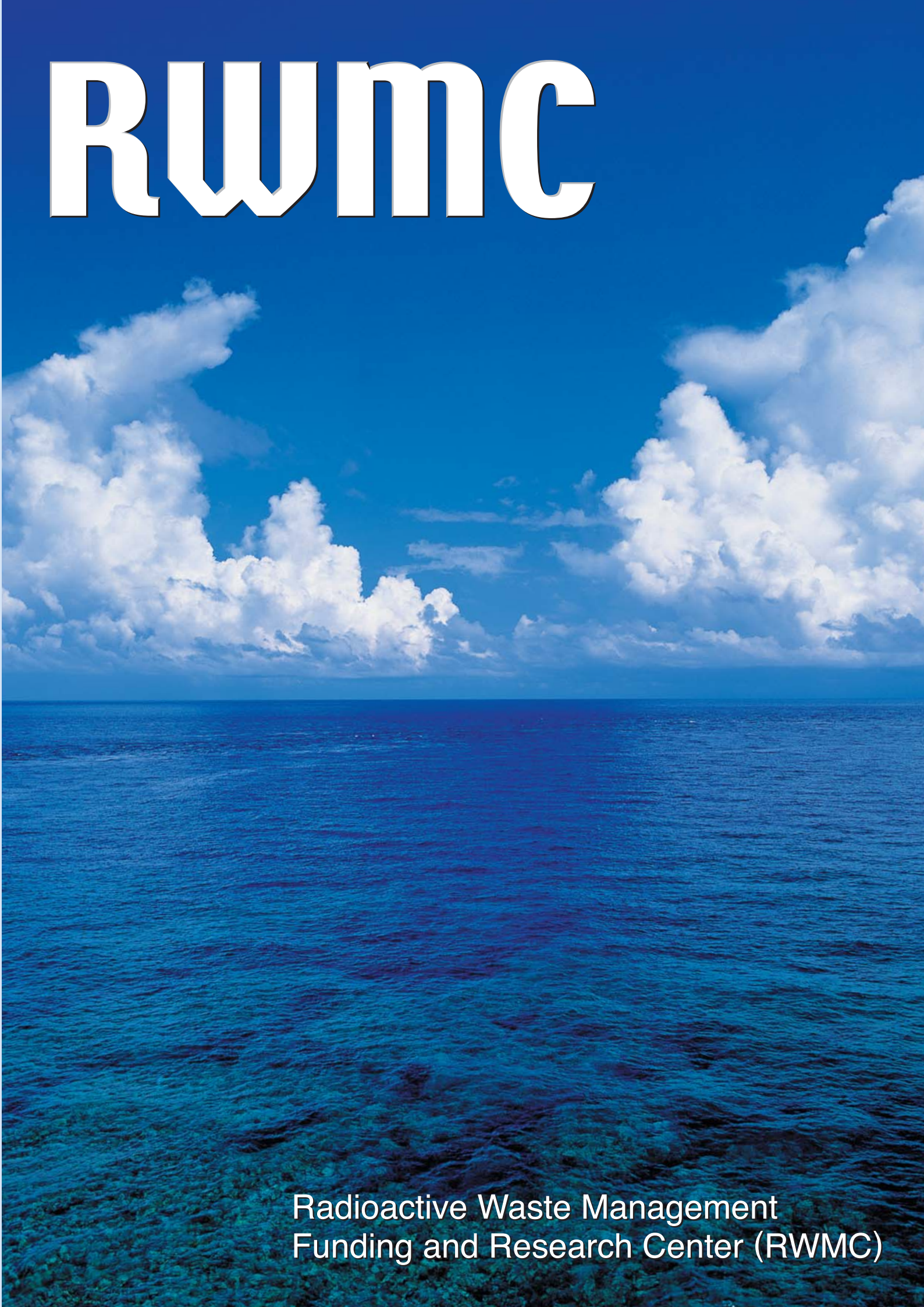
RWMC



Radioactive Waste Management
Funding and Research Center (RWMC)

Message from the President

RWMC has two pillar missions. One is research and development for safe radioactive waste management. The other is the fund administration for reliable implementation of geological disposal.

