Classification of Waste

Non-radioactive Waste	Domestic Waste	Garbage	Household garbage: General garbage (combustible/non-combustible), large items
			Commercial garbage: Waste from offices, restaurants, etc.
		Raw sewage	
		Specially controlled domestic waste *1	
	Industrial Waste	Of the waste generated in commercial activities, 20 types of waste stipulated by law *2	
		Specially controlled industrial waste *3	
Radioactive Waste	Low-level Radioactive Waste	Power plant waste	Waste having an extremely low radioactive level
			Waste having a relatively low radioactive level
			Waste having a relatively high radioactive level
		Uranium waste	
		Transuranic (TRU) radioactive waste	
	High-level Radioactive Waste		

*1 : Explosive, toxic, infectious and any other waste that is likely to result in damage to human health or the living environment.

*2 : Cinders, sludge, waste oil, scrap metal, glass & concrete waste, etc.

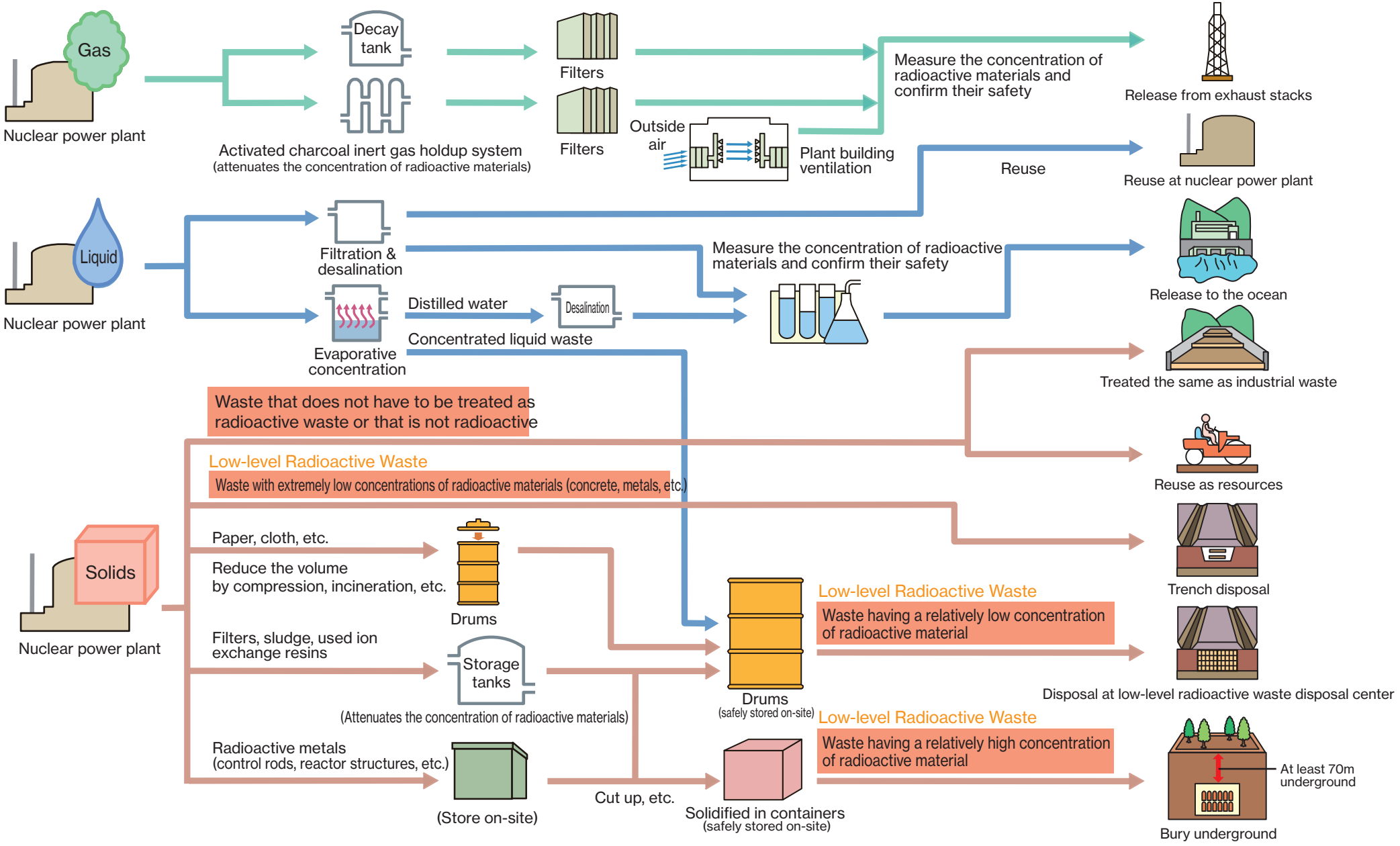
*3 : Excluding domestic waste, explosive, toxic, infectious and any other waste that is likely to result in damage to human health or the living environment.

Quantity of Waste Generated in Japan

	Amount of Waste Generated (tons/day)		Notes
Domestic Waste	Mainly kitchen waste generated in the home, but also large items, and waste such as paper generated from offices	117,057	Data from 2017
Industrial Waste	Of the waste generated in commercial activities, includes waste plastics, acids and alkalis, etc.	1,060,274	Data from 2016
Radioactive Waste	Radioactive waste generated in the operation and maintenance of nuclear power facilities.	High Level 1.4	Estimates for 2000 to 2006
		Low Level 44	Data from 2017

Sources: Ministry of Environment, The Status of Discharge and Processing of Domestic Waste (2017 Data) (Mar. 2019), The Status of Discharge and Processing of Industrial Waste (2016 Data) (Jan. 2019), Nuclear Regulatory Agency, The Status as of 2017 of Managing Radiation Dosages of Workers at Commercial Power Reactor Facilities, Research and Development Stage Power Reactor Facilities, Processing Facilities, Reprocessing Facilities, and Nuclear Waste Disposal Facilities and the Status of Managing Radioactive Waste Materials at Waste Disposal Facilities, (Oct.

Methods for Treating Nuclear Power Waste



Source: The Federation of Electric Power Companies of Japan, Radioactive Waste Q&A

Types of Radioactive Waste

Waste Type			Example of Waste	Where Generated	Treatment Method
Low-level Radioactive Waste	Power plant waste	Waste having an **extremely low** radioactive level	Concrete, metal, etc.	Nuclear power plant	Trench disposal
		Waste having a **relatively low** radioactive level	Solidified liquid waste, filters, used tools, materials and consumables		Pit disposal
		Waste having a **relatively high** radioactive level	Control rods, reactor structures, etc.		Medium depth disposal
	Uranium waste		Consumables, sludge, used tools and materials	Uranium enrichment and fuel fabrication plant	Medium depth disposal, pit or trench disposal; in some cases, deep geological disposal
	Transuranic (TRU) radioactive waste		Parts of fuel rods, liquid waste, filters	Reprocessing facilities, MOX fuel fabrication facilities	Geological, Medium depth disposal or pit disposal
High-level Radioactive Waste			Vitrified waste	Reprocessing plant	Geological disposal

