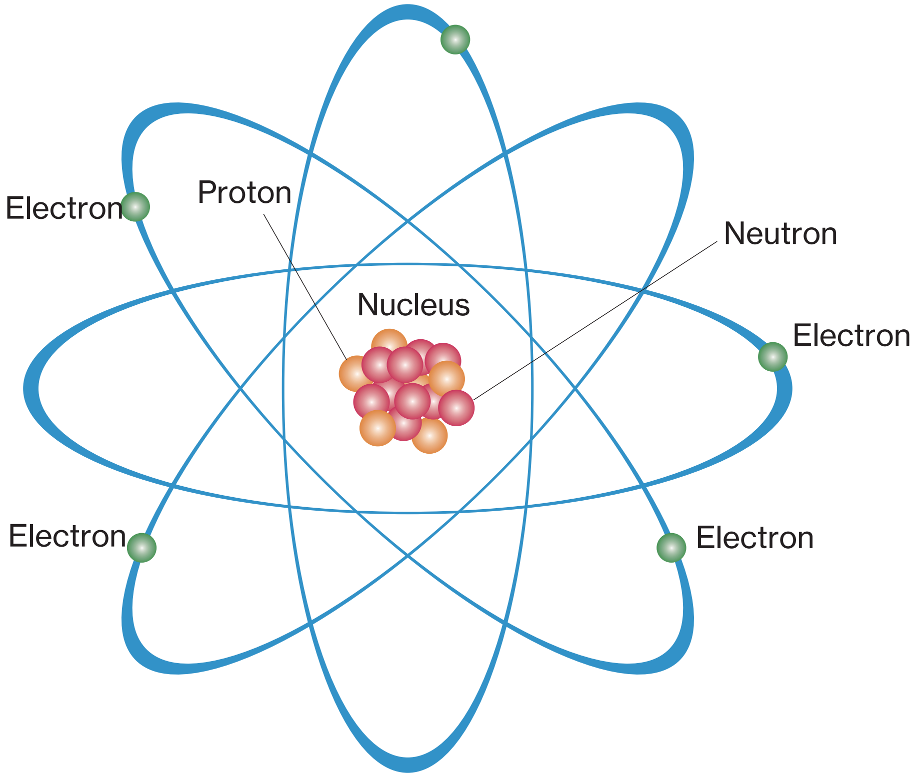
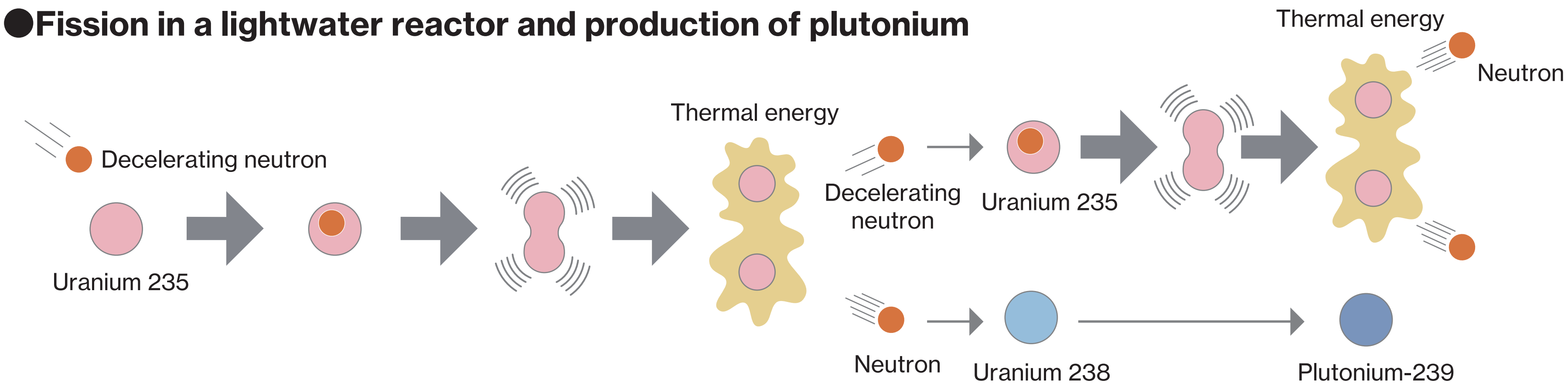
The Structure of Atoms



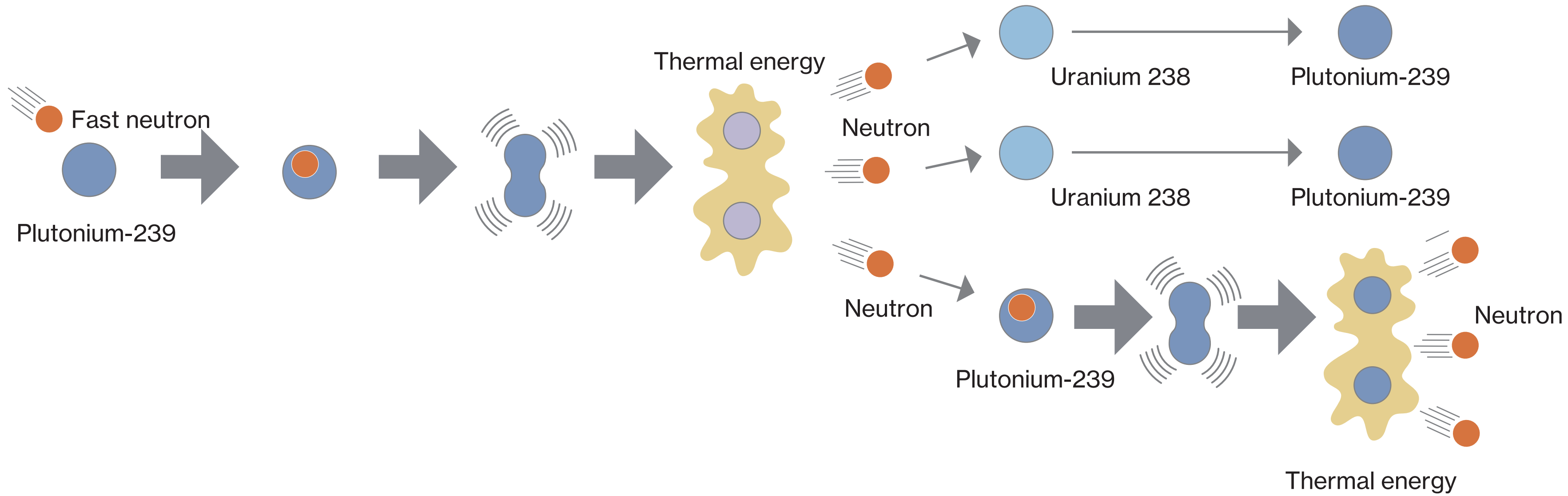
	No. of Protons	No. of Neutrons	Sum of Protons & Neutrons	Percent Naturally Occurring
Uranium 234	92	142	234	0.0055%
Uranium 235	92	143	235	0.7200%
Uranium 238	92	146	238	99.2745%