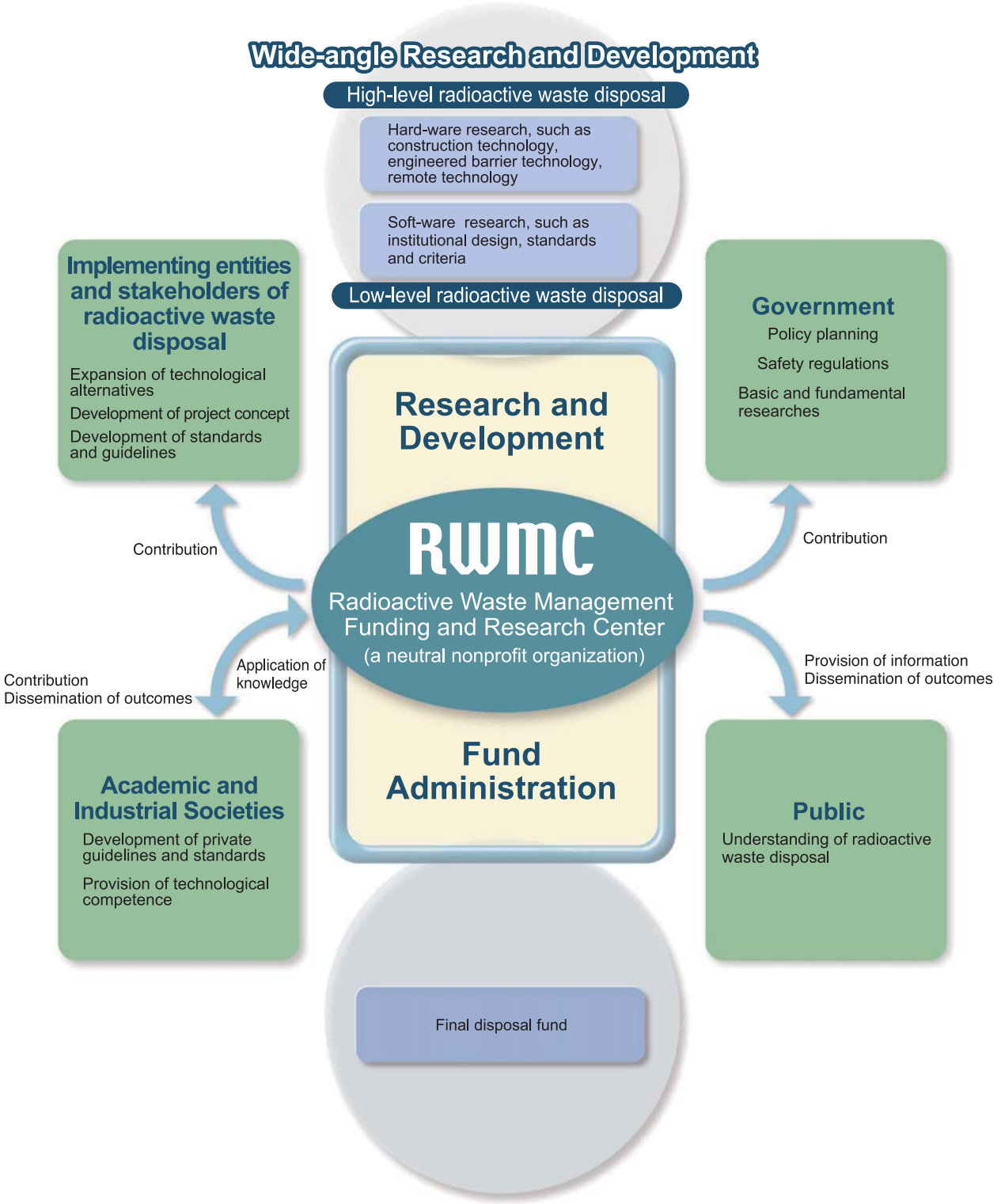
Since 1976, as a unique research organization dedicated to radioactive waste management in Japan, RWMC has been conducting a broad array of research and development by utilizing knowledge of academic and industrial sectors. Through research and development, we have been contributing to national policy planning, development of safety regulations, and expansion of technical options for the electric utilities and the disposal implementing entities.

Concerning the fund administration, as the designated organization under "the Designated Radioactive Waste Final Disposal Act", we commenced the administration of the final disposal fund for high-level radioactive waste in 2000. In addition, we also started managing the final disposal fund for TRU waste (subject to geological disposal) in 2008.

Although the environments surrounding nuclear powers are changing drastically, RWMC reaffirms the importance of our missions and will fulfill actively our missions contributing to the development of the society.

We would appreciate sincerely your further support and cooperation.

TAKETANI Noriaki
President
Radioactive Waste Management Funding and Research Center (RWMC)



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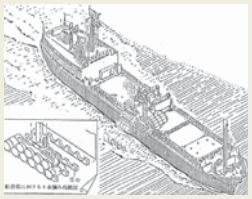
Chronology

Our progress

1970s

Oct. 1976 Radioactive Waste Management Center (RWMC) was established.
・Started study on pilot ocean dumping of low-level radioactive waste
・Started basic research on land disposal of low-level radioactive waste

1979 Started development of the receiving system of the returnable vitrified waste from the overseas reprocessing and basic research on management of high-level radioactive waste



1980s

1985 Started full research for No.1 Facility of low-level radioactive waste (solidified homogeneous waste) disposal

1987 Stared research on cost securing system for high-level radioactive waste disposal

1988 Started research on policy of uranium-bearing waste management

1990s

1990 Started full research for No.2 Facility of low-level radioactive waste (miscellaneous solid waste)disposal

1992 Started study on confirmation technology to accept the returnable vitrified wastes

Started research on TRU waste disposal
In the late 1990s, expanded research area to low-level radioactive waste with relatively high radioactivity

2000〜

2000 Started full research on high-level radioactive waste disposal

Nov.2000 Reorganized to Radioactive Waste Management Funding and Research Center (RWMC) Started the fund administration of the final disposal fund

Oct. 2005 Started the fund administration of the spent fuel reprocessing fund

Apr. 2008 Started the fund administration for final disposal of TRU waste (subject to geological disposal)

Feb. 2010 Authorized as a public interest foundation

Nov. 2016 Transferred the cash and bonds equivalent to the reserved fund for spent nuclear fuel reprocessing to Nuclear Reprocessing Organization of Japan based on “the Amendment Act to the Spent Nuclear Fuel Reprocessing Implementation Act”

Dec. 2016 Finished the fund administration of the reserve fund for spent nuclear fuel reprocessing

1984 Federation of Electric Power Companies of Japan(FEPC) offered

1985 Japan Nuclear Fuel Industries(JNFI) was established (the implementing entity of low-level radioactive waste land disposal).

Two companies combined

Japan Nuclear Fuel Ltd.(JNFL)

1992 JNFL started low-level radioactive waste disposal.

No. 1 Facility

1995 Japan Atomic Energy Research Institute (JAERI) conducted disposal of very low-level radioactive waste from dismantling of JPDR (Japan Power Demonstration Reactor).