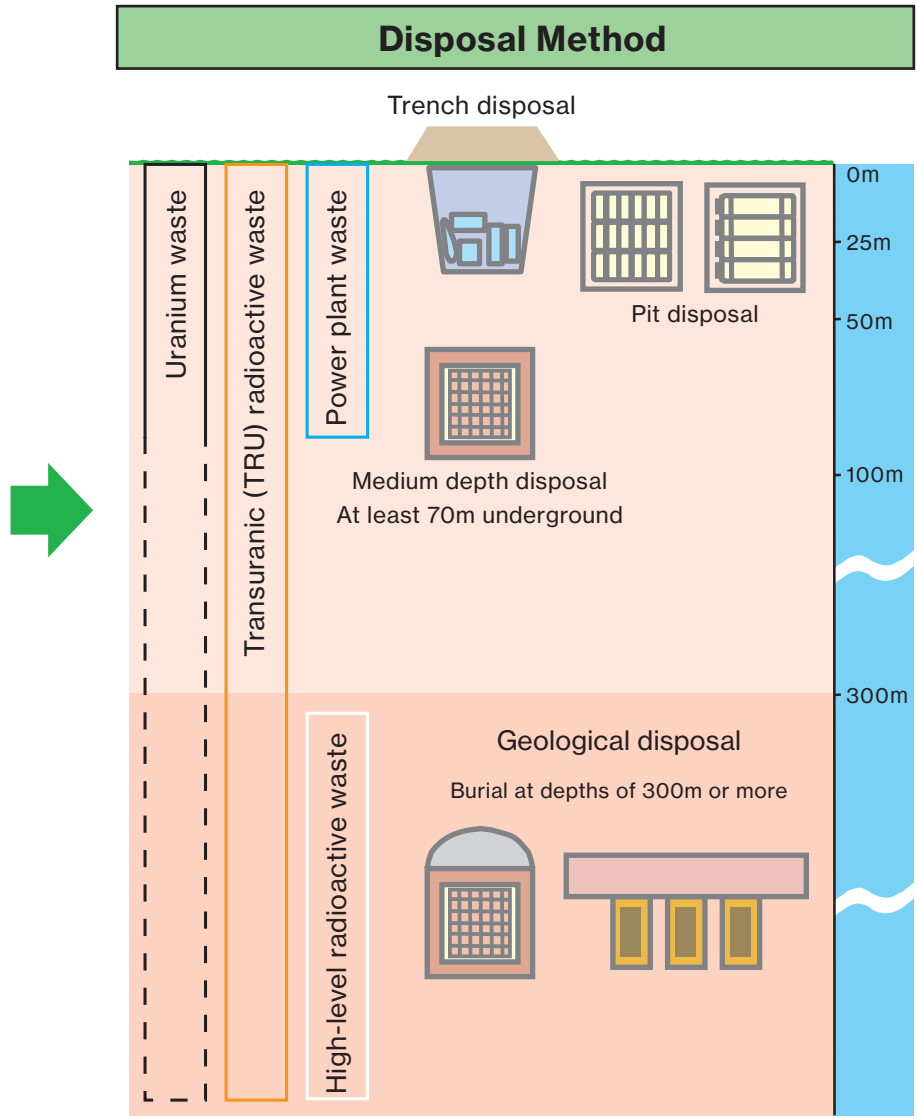
Waste below clearance level	Most of the waste from demolition of nuclear power plant	All power plants indicated above	Reuse or dispose of as general garbage

Source: Agency for Natural Resources and Energy homepage

Radioactive Waste Types and Disposal

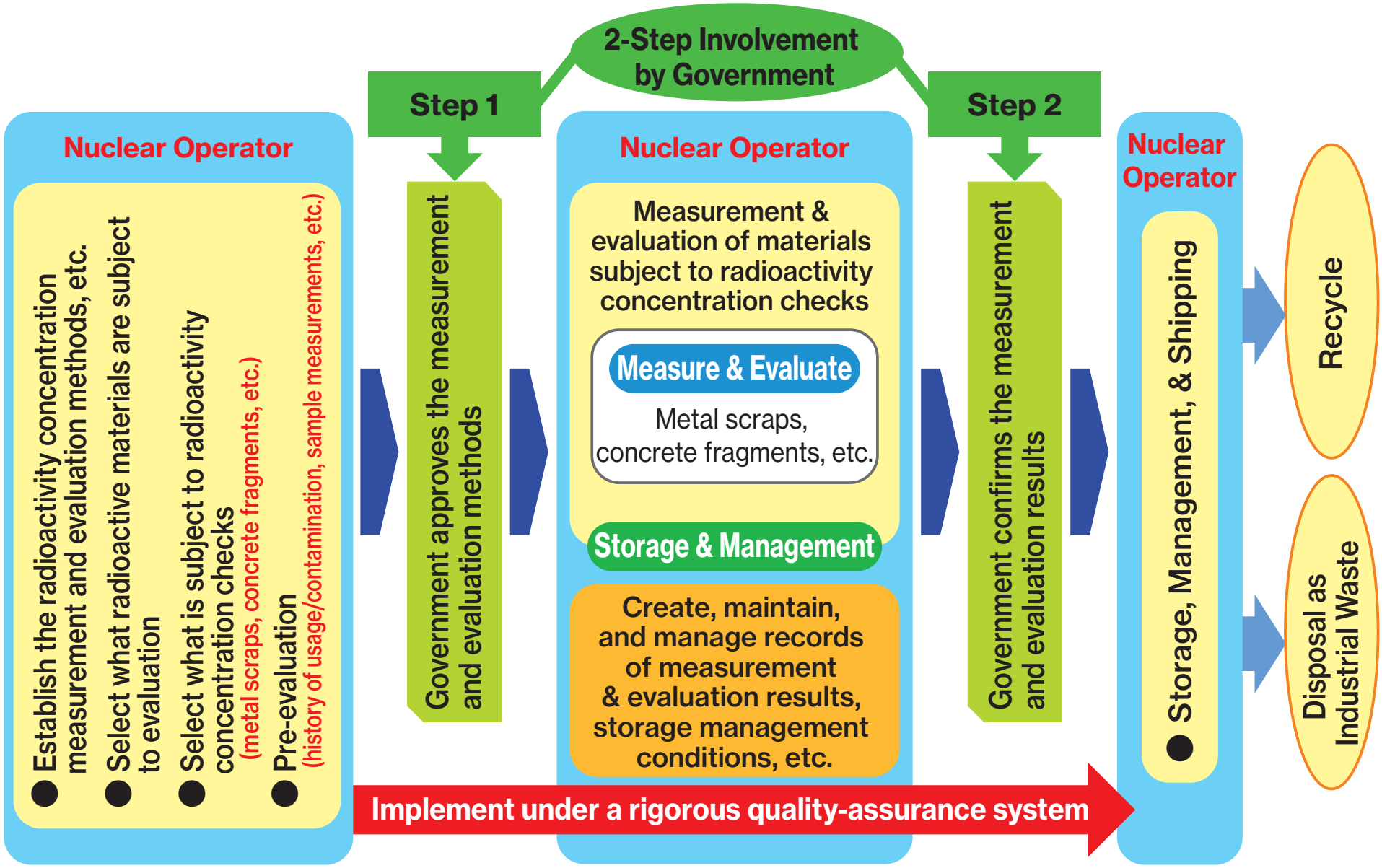
The depths and barriers are selected based on the radioactivity level, and the disposal of radioactive waste is performed using divided trench and pit disposal, medium depth disposal, and geological disposal.

Source	Waste Types		
Nuclear power plant	Low-level radioactive waste	Power plant waste	Waste having an extremely low radioactive level
			Waste having a relatively low radioactive level
			Waste having a relatively high radioactive level
Uranium enrichment and fuel fabrication plant		Uranium waste	
MOX fuel fabrication plant		Transuranic (TRU) radioactive waste	
Reprocessing plant			
	High-level radioactive waste		