Fission of Uranium, Production and Fission of Plutonium

●Fission in a lightwater reactor and production of plutonium

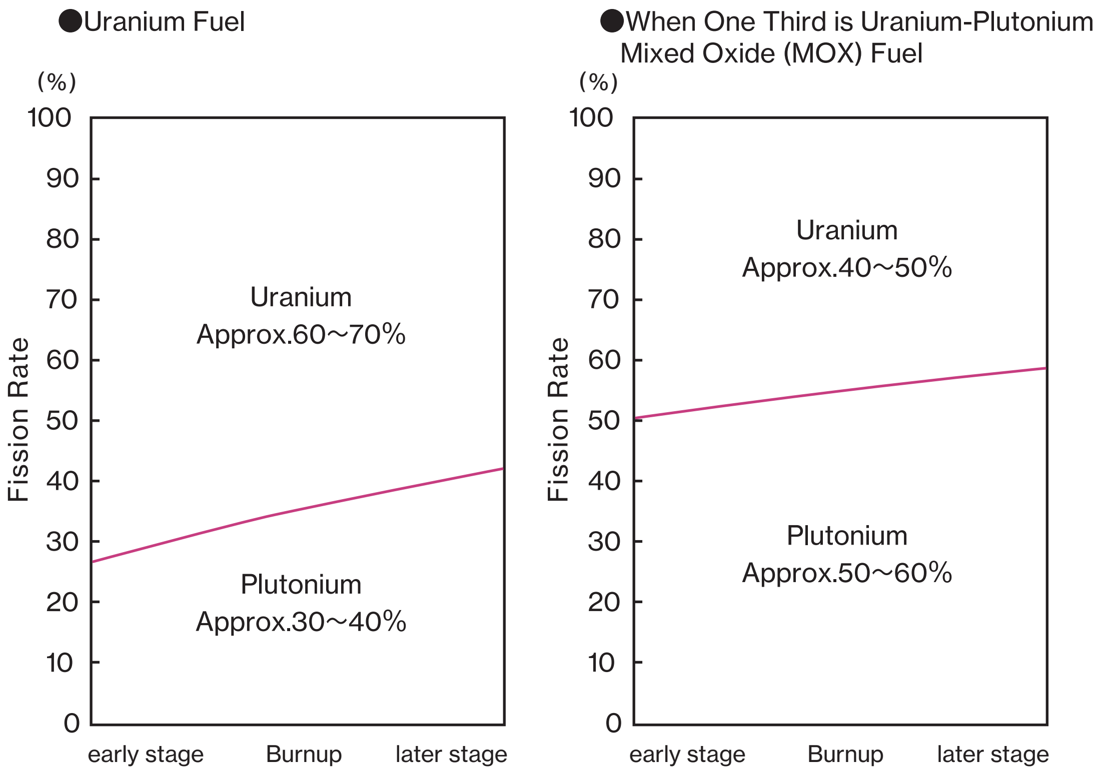


●Fission in a fast breeder reactor and production of plutonium (propagation)

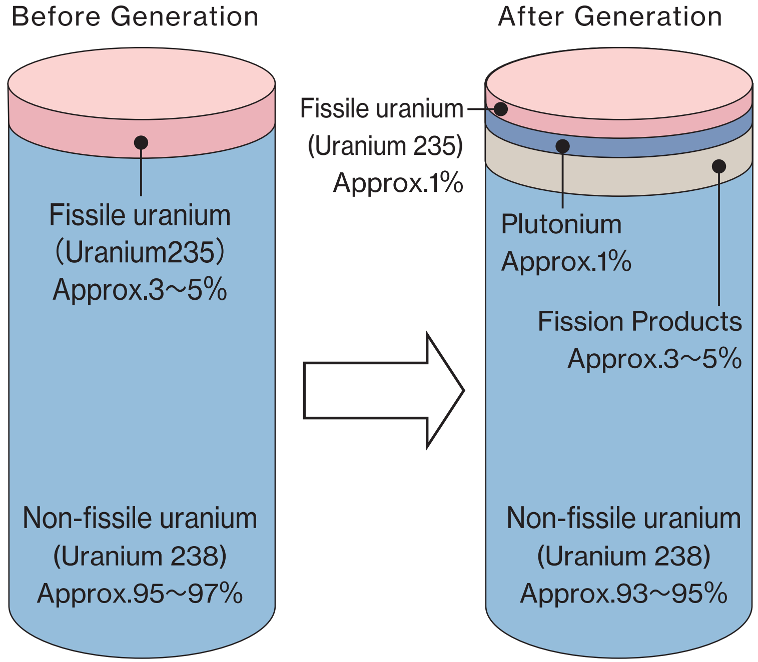


Nuclear Fission inside Light Water Reactors

① Fission rate of uranium and plutonium in reactor core (BWR equilibrium core)

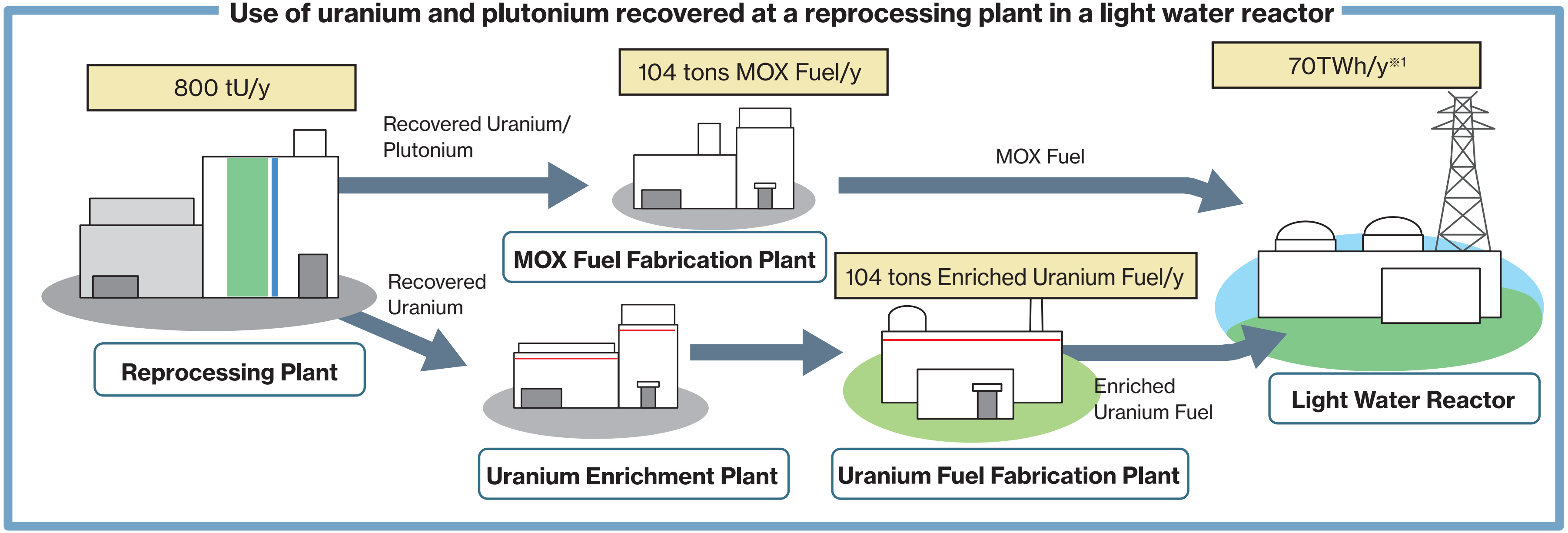


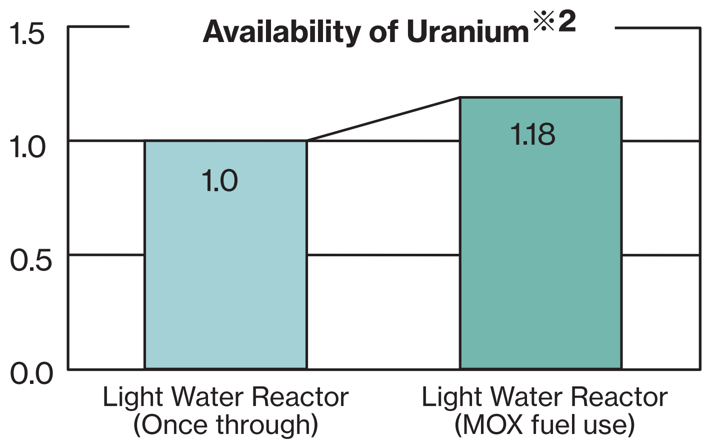
② Example of composition change of uranium fuel through generation