2000 No. 2 Facility

Next Facility

2006 "Report on uranium-bearing waste disposal and clearance"

Disposal of nuclear reactor waste
(low-level radioactive waste)

Uranium-bearing waste disposal

= low-level radioactive = high-level radioactive waste = TRU waste = Government

Surrounding circumstances

Domestic

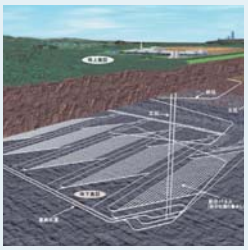
1980 Japan Nuclear Fuel Services(JNFS)was established (the implementing entity of commercial reprocessing).

d three types of nuclear fuel cycle facilities to Rokkasho Mura and Aomori Prefecture

1992 "Technical report on research and development for high-level radioactive waste disposal"

1995 First acceptance and storage of the returnable vitrified waste

1999 "Second report on geological disposal research and development" by Japan Nuclear Cycle Development Institute (JNC)



2000 Nuclear Waste Management Organization (NUMO) was established(the implementing entity of high-level radioactive waste disposal).

2002 NUMO started volunteer siting process for the Preliminary Investigation Areas.

2005 "H17: Development and Management of the Technical Knowledge Base for the Geological Disposal of HLW" (H17 Report)" by JAEA

2017 The Nationwide Map of Scientific Features for Geological Disposal

2018 "Comprehensive Technology Report (review version)" by NUMO

High-level radioactive waste disposal Geological disposal

2000 "TRU waste disposal concept study report (the first TRU report)" by JNC and FEPC

2005 "TRU waste disposal technical study report(the second TRU report)" by JAEA and FEPC

2008 NUNO was approved as the implementing entity of TRU waste disposal (for geological disposal).

TRU waste disposal Geological disposal

1976 "Provision for radioactive waste management" by Atomic Energy Commission(AEC)

1985 "Policy on radioactive waste management" by AEC

"Basic concepts of safety regulations for land disposal of solid radioactive waste" by AEC

1987 "Long-term Plan for Research, Development and Utilization of Nuclear Energy" by AEC

1994 "Long-term Plan for Research, Development and Utilization of Nuclear Energy" by AEC

2000 the Designated Radioactive Waste Final Disposal Act

"Long-term Plan for Research, Development and Utilization of Nuclear Energy" by AEC

"Basic concepts for uranium-bearing waste disposal" by AEC

2005 the Spent Nuclear Fuel Reprocessing Implementation Act

"Framework for Nuclear Energy Policy" by AEC

2006 "Japan's Nuclear Energy National Plan" by the Nuclear Energy Subcommittee of Advisory Committee on Energy and Natural Resources

2007 Amendment of the Designated Radioactive Waste Final Disposal Act

Mar. 2011 Accident in Fukushima Daiichi Nuclear Power Plant

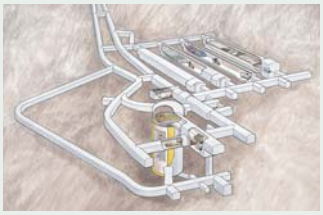
2012 Nuclear Regulation Authorithe was established

2016 the Amendment Act to the Spent Nuclear Fuel Reprocessing Implementation Act

Overseas

1959 UK started operations of low-level radioactive waste repository near Drigg.

1988 In Sweden, SKB started operations of low-level radioactive waste repository (SFR) in Forsmark.



1992 In Finland, TVO started operations of low and intermediate level radioactive waste repository (VLJ) in Olkiluoto.

1999 USA started operations of TRU waste repository (WIPP).

2001 Finnish Government decided high-level radioactive waste disposal site in Olkiluoto.

2002 In USA, high-level radioactive waste disposal site (Yucca Mountain) was selected by a resolution of repository siting approval of the Congress, and the resolution thereafter became law (The plan was withdrawn in 2009 to consider alternatives for managing the back end of the nuclear fuel cycle.).

2009 In Sweden, SKB selected high-level radioactive waste disposal site in Forsmark.

2011 SKB submitted the applications to construct high-level radioactive waste repository in Forsmark.

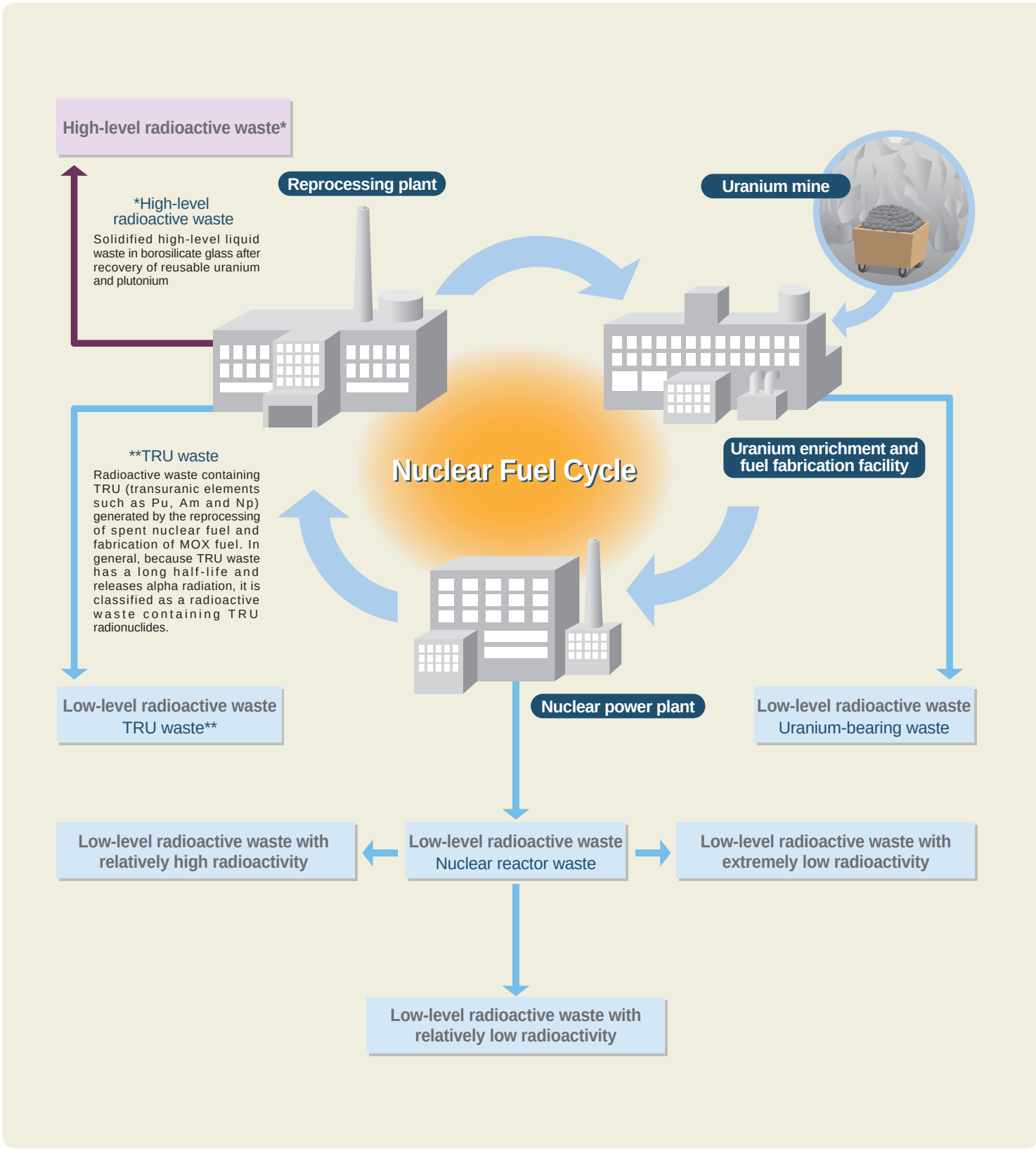
2012 Posiva Oy submitted the application to construct high-level radioactive waste repository in Olkiluoto.