Source: Agency for Natural Resources and Energy homepage

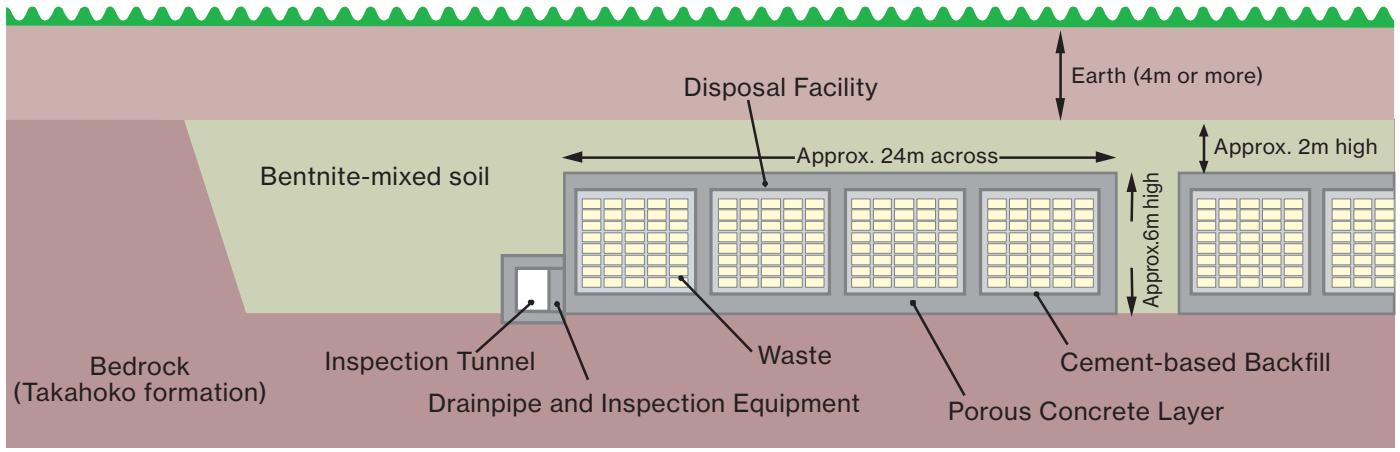
Overview of the Clearance System



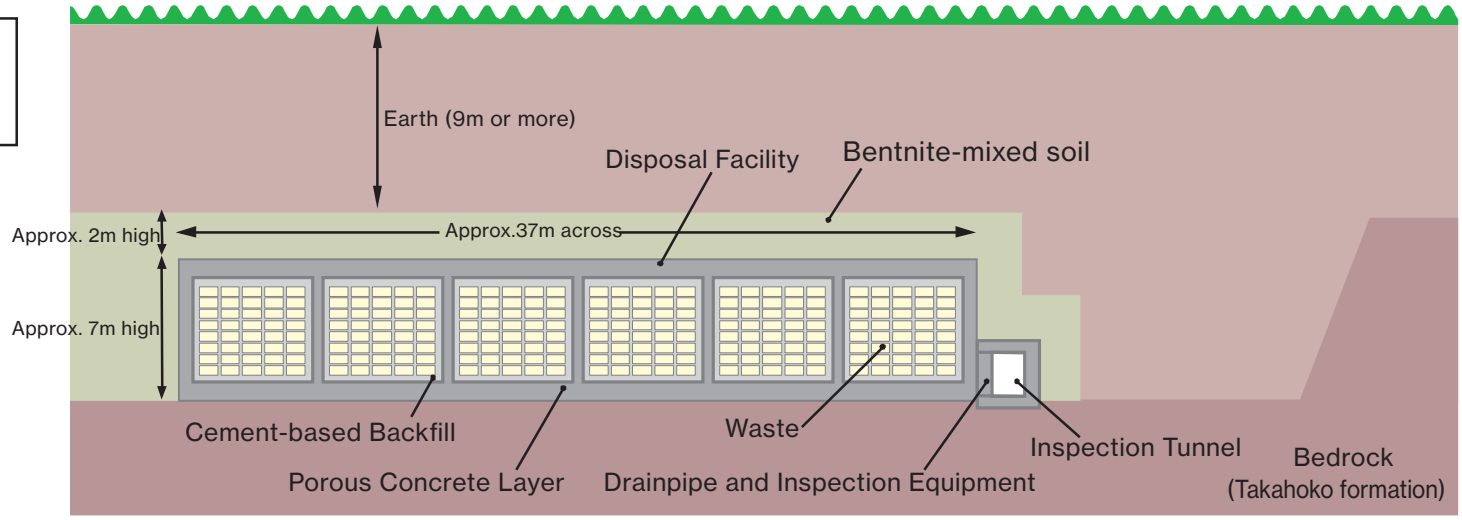
Source: Nuclear Regulation Authority homepage

Structure of Low-level Radioactive Waste Disposal Facility

Structure of No.1 Disposal Facility



Structure of No.2 Disposal Facility



Source: Japan Nuclear Fuel Ltd.

Stages in the Management of Low-level Radioactive Waste After Underground Storage

<table>
<tr><th></th><th>Stage 1</th><th>Stage 2</th><th>Stage 3</th></tr>
<tr><td>Scheduled End Time</td><td>After Underground Storage Starts
Unit 1: 30 to 35 years
Unit 2: 25 to 30 years</td><td>30 Years after Stage 1 Ends</td><td>300 Years after Stage 1 Ends</td></tr>
<tr><td>Concept</td><td>Contain in an Underground Facility</td><td>Suppress Migration
by Underground Facility
and Surrounding Soil</td><td>Mainly Suppress Migration
by the Surrounding Soil</td></tr>
<tr><td rowspan="3">Description of Management</td><td colspan="3">•Establish a disposal conservation area, patrol the waste disposal site, reclaim the soil
•Environmental monitoring</td></tr>
<tr><td colspan="2">•Establish a peripheral monitoring area
•Monitor the concentration of radioactive materials in groundwater
•Provide drainage via drainage and monitoring equipment</td><td>•Restrict excavation, drilling, etc.</td></tr>
<tr><td>•Ensure that there is no leakage
•Maintain buried equipment</td><td>•Monitor the status of leaking</td><td></td></tr>
</table>

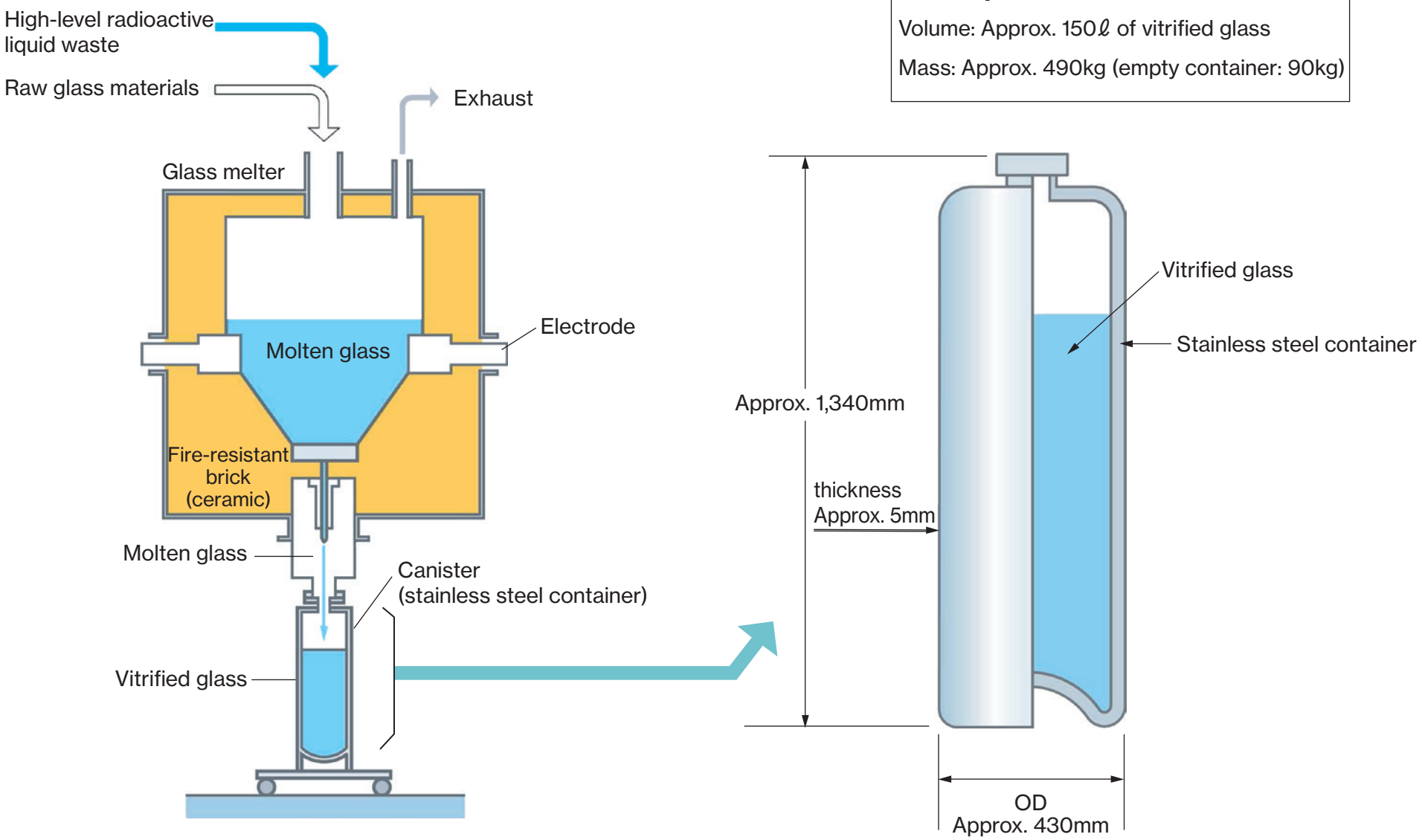
Source: Japan Nuclear Fuel Ltd. pamphlet