Source: Agency for Natural Resources and Energy

Utilization of Uranium Resources

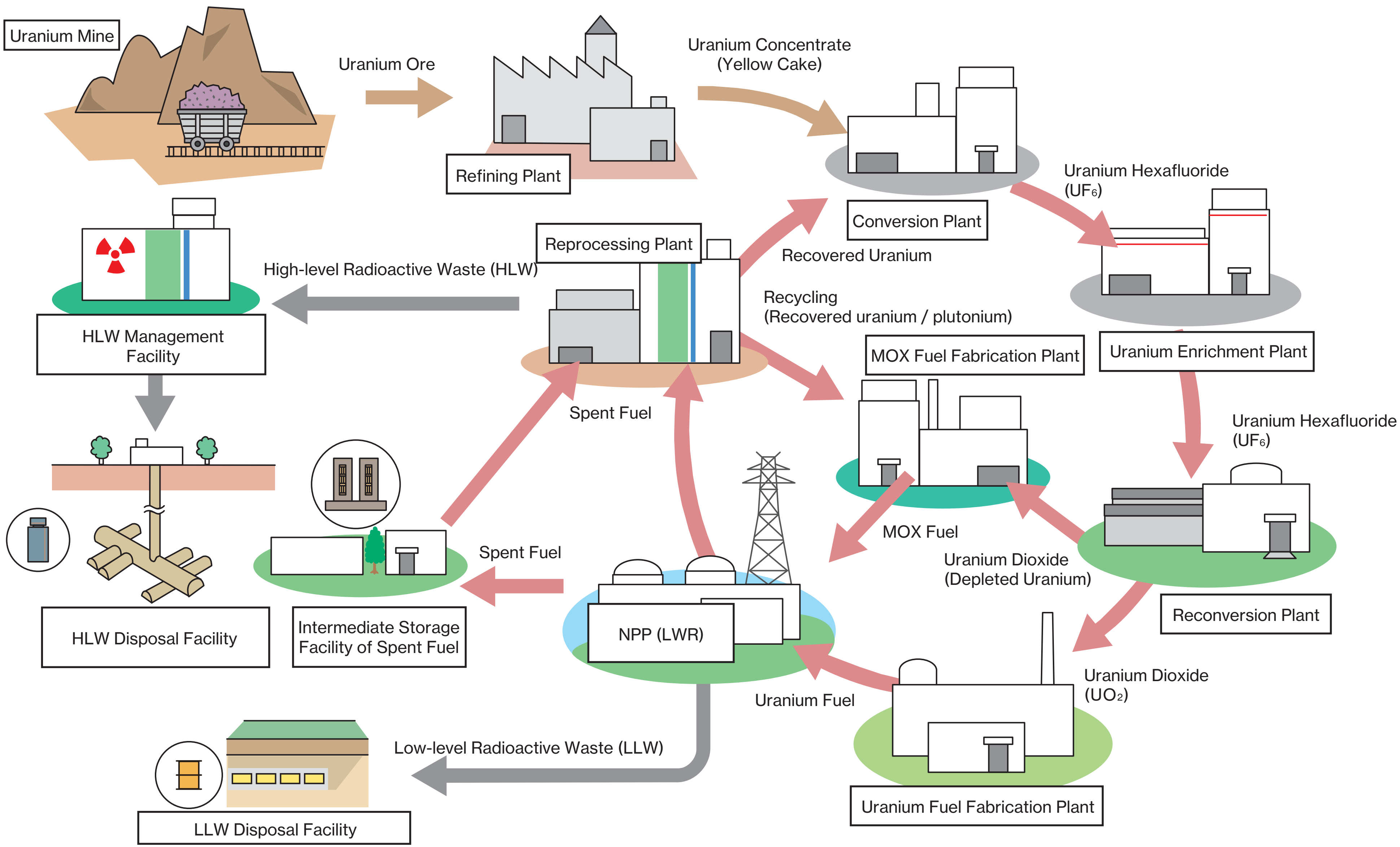




※1 70TWh is equivalent to the annual output of ten 1GW capacity nuclear reactors. (1)
※2 Usage of plutonium can improve the usage efficiency of uranium by about 30 times when the fast breeder reactor comes into practical use. (2)

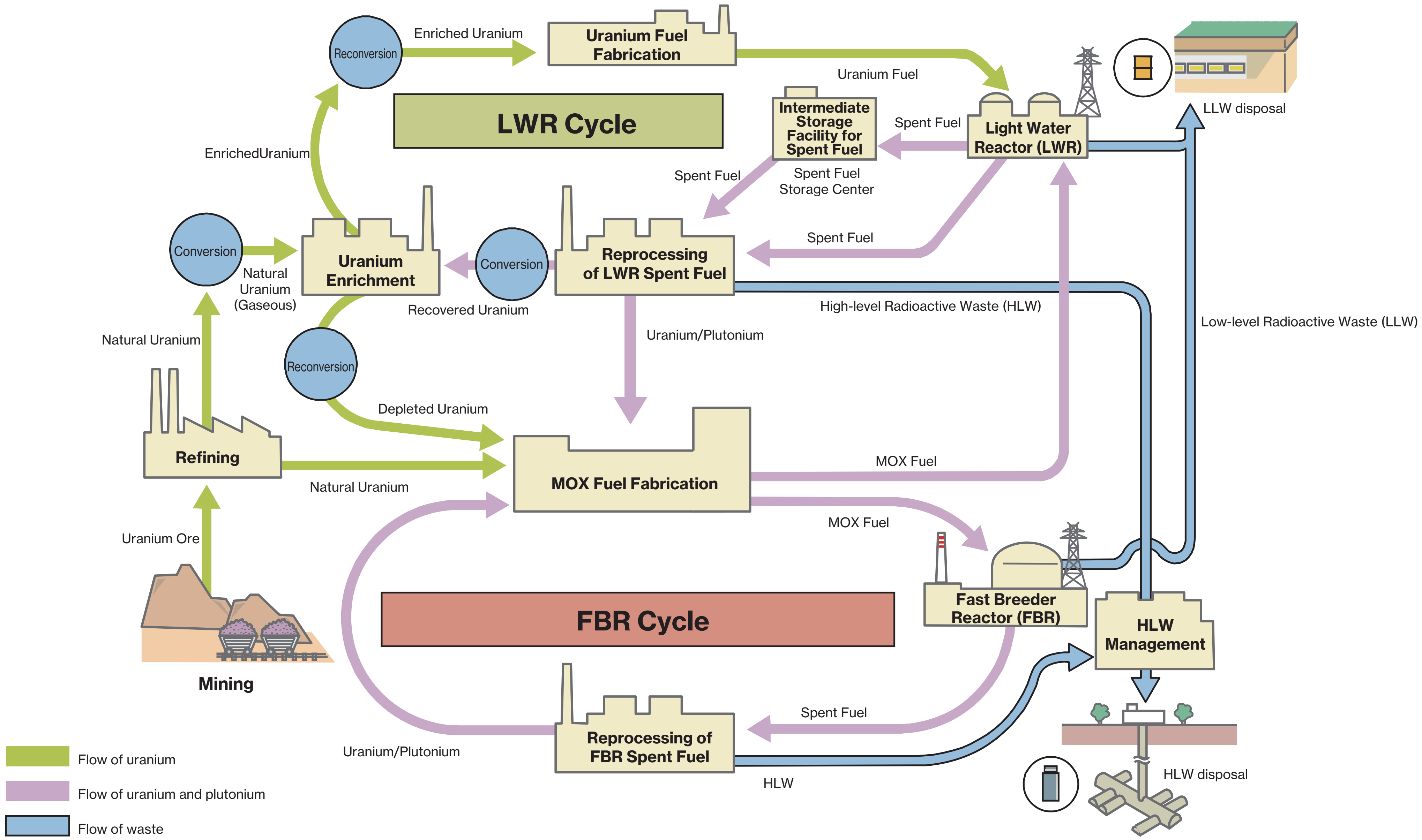
Source: (1) Atomic Energy Commission of Japan (2004)　(2) OECD and IEA, URANIUM2003