2015 Finnish government issued construction permission for high-level radioactive waste repository in Olkiluoto.

2016 Posiva Oy began to construct high-level radioactive waste repository in Olkiluoto.

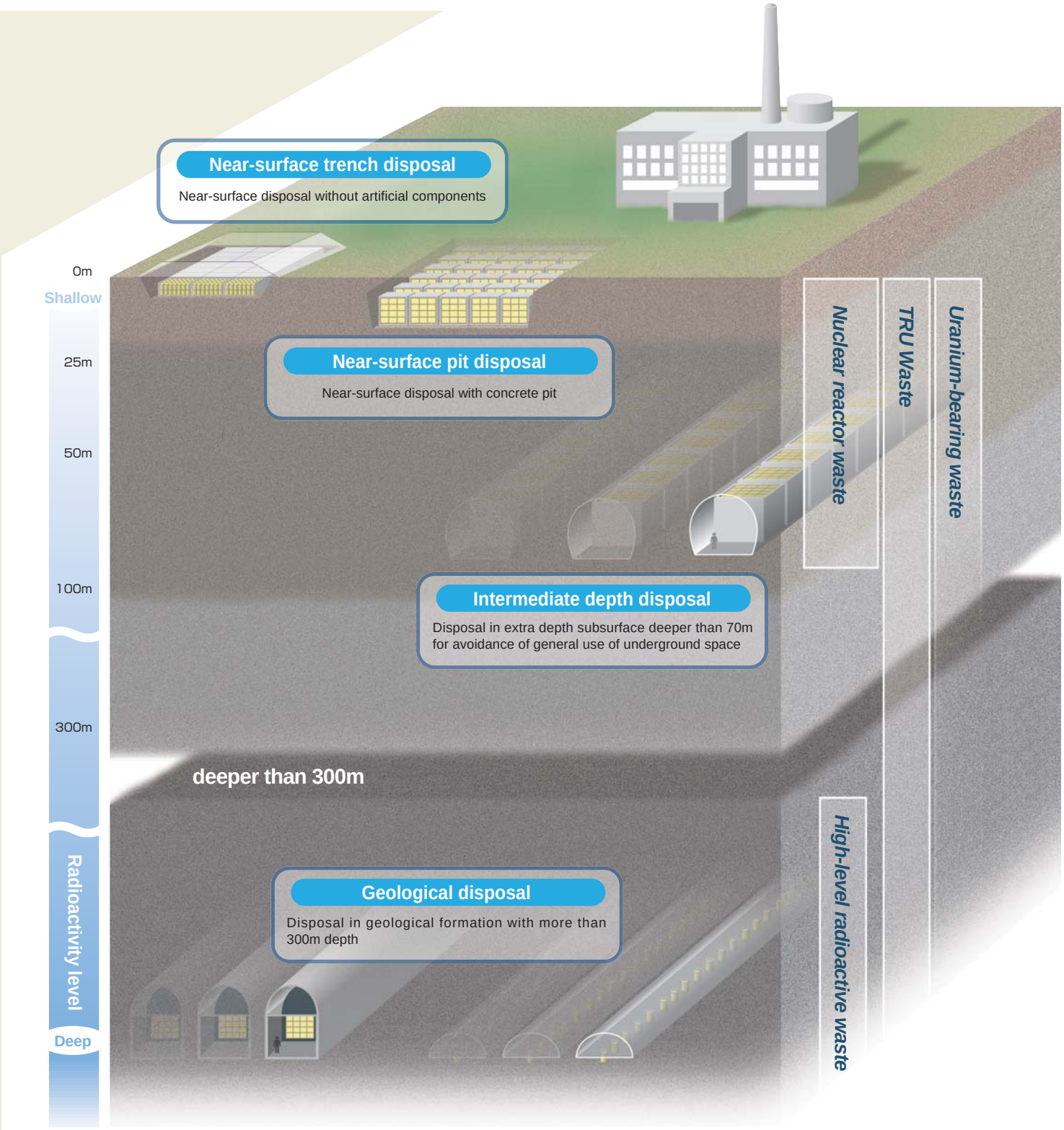
Generation of Radioactive Waste

In the nuclear fuel cycle, uranium and plutonium are recovered from nuclear fuels (reprocessing) used in nuclear reactors (spent fuels) for reuse as fuels. The various wastes generated in the nuclear fuel cycle are categorized by type and concentration of radionuclide and by place of generation.