How Vitirified Waste is Created

Properties of Vitrified Glass

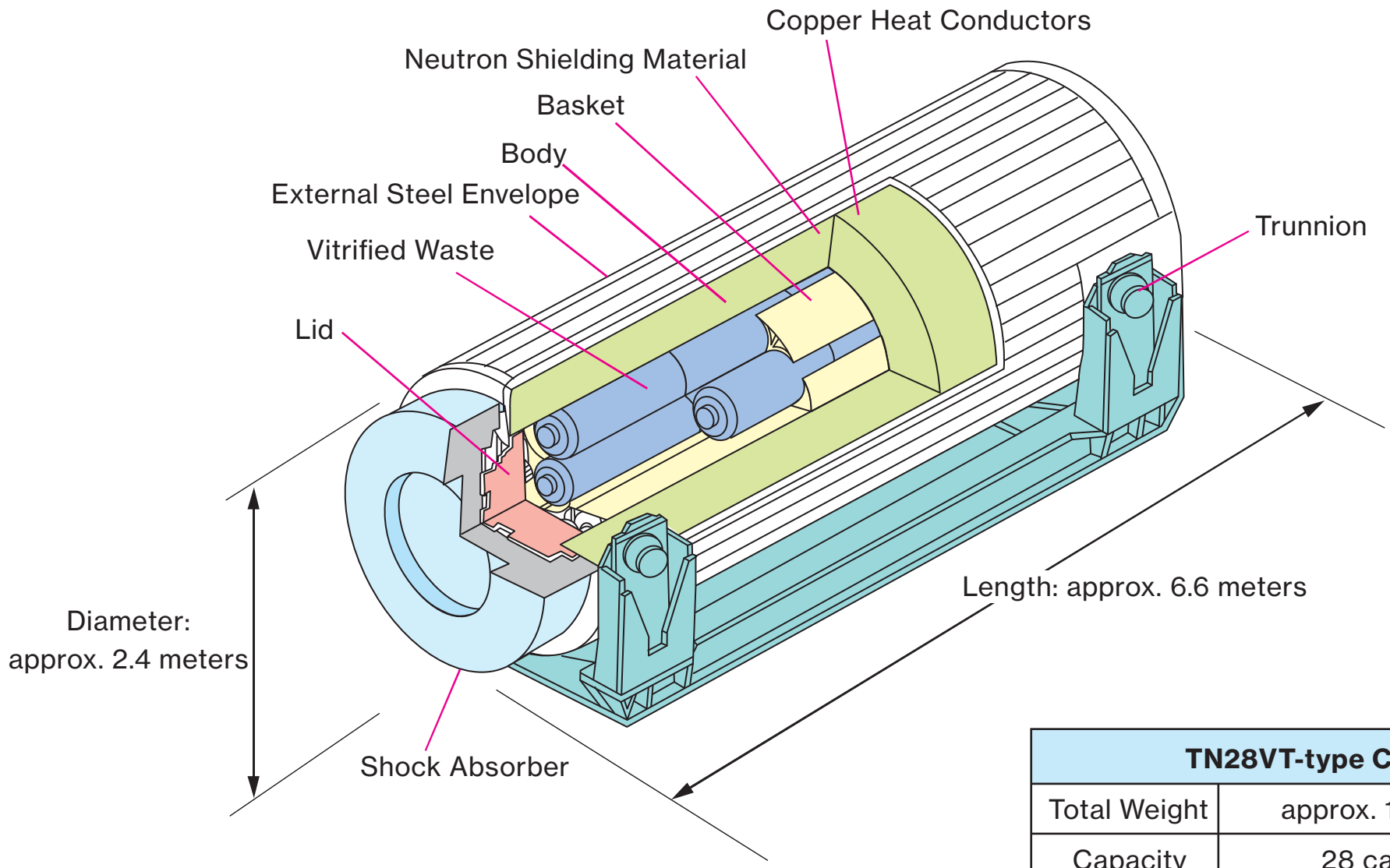
Volume: Approx. 150ℓ of vitrified glass

Mass: Approx. 490kg (empty container: 90kg)



Source: Japan Nuclear Fuel Ltd. pamphlet

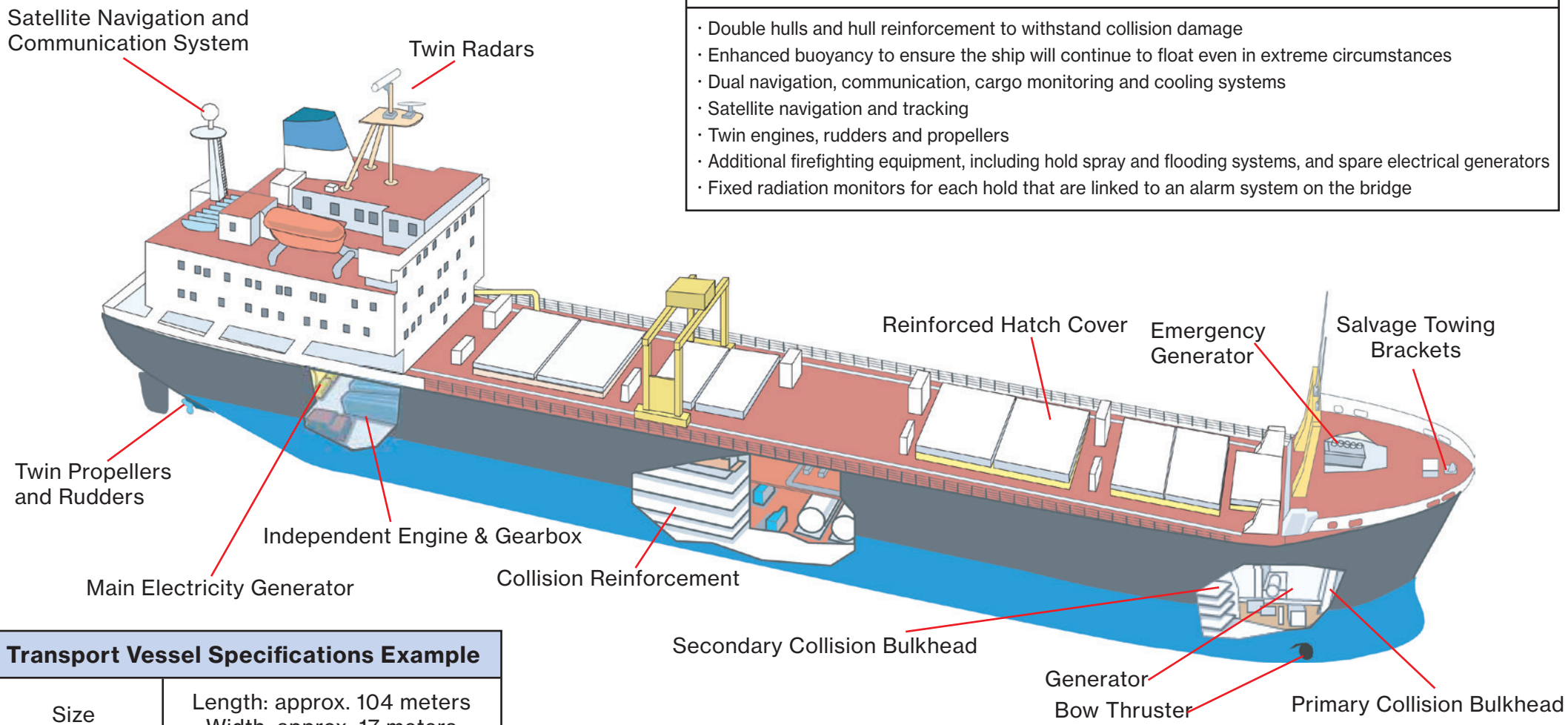
Transport Casks for High-level Radioactive Waste (Vitrified Waste) Shipment Container



TN28VT-type Cask	
Total Weight	approx. 113.5 tons
Capacity	28 canisters

Transport Vessels for High-level Radioactive Waste (Vitrified Waste)