Nuclear Fuel Cycle



(Note) MOX Fuel: Uranium-Plutonium mixed oxide fuel

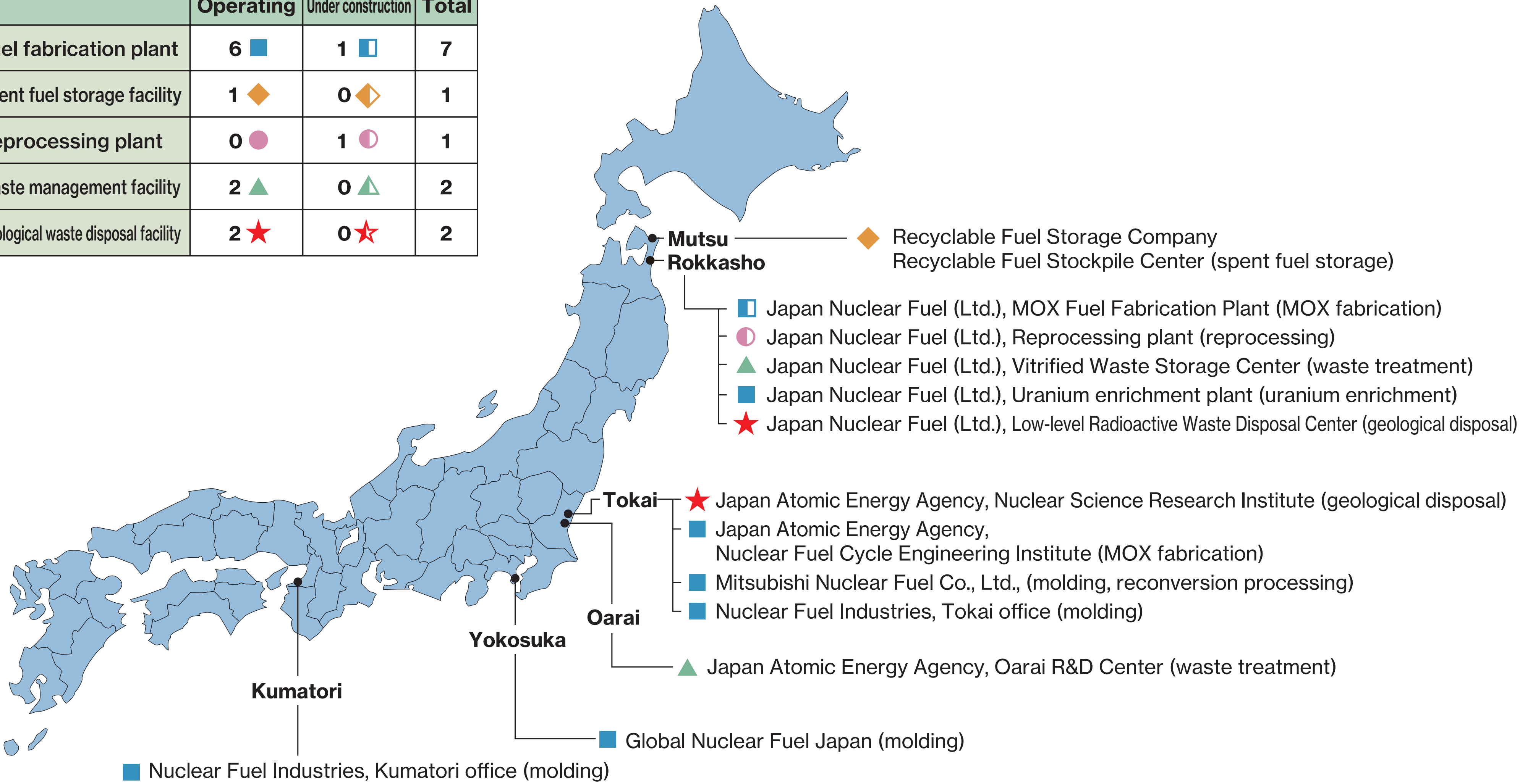
Nuclear Fuel Cycle (Including FBR)



Locations of Nuclear Fuel Cycle Facilities

(As of Apr. 2025)

	Operating	Under construction	Total
Fuel fabrication plant	6	1	7
Spent fuel storage facility	1	0	1
Reprocessing plant	0	1	1
Waste management facility	2	0	2
Geological waste disposal facility	2	0	2