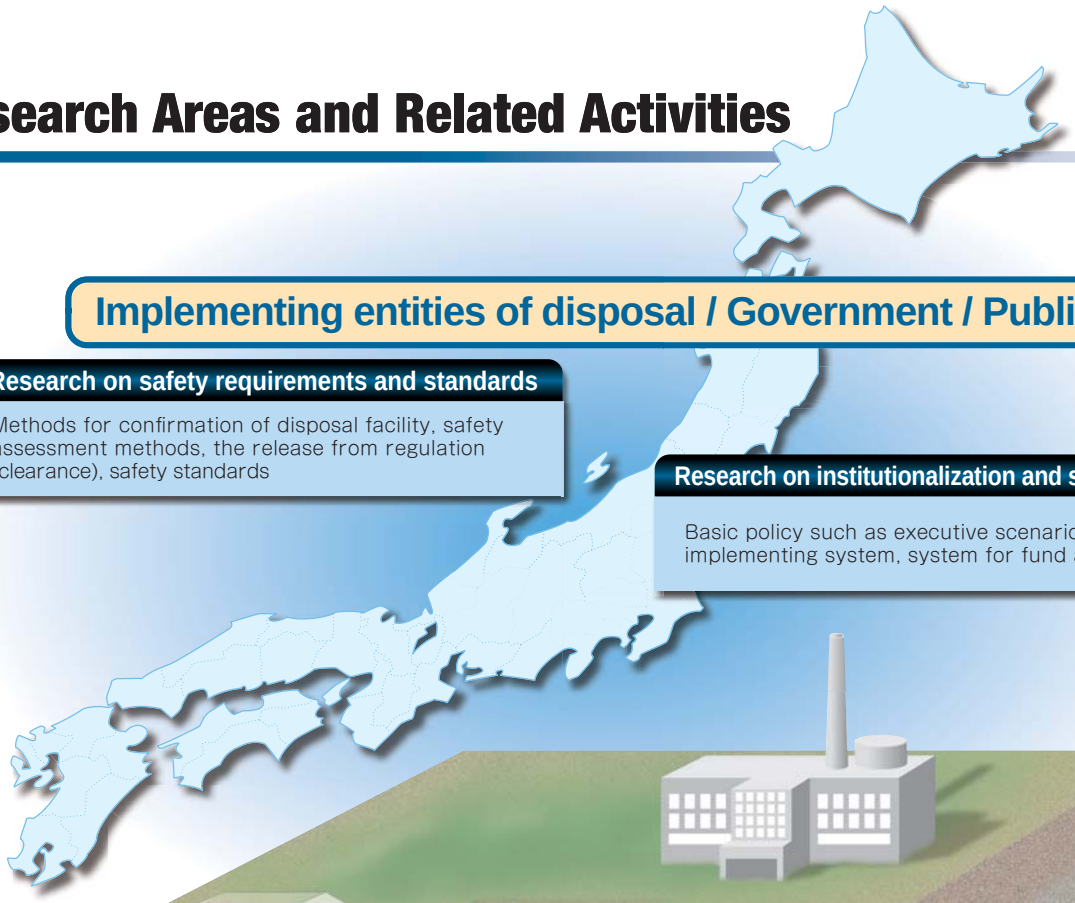


Concept of Disposal

Radioactive wastes are classified by radionuclide content and concentration, and by originating facility.
Radioactive waste disposal is conducted safely and rationally according to this classification. Disposal concepts are classified into the following types by disposal depth and the artificial barrier (engineered barrier) enclosing the wastes and according to the characteristics of the wastes.



Research Areas and Related Activities



Implementing entities of disposal / Government / Public

Research on safety requirements and standards

Methods for confirmation of disposal facility, safety assessment methods, the release from regulation (clearance), safety standards

Research on institutionalization and social response

Basic policy such as executive scenarios, project implementing system, system for fund administration

Research and development on disposal technology

Construction technology, remote technology, waste package, waste solidification technology and long-term behavior of engineered barriers

Information services

Collection, analysis and provision of domestic and international information

Promotion of understanding to radioactive waste disposal

Publishing brochures, preparation and exhibition of full-scale demonstrating facility of geological disposal

International cooperation

Information exchange and collaborative research with overseas research institutions and implementing entitites