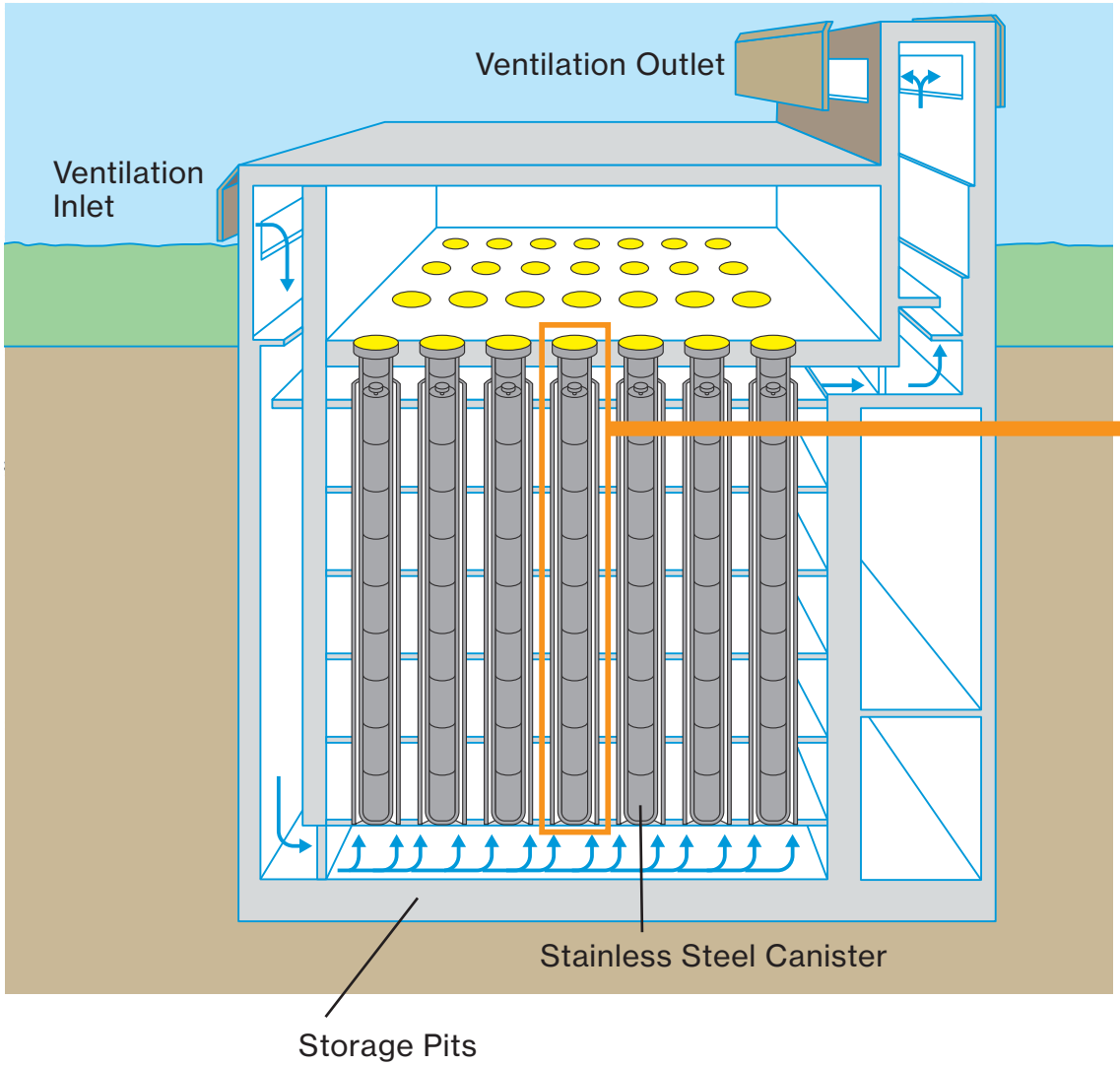
Safety Features of Transport Vessels for HLW (vitrified waste)
· Double hulls and hull reinforcement to withstand collision damage · Enhanced buoyancy to ensure the ship will continue to float even in extreme circumstances · Dual navigation, communication, cargo monitoring and cooling systems · Satellite navigation and tracking · Twin engines, rudders and propellers · Additional firefighting equipment, including hold spray and flooding systems, and spare electrical generators · Fixed radiation monitors for each hold that are linked to an alarm system on the bridge



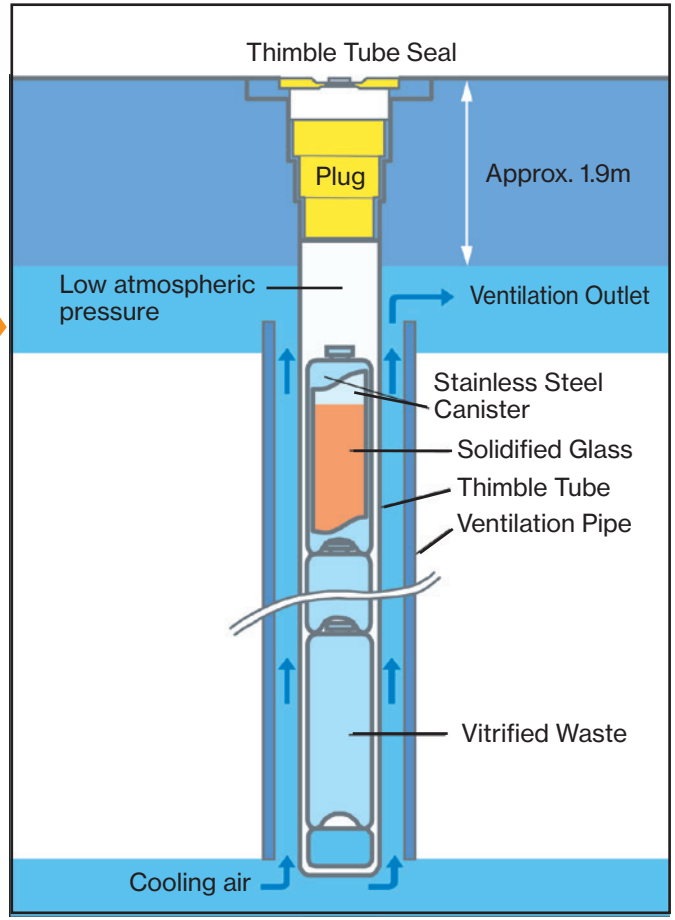
Transport Vessel Specifications Example	
Size	Length: approx. 104 meters Width: approx. 17 meters
Gross Tonnage	approx. 5,000 tons
Deadweight	approx. 3,500 tons

Source: The Federation of Electric Power Companies of Japan pamphlet

Temporary Storage for High-level Radioactive Waste (Vitrified Waste)



Enlarged image of storage pits



Source: Japan Nuclear Fuel Ltd. pamphlet

Record of Return and Acceptance of High-Level Radioactive Waste (Vitrified)

(As of Feb. 2018)

Returned Shipment Count	Name of Transport Ship	Transport Containers	Route	Qty of Returned Vitrified Canisters	Origin	Destination	Receipt Complete
1st	Pacific Pintail	1	Via S. America/Cape Horn	28	France, Cherbourg Harbor 2/23/1995	Mutsu-Ogawara Port 4/26/1995	October 12, 1995
2nd	Pacific Teal	2	Via Cape of Good Hope/SW Pacific	40	France, Cherbourg Harbor 1/13/1997	Mutsu-Ogawara Port 3/18/1997	July 29, 1997
3rd	Pacific Swan	3	Via Panama Canal	60	France, Cherbourg Harbor 1/21/1998	Mutsu-Ogawara Port 3/13/1998	September 15, 1998
4th	Pacific Swan	2	Via Panama Canal	40	France, Cherbourg Harbor 2/25/1999	Mutsu-Ogawara Port 4/15/1999	July 26, 1999
5th	Pacific Swan	4	Via Panama Canal	104	France, Cherbourg Harbor 12/29/1999	Mutsu-Ogawara Port 2/23/2000	August 21, 2000
6th	Pacific Swan	8	Via S. America/Cape Horn	192	France, Cherbourg Harbor 12/19/2000	Mutsu-Ogawara Port 2/20/2001	May 17, 2002
7th	Pacific Sandpiper	6	Via Panama Canal	152	France, Cherbourg Harbor 12/5/2001	Mutsu-Ogawara Port 1/22/2002	June 11, 2003
8th	Pacific Swan	6	Via Panama Canal	144	France, Cherbourg Harbor 6/4/2003	Mutsu-Ogawara Port 7/23/2003	June 2, 2004
9th	Pacific Sandpiper	5	Via Panama Canal	132	France, Cherbourg Harbor 1/19/2004	Mutsu-Ogawara Port 3/4/2004	July 20, 2005
10th	Pacific Sandpiper	5	Via Cape of Good Hope/SW Pacific	124	France, Cherbourg Harbor 2/17/2005	Mutsu-Ogawara Port 4/20/2005	April 26, 2006
11th	Pacific Sandpiper	7	Via Panama Canal	164	France, Cherbourg Harbor 2/1/2006	Mutsu-Ogawara Port 3/23/2006	April 10, 2007
12th	Pacific Sandpiper	6	Via Panama Canal	130	France, Cherbourg Harbor 2/8/2007	Mutsu-Ogawara Port 3/27/2007	August 31, 2007
13th	Pacific Sandpiper	1	Via Panama Canal	28	UK Barrow Harbor 1/21/2010	Mutsu-Ogawara Port 3/9/2010	June 4, 2010
14th	Pacific Glebe	3	Via Panama Canal	76	UK Barrow Harbor 8/3/2011	Mutsu-Ogawara Port 9/15/2011	August 31, 2012
15th	Pacific Glebe	1	Via Panama Canal	28	UK Barrow Harbor 1/9/2013	Mutsu-Ogawara Port 2/27/2013	April 9, 2013
16th	Pacific Glebe	5	Via Cape of Good Hope/SW Pacific	132	UK Barrow Harbor 2/14/2014	Mutsu-Ogawara Port 4/22/2014	January 29, 2015
17th	Pacific Glebe	5	Via Panama Canal	124	UK Barrow Harbor 7/28/2015	Mutsu-Ogawara Port 9/16/2015	March 27, 2016
18th	Pacific Glebe	5	Via Panama Canal	132	UK Barrow Harbor 9/1/2016	Mutsu-Ogawara Port 10/20/2016	March 10, 2017