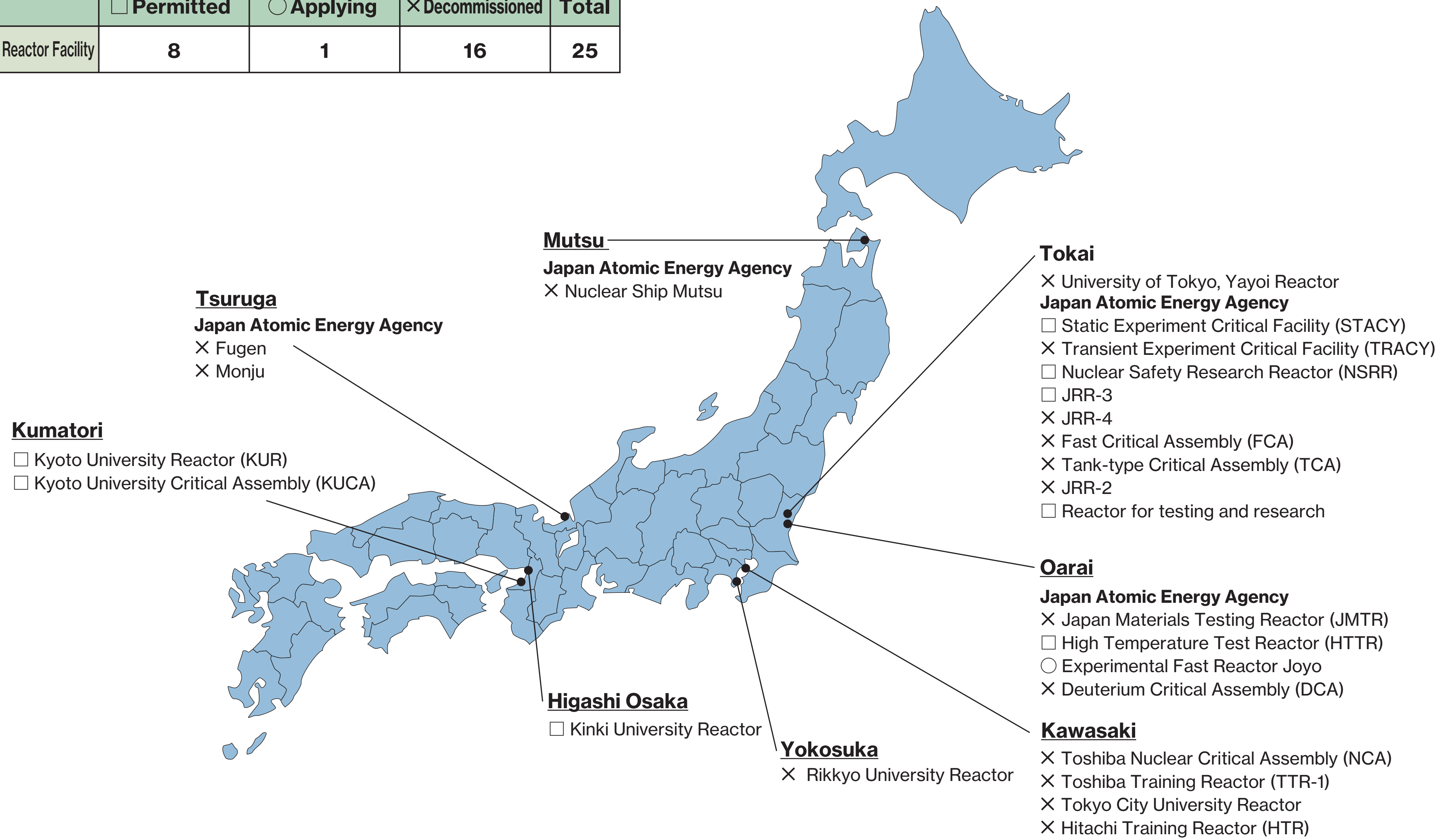


Source: Nuclear Regulation Authority homepage, with others

Locations of Nuclear Reactor Facilities for Testing and Research or at the R&D Stage

(As of Nov. 10, 2021)

	□ Permitted	○ Applying	× Decommissioned	Total
Nuclear Reactor Facility	8	1	16	25



Source: Nuclear Regulation Authority homepage

Outline of JNFL's Nuclear Fuel Cycle Facilities

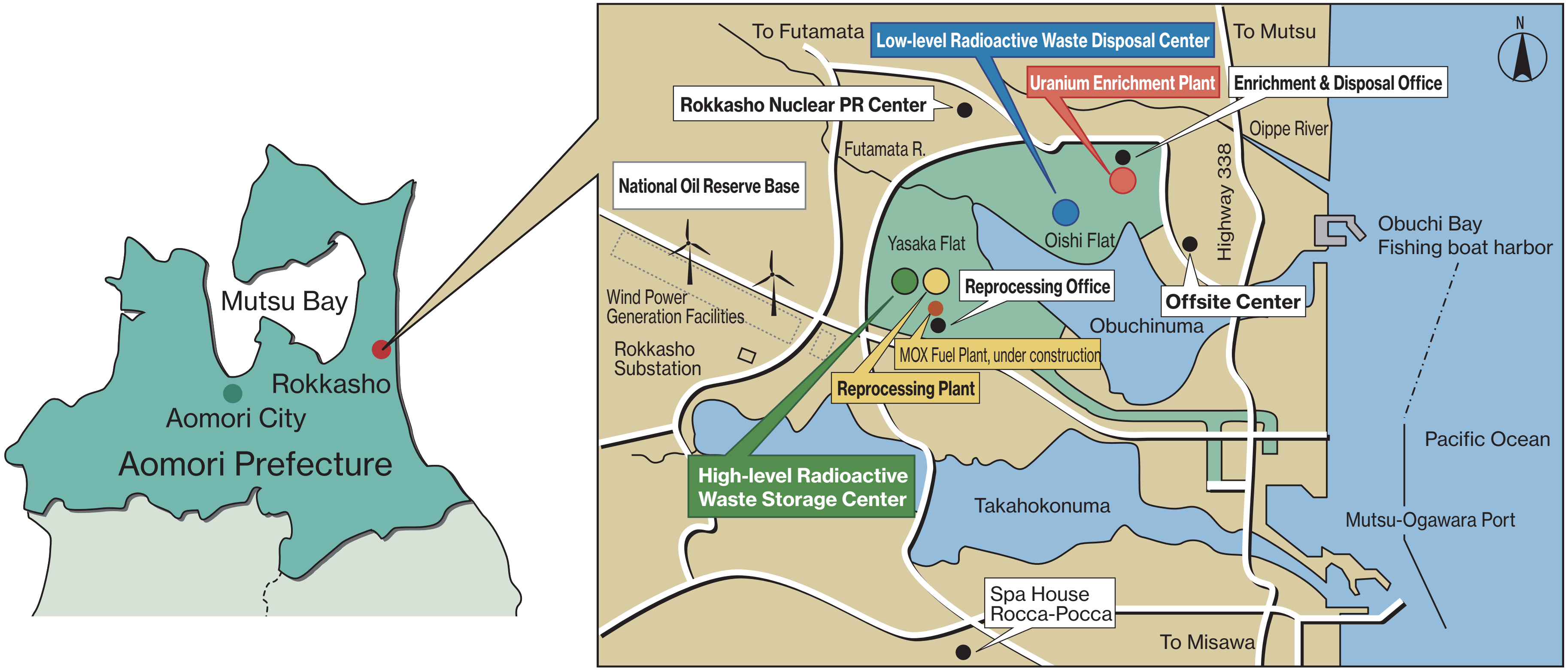
(As of Oct. 2024)

	Reprocessing Plant	Vitrified Waste Storage Center	MOX Fuel Fabrication Plant	Uranium Enrichment Plant	Low-level Radioactive Waste Disposal Center
Location	Aza-Okizuke, Oaza-Obuchi, Rokkasho-mura, Kamikita-gun, Aomori Prefecture			Aza-Nozuki, Oaza-Obuchi, Rokkasho-mura, Kamikita-gun, Aomori Prefecture	
Capacity	Area of site: approx. 3.9 million m²		Maximum capacity: 130 t-HM*2/y MOX fuel assemblies for domestic light water reactors (BWR and PWR)	Area of site: approx. 3.4 million m²	
	Maximum yearly reprocessing capacity: 800 t-U*1/year Maximum daily reprocessing capacity: 4.8 tU*1 Storage capacity for spent fuel: 3,000 t-U*1	Storage capacity for waste returned from oversea plants: 2,880 canistiers of vitrified waste		450 t-SWU*3/year	[Existing Facilities] Number one disposal facility: approx. 40,960 m³ (Equivalent to 204,800 200-liter drums) Number two disposal facility: approx. 41,472 m³ (Equivalent to 207,360 200-liter drums) [Planned New Facilities] Number three disposal facility: approx. 42,240 m³ (Equivalent to 211,200 200-liter drums) Planned to be expanded to 600,000 m³
Current Status	Under construction	Cumulative number of stored canisters: 1,830	Under construction	Operation stopped	Number one disposal facility: 151,803 drums Number two disposal facility: 198,824 drums
Schedule	Start of construction: 1993 Completion: 2026	Start of construction: 1992 Business operation: 1995	Start of construction: 2010 Completion: 2027	Start of construction: 1988 Business operation: 1992	Start of construction: 1990 Start of disposal: 1992

＊1 U: The mass of uranium in the metal state.
＊2 HM: The mass of the metal component of plutonium and uranium in MOX fuel.
＊3 SWU: Separating work units when the natural uranium is separated from enriched uranium.