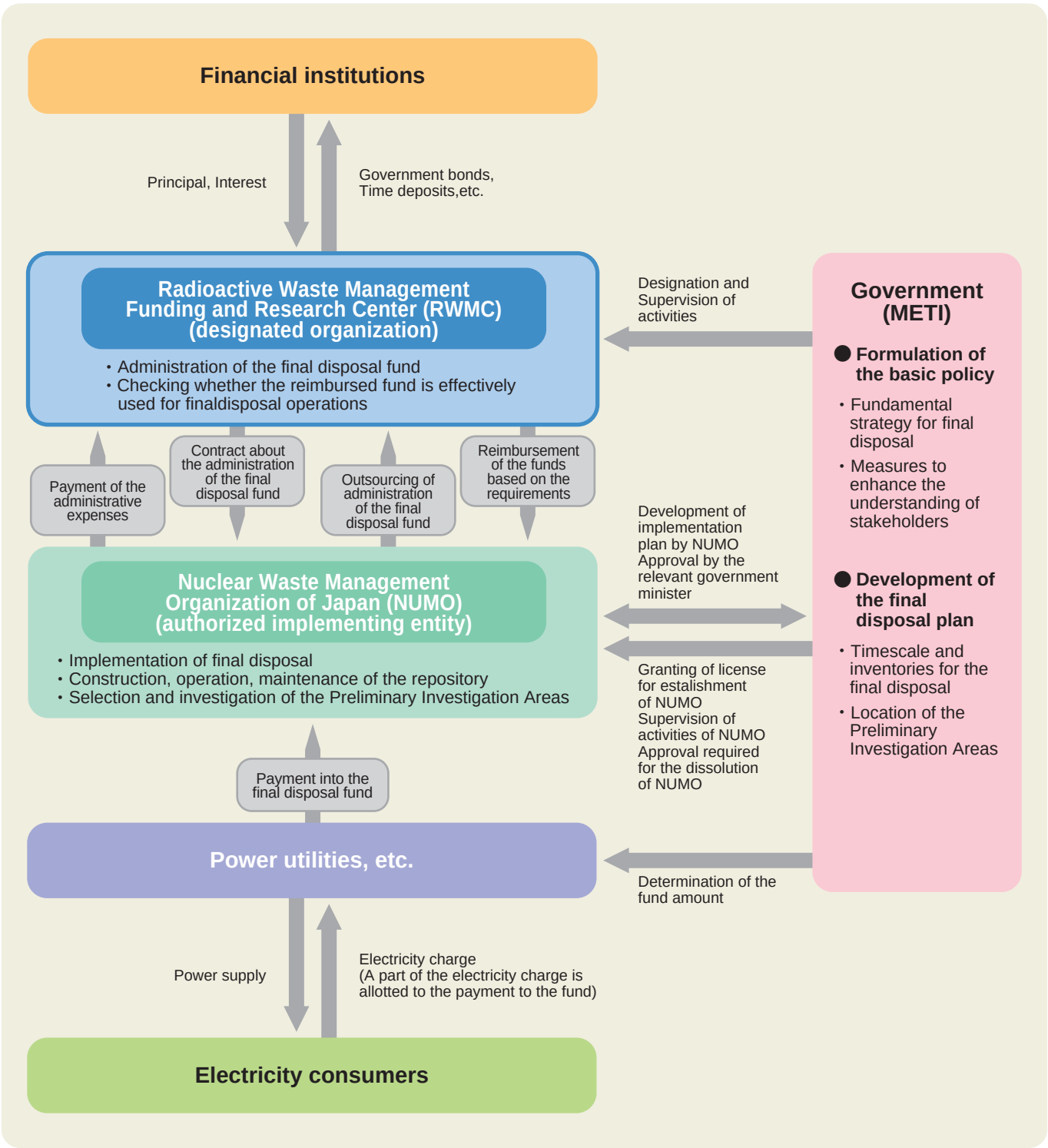
Dissemination of outcomes

Publishing and informing through the website

Fund Administration

In June, 2000, “the Designated Radioactive Waste Final Disposal Act” that prescribes designation of an organization to manage the final disposal fund was enacted, and in November, RWMC was designated as the organization by METI. Following the designation, RWMC newly established “the fund administration division” and started to manage the fund related to high-level radioactive waste accumulated by Nuclear Waste Management Organization of Japan (NUMO). Along with this, we established “Rules of information disclosure on the fund administration” and “Rules of ethics on the fund administration” to disclose appropriate information and maintain ethics of the related officers and employees. Furthermore, in April, 2008, RWMC also started to manage the final disposal funds related to TRU waste subject to geological disposal.

Basic schematic diagram regarding the final disposal fund administration



Research and Development on High-level Radioactive Waste and TRU waste

RWMC started research and development (R&D) on high-level radioactive waste(HLW) in development of a receiving system for returning HLW from the overseas reprocessing and feasibility study on management of HLW. Following these projects, we conducted research on long-term stability of geological structure necessary for geological disposal, study on operating system of geological disposal. In addition, we have been developing and providing appropriate technical information for national policy planning, as well as safety standards and regulation for HLW disposal.
After "the Designated Radioactive Waste Final Disposal Act" was enacted in 2000, Nuclear Waste Management Organization of Japan (NUMO), geological disposal implementing entity, was established to start siting process of geological repository. In response to this movement, RWMC has been conducting R&D on technologies necessary for the implementation of geological disposal project such as the design, construction and quality control of engineered barriers and other underground components, operation of the repository, retrieval after waste package emplacement by proceeding with basic tests, development of elemental technologies, engineering verification at actual scales, and development of analysis technologies.
In addition, RWMC has been conducting fundamental research on important basic technologies with universities.
Regarding TRU waste, "the Designated Radioactive Waste Final Disposal Act" was amended to designate NUMO as an implementing entity of TRU waste disposal in 2007. RWMC also has been conducting R&D on conditioning and disposal concepts, disposal technologies, and study on basic phenomenon for performance assessment for TRU waste disposal.
Together with these research projects, we also have been conducting projects to promote understanding of geological disposal.

●indicates the ongoing projects

1 R&D on Engineering Technologies for HLW Disposal

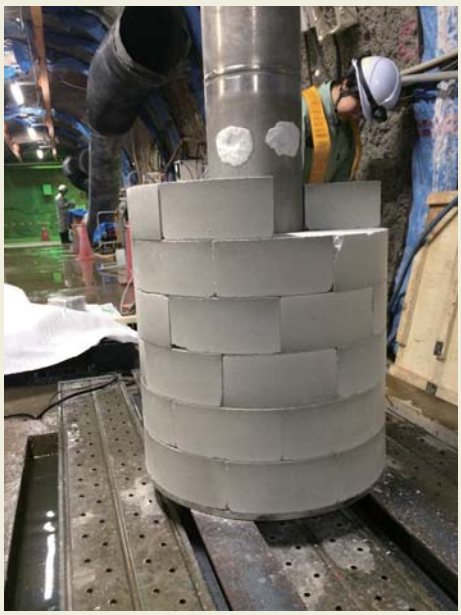
- Remote welding technology of overpack lid closure and non-destructive inspection technology for overpack lid closure welds
- Manufacturing and emplacement technology of buffer materials
- Structural integrity and corrosion characteristics of overpack closure welds

