards Advanced Decommissioning of Fukushima-Daiichi NPP-

～November 10-11, 2015 at Tokai, Ibaraki～

Around 130 participants including 19 experts from abroad




Summary

- Wastes generated from nuclear facility are classified into three categories as High-level radioactive waste (HLW), Low-level radioactive waste (LLW), and WBCL (Waste below clearance level).
- LLW disposal facilities for wastes from NPS have been in operation.
- R & D on the Fukushima Daiichi radioactive wastes are intensively conducted by JAEA/CLADS under the domestic and international collaborations.