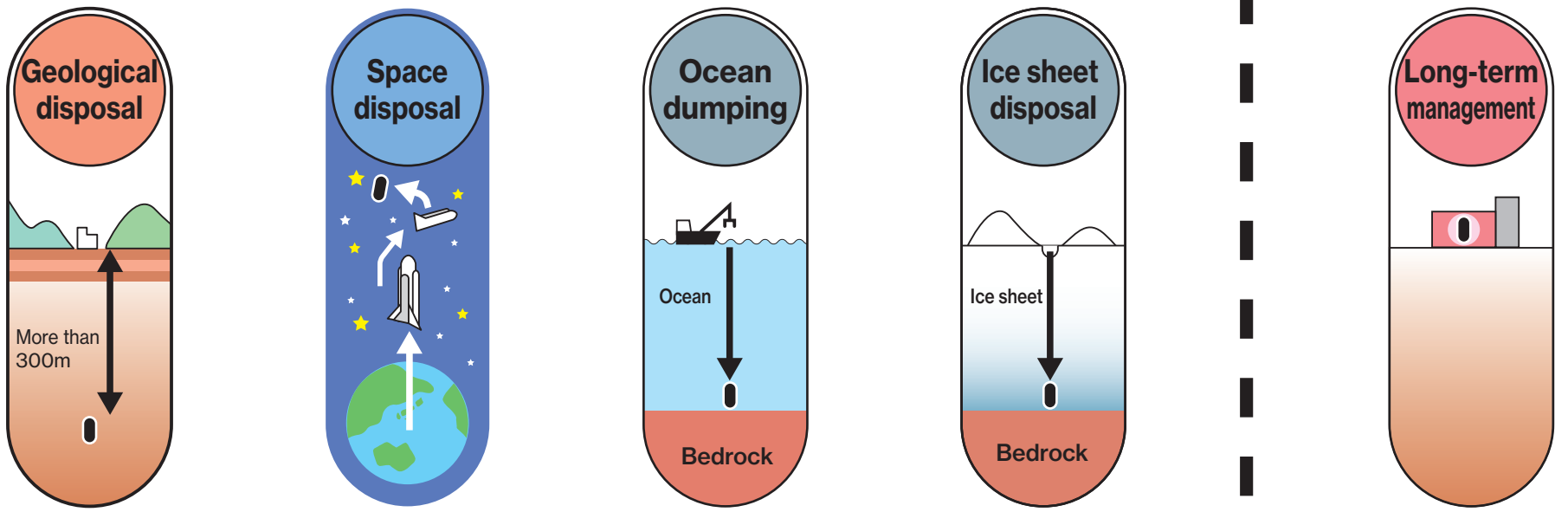
Total Received: 1,830

Source: Japan Nuclear Fuel (Ltd.) homepage

Examination of Methods for Disposing of High-Level Radioactive Waste

Given the difficulties of people managing wastes into perpetuity and not burdening future generations with monitoring them, methods have been examined that would allow safe disposal without the need for human management.

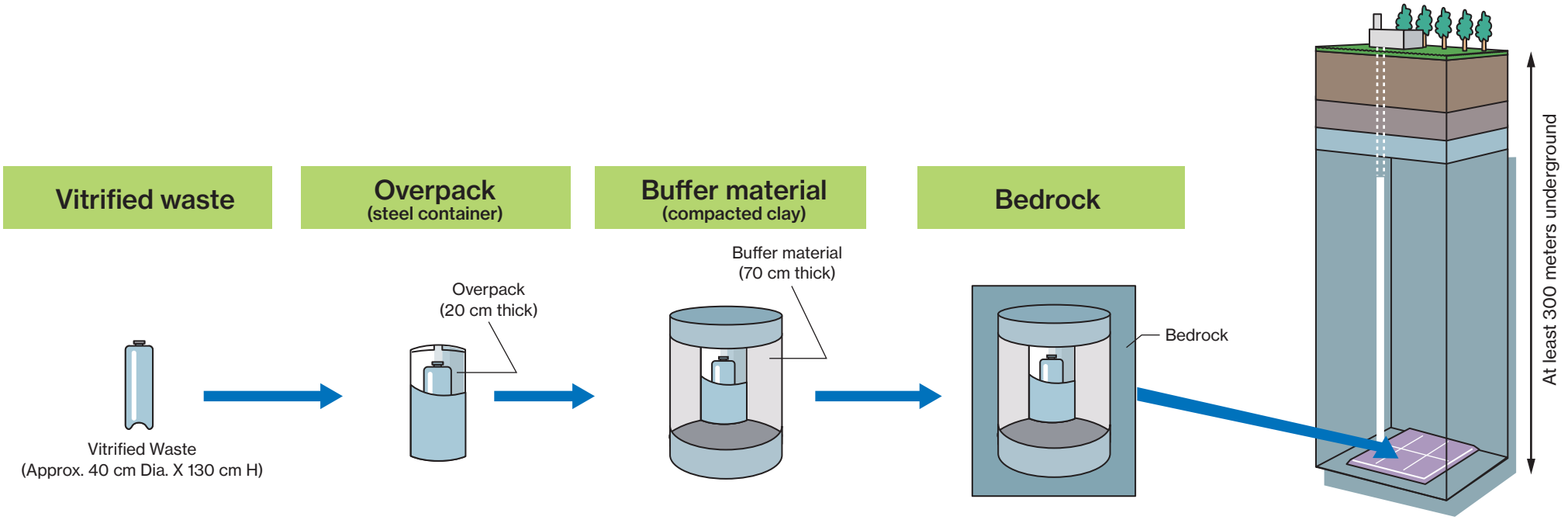
- Disposal in geological formations are considered highly feasible, given the numerous examples of underground resources already being maintained for a long time.
- With disposal in space, problems exist in reliability of launching technologies.
- Ocean dumping, in which waste is discarded in deep parts of the sea, is banned under the London Convention.
- Disposal in polar ice is banned under the Antarctic Treaty. Further, features of the ice sheet are not fully known.



- Use the properties inherent to geological formation to lock up materials
- Problems with reliability of launch technologies
- Banned by London Convention regulating ocean dumping
- Banned by Antarctic Treaty
- Features of ice sheet not fully known
- Human management in perpetuity difficult
- Burdens future generations with monitoring

Source: Nuclear Waste Management Organization of Japan (NUMO)

Multi-Barrier System for Disposing of High-Level Radioactive Waste



Geological Disposal Facility

Radioactive waste is sealed in glass to prevent leakage into groundwater.

The radioactive material is encased in a solid mass of glass.

Vitrified waste is enclosed to prevent exposure to groundwater.

Overpacking prevents the vitrified waste from any contact with groundwater for a period until the radioactivity of the waste has decreased a certain degree.

Delays any seepage of radioactive material to groundwater.

The buffer material is made of a clay called bentonite, a property of which is low permeability, which restricts the movement of water and the radioactive material.

Delays any seepage of radioactive material.

Groundwater moves extremely slowly through bedrock deep underground, so the radioactive material seeps into the bedrock and is absorbed, slowing the movement even more.