● **Study on re-saturation process of buffer materials**

● **Study on quality assurance and performance confirmation technology applied for disposal facility and development of monitoring equipments**

● **Development of technologies for retrievability**

● **Study on technical feasibility of disposal facility on the coastal area**



Specimen for bentonite erosion test of buffer material at the underground research laboratory (URL)

State of the specimen after bentonite erosion test at the URL

From “Development of verified engineering technology for geological disposal”

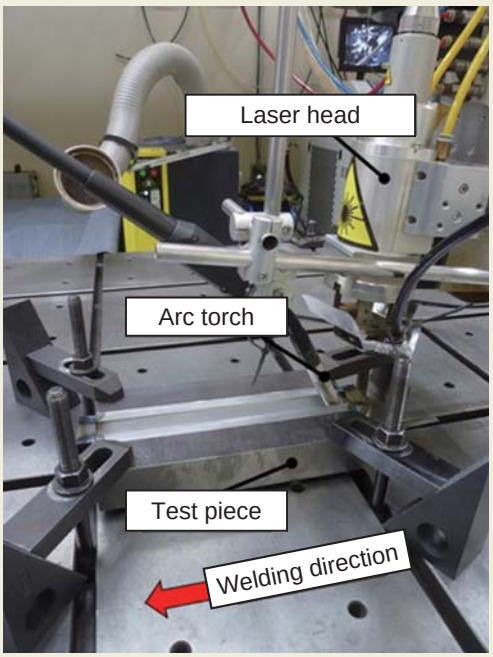
Demonstration equipment of emplacement and retrieval

Backfilling test by spraying method

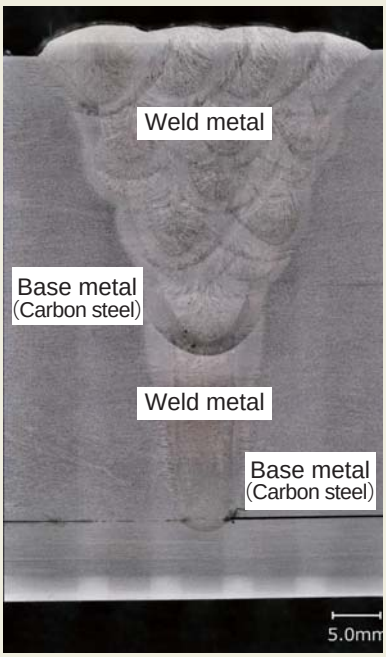
From “Research and development of advanced technology for reversibility and retrievability”

2 R&D on Engineering Technologies for TRU Waste Disposal

- **Development of waste package with containment ability for the duration of several hundred years**
- **Study on gas migration behavior considering long-term alteration of cementitious and bentonitic materials**
- **Development of immobilization technique for anion nuclides (especially I-129) which has important effect in sefety assessment**
- **Study on release behavior of anionic nuclides (especially C-14) from activated metal waste**
- **Study on natural analogues of bentonitic materials**



Test equipment of laser-arc hybrid welding for waste package



Cross section of test piece welded by laser-arc hybrid welding

From “Advanced technology development for geological disposal of TRU waste”

Research and Development on High-level Radioactive Waste and TRU waste

3 Research on Criteria and Standards

- Classification of TRU waste and safety assessment method
- Scenario in TRU waste disposal
- **Safety standards for geological disposal**

4 Promotion of Understanding for Disposal Technology

- Publishing brochures for public relation
- **Open operation of the actual scale test facility to provide realizing, feeling and understanding disposal concept, engineering feasibility and long-term behavior of geological disposal**

Explanation of engineered barrier system using the full- scale equipments and real material

Open test of buffer material handling

Experimental test of swelling behavior of buffer material

Introduction of buffer material removal technology related to retrievability

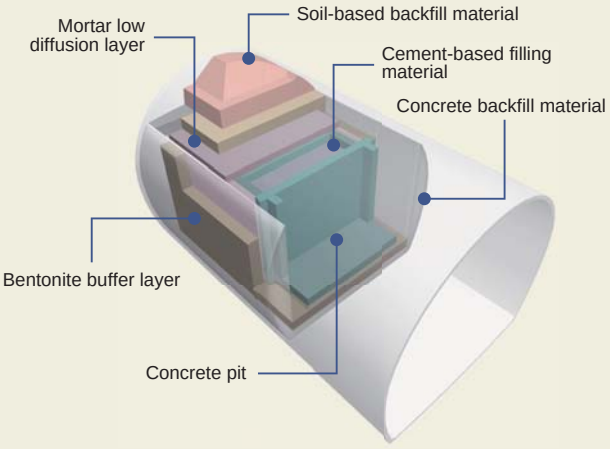
Research and Development on Low-level Radioactive Waste

Japan Nuclear Fuel Co., Ltd. Has been conducting disposal projects of low-level radioactive waste (LLW) from nuclear power plants in Rokkasho-mura, Aomori Prefecture since 1992. Prior to the implementation of these waste disposal projects, RWMC conducted research and development (R&D) on waste conditioning technologies, waste packaging standards for disposal, waste inspection and confirmation technology, research on safety assessment. Currently, RWMC is conducting research on conditioning and disposal systems and technical standards for the disposal with focus on spent control rods and LLW with relatively high radioactivity generated from decommissioning of nuclear power plants.