Source: Japan Nuclear Fuel Ltd., with others

Locations of Nuclear Fuel Cycle Facilities



Source: Japan Nuclear Fuel (Ltd.) pamphlet

Nuclear Fuel Cycle Costs

Reprocessing Model

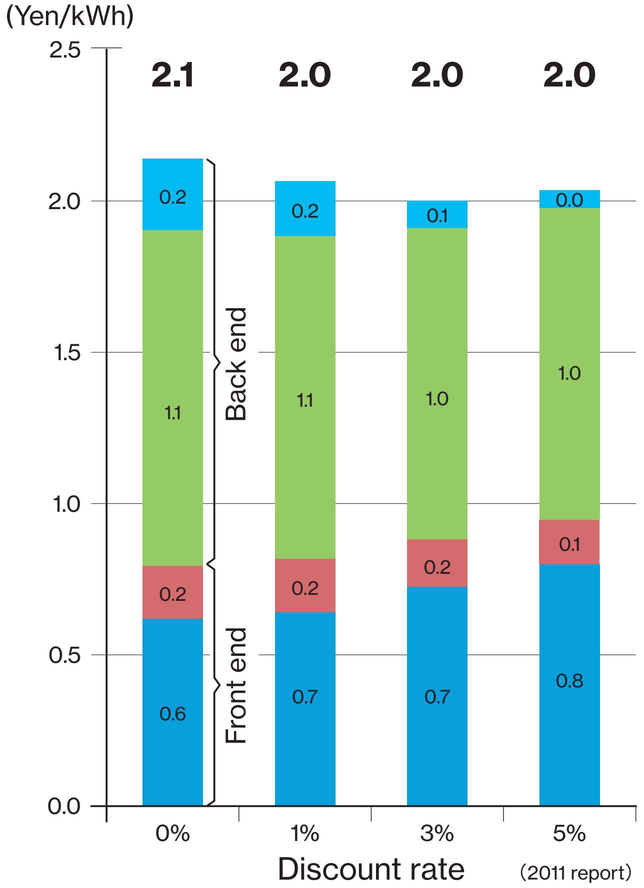
Reprocess all spent fuel and recycle

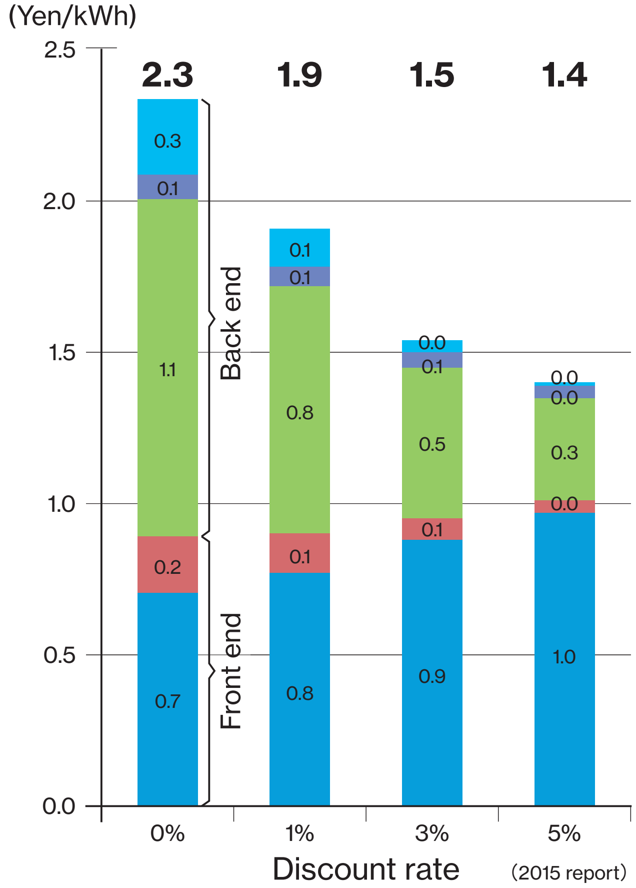
Current Model

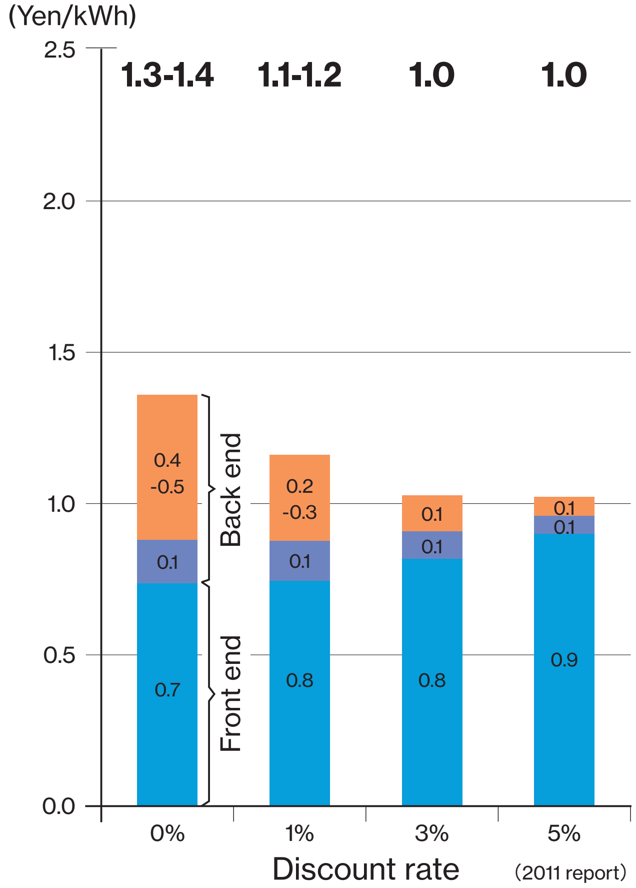
Put all spent fuel into safe storage and reprocess

Direct Disposal Model

Direct disposal after interim storage of all spent fuel







Uranium fuel | MOX fuel | Reprocessing, etc. | Interim storage, etc. | High-level waste disposal | Direct disposal

(Note) Totals may not add up due to rounding.

Source: Energy and Environment Council, Cost Verification Committee Report (May 2015)