When waste is stored at more than 300m underground, even if the radioactive material were to melt, it would take a very long time to reach our living environment, and by that time the radiation would be so slight compared to the radiation we receive in our daily lives, that it would have no impact on human health.

Engineered Barriers + **Natural Barriers** = **Multi-Barrier System**

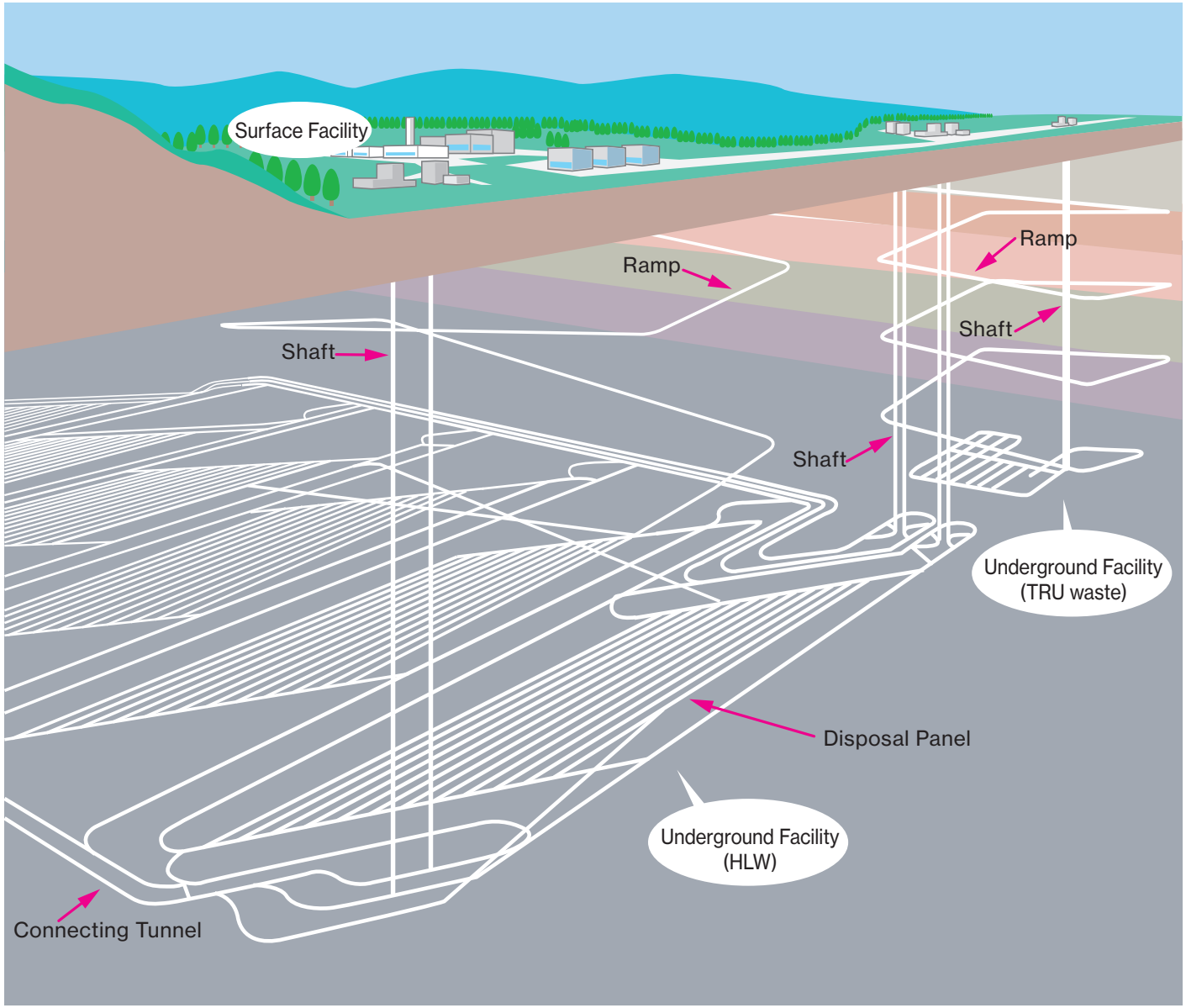
Source: Nuclear Waste Management Organization of Japan, Mechanisms for Confining Radioactive Waste

Geological Disposal of High-level Radioactive Waste

Example of layout in case of co-location with TRU waste disposal facility

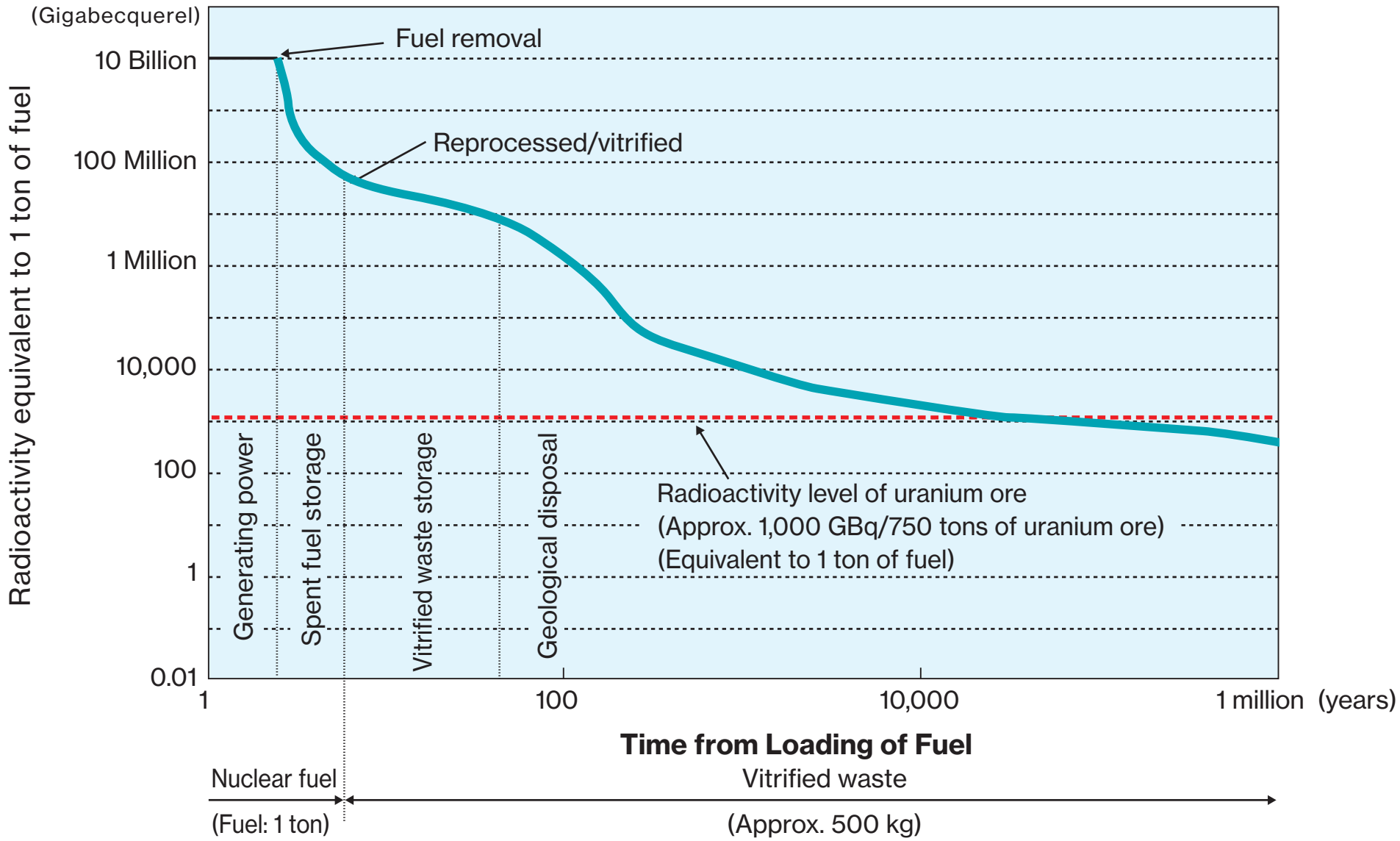
Example of specifications
(crystalline basement, depth of 1,000m)

Surface Facility	Ground area: 1 ~ 2km^2
Underground facility for HLW	Disposal area: Approx. 3km x 2km
Underground facility for TRU waste	Disposal area: Approx. 0.5km x 0.3km