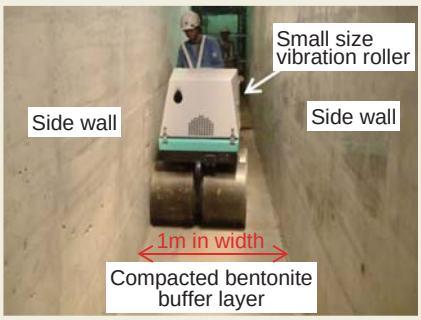
●indicates the ongoing projects

① R&D on Engineering Technologies for LLW Disposal

・Verification of construction and closing technologies for underground cavern disposal facility



Conceptual illustration of a cavern disposal facility

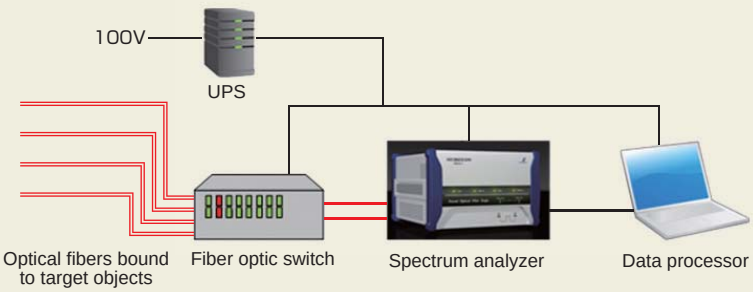


Construction test of compacted bentonite buffer layer in a narrow space

Backfilling test with sprayed soil-based backfill material

From “Performance verification test for underground cavern disposal facility”, “Verification test of closure technology for a cavern disposal facility”

● Development of monitoring strategy and technology for underground cavern disposal facility



System of distributed optical fiber sensing

Strain measurement of upper mortar low diffusion layer

From “Function confirmation test for underground cavern disposal facility”

② Study on Criteria and Standards

- **Study on standardization of safety assessment for low-level radioactive waste disposal**
- **Study on standardization of production and inspection method for solidified waste**

Information Services in Radioactive Waste Management Fields

◆ Survey of Radioactive Waste Management Issues

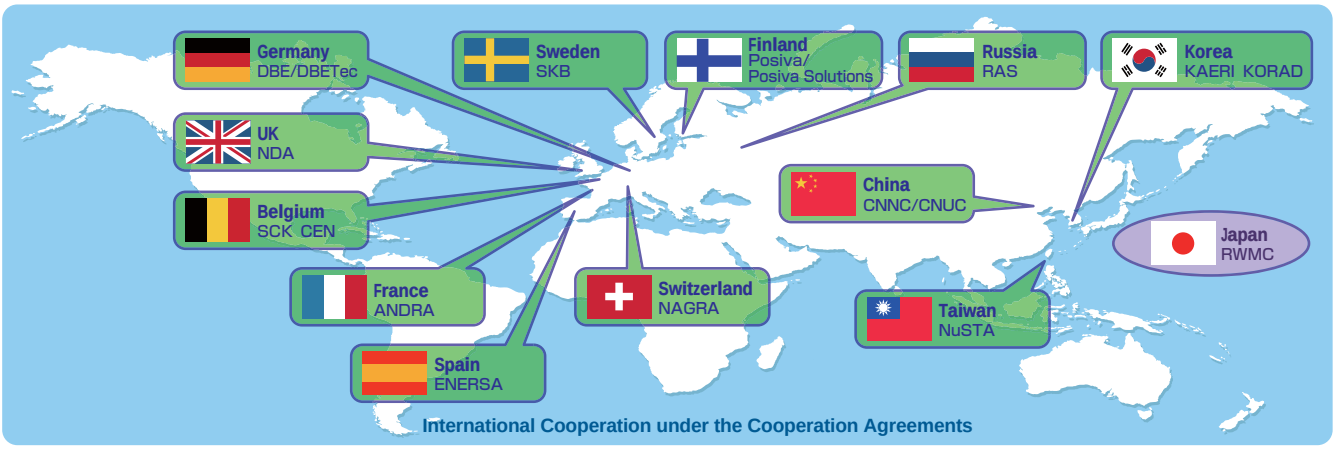
○With the purpose of supporting national policy planning and evaluation, RWMC continuously collects and analyzes information on radioactive waste disposal programs, site selection, repository concepts, research and development in foreign countries and provides this information by establishing a broad data base to the Atomic Energy Commission, the Agency for Natural Resources and Energy and other stakeholders.

○For the purpose of supporting safety regulation concerning radioactive waste disposal, we collect and analyze information related to legislation, safety regulation and their background in foreign countries, and provide the outcomes to the Nuclear Regulatory Authority.

◆ International Cooperation

1 Cooperation Agreements

Based on cooperation agreements with implementing entities and research organizations of various countries, RWMC exchanges information on legal frameworks, safety regulations and standards and statuses of disposal projects, and conducts collaborative research with those international partners.



International Cooperation under the Cooperation Agreements

2 International Collaboration

RWMC participates in the following international research projects to promote cooperation in research and obtain new research information.

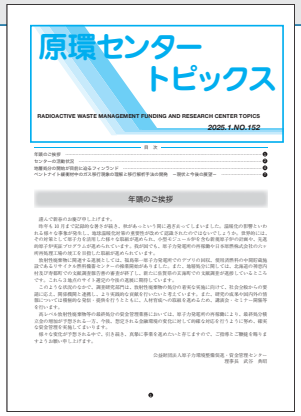
- Steering committee of Grimsel Test Site(GTS) operated by NAGARA
- Joint work with IAEA on functional extension of Nuclear Fuel Cycle System Simulation Code
- OECD/NEA Horonobe International Project (HIP)

◆ Dissemination of Outcomes

○RWMC publishes research outcomes in presentations at academic conferences and scientific papers at academic journals.

○RWMC provides information from our research through periodic newsletters (the RWMC Topics), the Annual Technical Report and its website.

○RWMC provides technical information through the Annual Workshop and lecture meetings.



◆ Human Resource Development

RWMC regularly organizes seminars by academic experts for mid-level engineers and researchers to help them understand advanced knowledge of radioactive waste disposal.

Radioactive Waste Management Funding and Research Center (RWMC)

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