Major Uranium Conversion Plants Worldwide

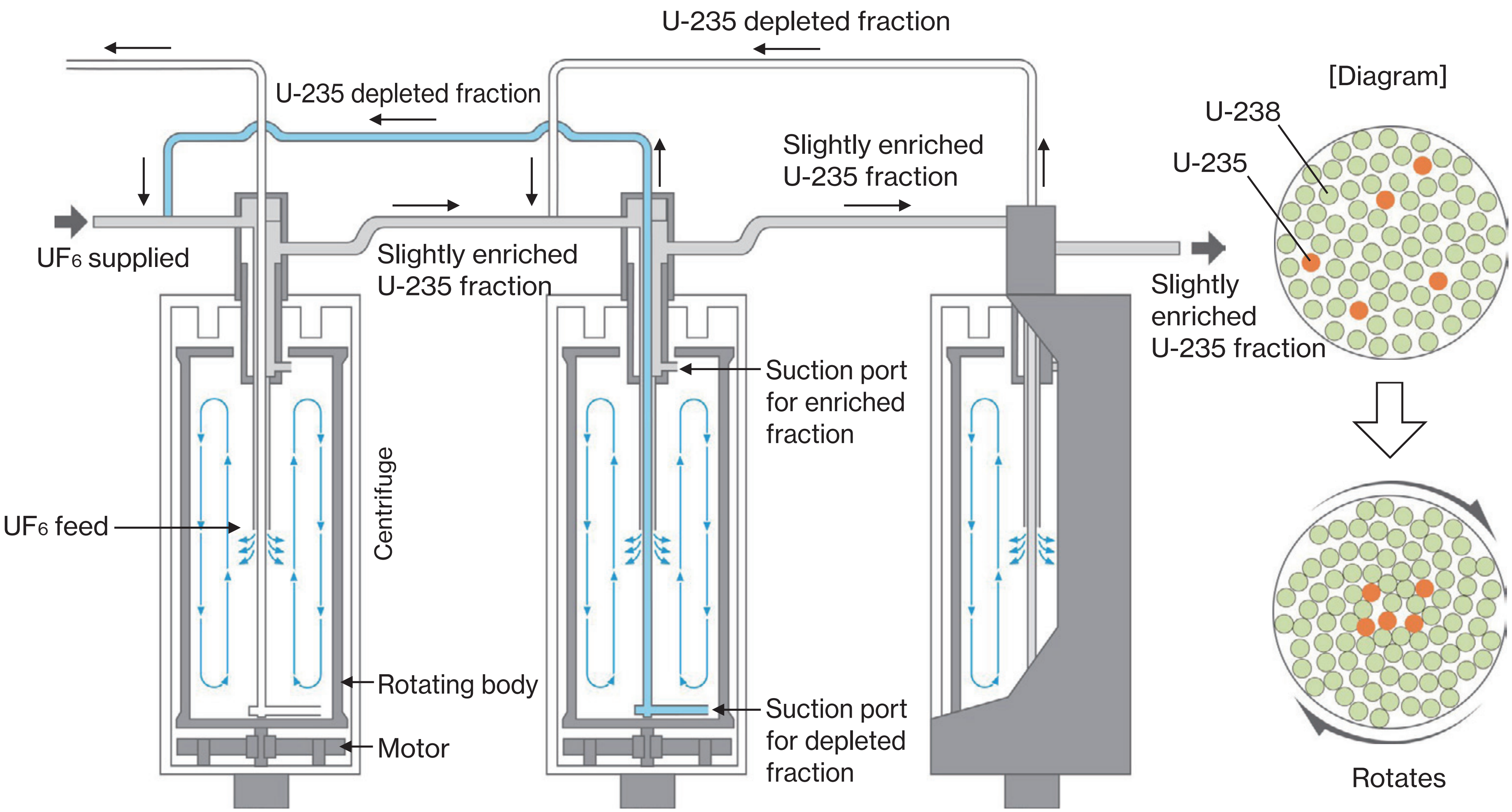
(As of Jan. 2024)

Country	Company Name	Location	Capacity (tU*/year)	Commercial Operation
Canada	Cameco Corp.	Port Hope	12,500	1970
China	China Nuclear Energy Indaustry Corp.	Lanzhou, Gansu	3,000tHM	1980
	hengyang Uranium Plant	Ziyang City, Hunan Province	3,000	2016
France	Orano CE Tricastin	Pierrelatte	14,000	1953
Russia	TVEL, Fuel Company of Rosatom	Seversk	—	2018
U.K.	Springfields Fuels Ltd.	Lancashire	6,000	1993
U.S.A.	ConverDyn	Metropolis	7,000	1964

∗ U: The weight of uranium in its metal state HM : The mass of metal component of plutonium and uranium in MOX fuel

Source: Trends in nuclear power development in the world (2024)

How Centrifuges Work



Major Uranium Enrichment Plants Worldwide

(As of Dec. 2024)

Country	Company Name	Location	Enrichment Method	Capacity (tSWU*/year)	Commercial Operation
Brazil	Indústrias Nucleares do Brasil (INB)	Resende	Centrifugation	70	2009
China	China Nuclear Energy Indaustry Corp.(CNEIC)	Lanzhou, Gansu	Centrifugation	500	2005
		Hanzhong, Shaanxi	Centrifugation	1,000	1997
France	Orano CE Tricastin	Pierrelatte	Centrifugation	7,500	2011
Germany	URENCO Deutschland GmbH	Gronau	Centrifugation	3,600	1985
Japan	Japan Nuclear Fuel Ltd. (JNFL)	Rokkasho, Aomori	Centrifugation	1,050	1992
Netherlands	URENCO Nederland B.V.	Almelo	Centrifugation	5,200	1972
Russia	TVEL, Fuel Company of Rosatom	Seversk	Centrifugation	–	1953
		Angarsk	Centrifugation	–	1954
		Novouralsk	Centrifugation	–	1964
		Zelenogorsk	Centrifugation	–	1962
U.K.	URENCO UK Ltd.	Capenhurst	Centrifugation	4,400	1972
U.S.A.	Louisiana Energy Services LLC	New Mexico	Centrifugation	4,500	2010
	Centrus Energy Corp.	Piketon	Centrifugation	–	2023

*SWU: Unit that represents the amount of work involved in separating naturally occurring uranium into enriched uranium.

Source: Japan Nuclear Fuel Ltd., Trends in nuclear power development in the world (2024)

Major Uranium Reconversion Plants Worldwide

(As of Jan. 2024)

Country	Company Name	Location	Capacity (tU*/year)	Commercial Operation
Brazil	Indástrias Nucleares do Brasil	Resende	120	2000
Canada	Cameco Corp.	Port Hope	2,800	1970
France	FRAMATOME SAS	Romans sur Isère	1,800	1974
Germany	Advanced Nuclear Fuel GmbH	Lingen	800	1974
India	Nuclear Fuel Complex(NFC)	Hyderabad	450tHm	1972
Japan	Mitsubishi Nuclear Fuel Co., Ltd. (MNF)	Tokai, Ibaraki	450	1972
Kazakhstan	Ulba Metallurgical Plant (UMP)	Ust-kamenogorsk	——	——
South Korea	KEPCO Nuclear Fuel Co.,Ltd. (KEPCO NF)	Daejeon	700	1990
Romania	Societatea Nationala Nuclearelectrica S.A.(SNN)	Brasov	300	1978
U.K.	Springfields Fuels Ltd.	Lancashire	900	1993
U.S.A.	FRAMATOME Inc.	Richland	1,200	1972

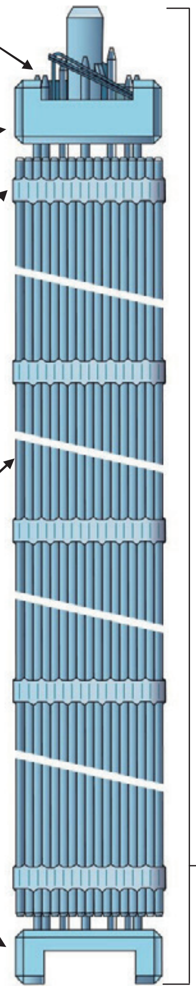
*U: Weight of uranium in its metal state

Source: Trends in nuclear power development in the world (2024)

Process of Fabricating Uranium Fuel

Cylinder of Enriched Uranium Hexafluoride (UF_6)

Fuel Assembly



Conversion Process

Aqueous ammonia is added to a solution produced in a reaction of enriched UF_6 and pure water; after precipitation, filtration and drying, it is baked and reduced to produce uranium dioxide (UO_2) powder.

Pellet Molding Process

The UO_2 powder is made granular and molded in a rotary press; then it is sintered at over 1,700°C, ground and made into UO_2 pellets.