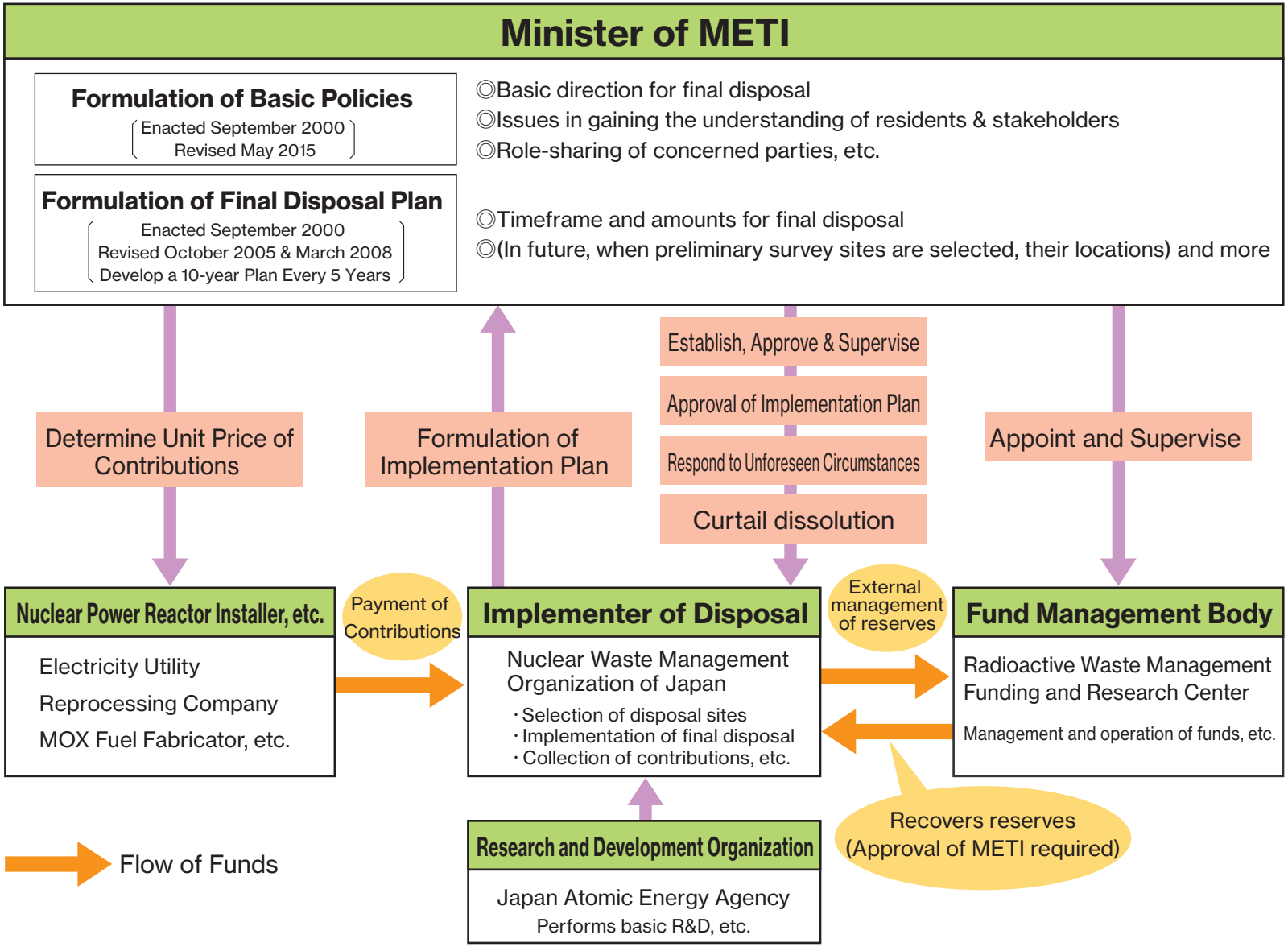
Source: Nuclear Waste Management Organization of Japan

Decay of Radioactivity of High-Level Radioactive Waste



Source: Japan Nuclear Cycle Development Institute (today's Japan Atomic Energy Agency), The Technical Reliability of Geological Disposal of High-Level Radioactive Waste in Japan

Systems for Handling the Treatment and Disposal of High-Level Radioactive Waste



(Note) In terms of final disposal methods, high-level radioactive waste generated from nuclear power generation is referred to as "specific radioactive waste" and geological disposal is referred to as "final disposal".

Source: Atomic Energy Commission, New Framework for Nuclear Energy Policy Council Materials

Geological Disposal Site Selection Process

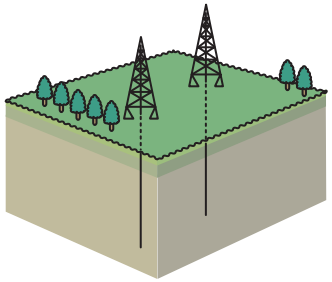
Proposal of nationwide map of scientific features for geological disposal (mapping)

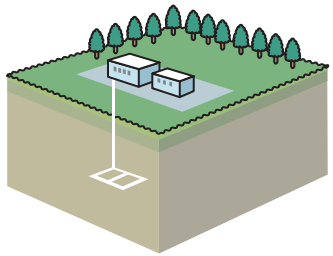
Activities focused on gaining understanding (holding explanatory meetings etc.)

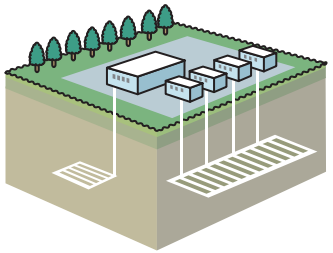
- Applicants from municipalities
- Proposals from the Government for multiple locations

Add a new process for the start of literature surveys

Selection process determined by the final disposal Act







(1) Literature surveys → **(2) Preliminary Investigations** (Implementation of boring etc.) → **(3) Detailed Investigation** (Construction and testing of underground facilities) → **Facilities construction Start of waste introduction**

Approximately 20 years

(Note) The opinions of local governments at each survey stage are listened to and fully respected (in the case of opposition, do not proceed to the next stage).

Source: METI Advisory Committee for Natural Resources and Energy, Electricity and Gas Industry Committee, and Nuclear Energy Subcommittee documentation

Disposal Plans for High-Level Radioactive Waste by Country

(as of the end of December 2024)

Country	Implementing Body	Type of Waste	Amount	Disposal Sites (Candidate) & Rock Types	Disposal Depth	Scheduled Start Operation Time
France	French National Radioactive Waste Management Agency (ANDRA)	High-level, vitrified waste	11,800m³ (if all is reprocessed)	Meuse , 11 municipalities of Haute-Marne (Near the Bure Underground Laboratory) Rock type: clay layer	About 500m	2040s
Japan	Nuclear Waste Management Organization of Japan (NUMO)	High-level, vitrified waste	40,000 + canisters	Site to be determined Rock type: to be determined	300m+	To be determined
Belgium	National Agency for Radioactive Waste and Enriched Fissile Materials (ONDRAF/NIRAS)	High-level, vitrified waste & spent fuel (Category C)	11,700m³ (if reprocessed)	Site to be determined Rock type: to be determined	To be determined	2080
Switzerland	National Cooperative for the Disposal of Radioactive Waste (NAGRA)	High-level, vitrified waste & spent fuel	1,490m³	Noerdlich Laegern Rock type: Opalinus clay	About 800m	Around 2060
U.S.A.	Department of Energy (DOE)	Spent fuel (mainly for commercial use) High-level, vitrified waste (mainly for national defense)	70,000 tons (Uranium heavy metal basis)	Nevada Yucca Mountains (Nuclear Waste Policy Act) Rock type: tuff	200 to 500m	2048
Germany	Bundesgesellschaft für Endlagerung (BGE)	High-level, vitrified waste & spent fuel	27,000m³ (Volume value includes waste container)	Site to be determined Rock type: to be determined	300m+	To be determined
Finland	Posiva Oy	Spent fuel	6,500 tons (uranium basis)	Olkiluoto, Eurajoki Rock type: crystalline rock	About 400m to 450m	2020s
Sweden	Swedish Nuclear Fuel and Wastes Management Co. (SKB)	Spent fuel	12,000 tons (uranium basis)	Forsmark, Östhammar Rock type: Crystalline rock	About 500m	2030s

Source: Agency for Natural Resources and Energy, The Disposal of High-level Radioactive Waste in Other Countries, (Feb. 2025)