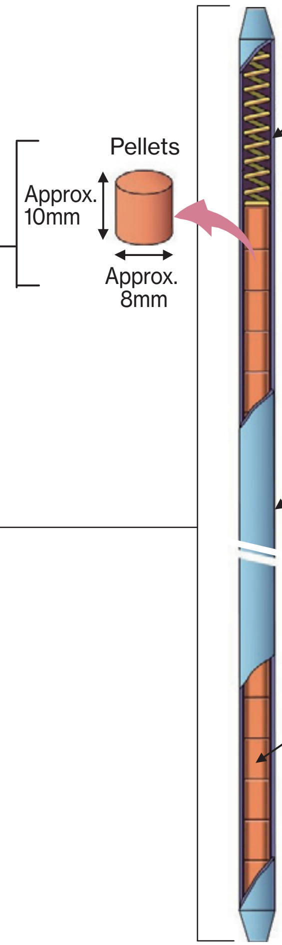
Fuel Rod Assembly

To create fuel rods, the UO_2 pellets are loaded into fuel cladding tubes, a spring inserted in one end and plugs welded onto both ends to seal the tube.

Fuel Assembly Fabrication Process

To complete the fuel rod assembly, fuel rods are inserted into the support lattice.

Fuel Rod



(Note) For PWR

Major Uranium Fuel (for Lightwater Reactors) Fabrication Plants Worldwide

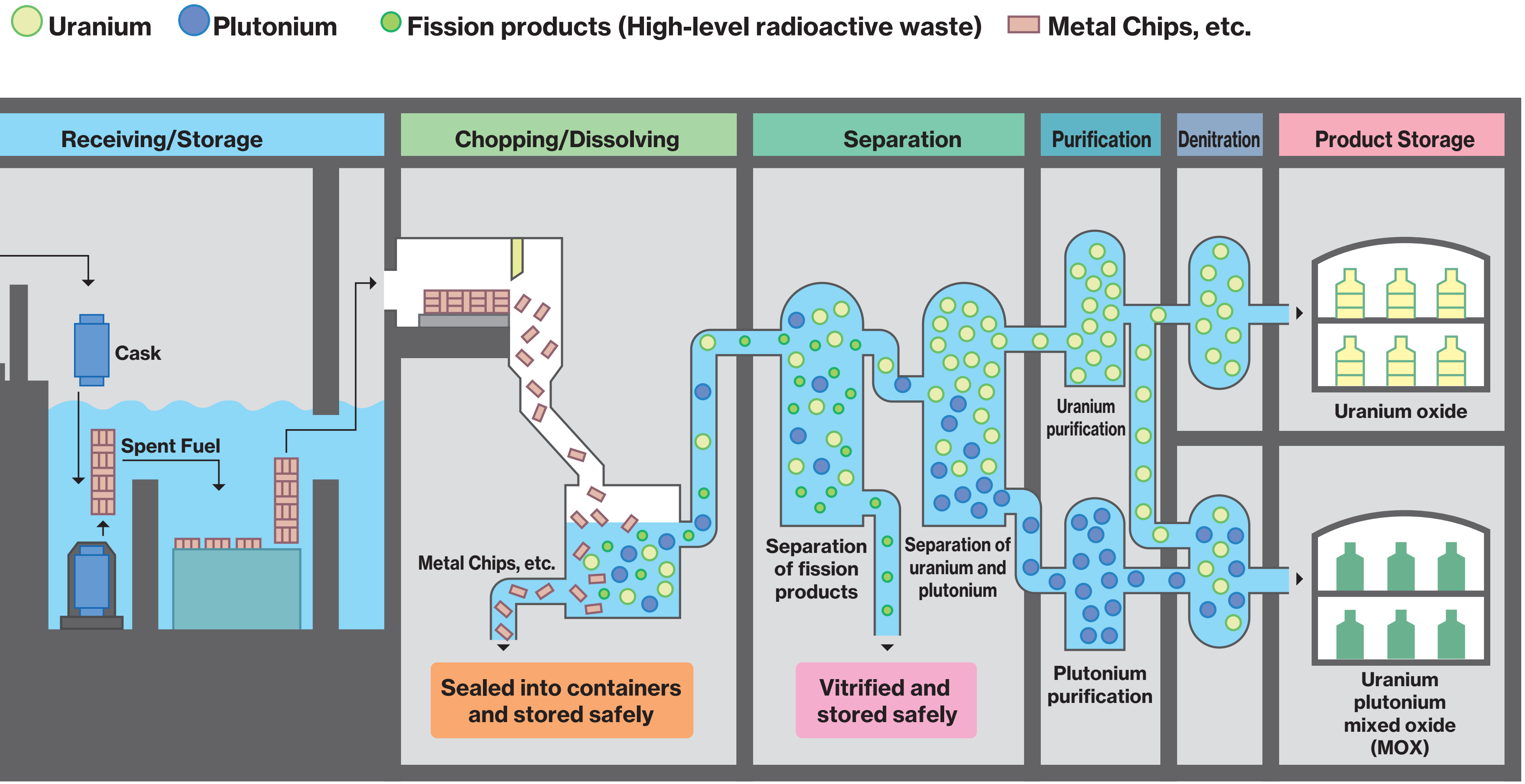
(As of Jan. 2024)

Country	Company Name	Location	Fuel Type	Capacity (tU)	Commercial Operation
Argentina	CONUAR S.A	Ezeiza	PHWR,RWR	240	1982
Brazil	Indústrias Nucleares do Brasil (INB)	Resende	PWR	240	1982
China	CNNC Jianzhong Nuclear Fuel Co.,Ltd.	Yibin City, Sichuan Province	PWR,VVER	800	1998
	Bautou Nuclear Fuel Elment Plant	Baotou, Inner Mongolia Autonomous Region	PWR	600	2012
			PHWR	200tHM	2003
France	FRAMATOME SAS	Romans-sur-Isère	PWR	1400tHM	1974
Germany	ANF - Advanced Nuclear Fuel GmbH	Lingen	PWR,BWR	650	1974
India	Nuclear Fuel Complex(NFC)	Hyderabad	BWR	24tHM	1974
			PHWR	300tHM	1997
			PHWR	300tHM	1974
Japan	Global Nuclear Fuel-Japan Co., Ltd. (GNF-J)	Yokosuka, Kanagawa	BWR	750	1970
	Mitsubishi Nuclear Fuel Co., Ltd. (MNF)	Tōkai, Ibaraki	PWR	440	1972
	Nuclear Fuel Industries Ltd. (NFI)	Kumatori, Osakai	PWR	284	1975
		Tōkai, Ibarak	BWR	250	1980
Kazakhstan	Ulba Metallurgical Plant (UMP) JSC	Ust-kamenogorgk	VVER,RBMK,PWR	—	—
South Korea	Korea Nuclear Fuel Co., Ltd. (KEPCO NF)	Daejeon	PWR	550	1989
			PHWR	400	1998
Russia	TVEL, Fuel Company of Rosatom	Elektrostal	VVER,BWR,PWR	1100	1965
			RBMK	460	1965
		Novosibirsk	VVER	1200	1979
Spain	ENUSA Industrias Avanzadas, S. A.	Juzbado	PWR,VVER,BWR	500	1985
Sweden	Westinghouse Electric Sweden AB	Västerås	BWR,PWR,VVER	600	1969
U.K.	Springfields Fuels Ltd.	Lancashire	PWR	200	1993
U.S.A.	FRAMATOME Inc.	Richland	PWR,BWR	1200tHM	1972
	Westinghouse Electric Co. LLC	Hopkins	PWR,BWR	1350	1969
	Global Nuclear Foel	Wilmington	BWR	—	—

*U: Weight of uranium in its metal state

Source: Trends in nuclear power development in the world (2024)

Flow of Reprocessing



Source: Japan Nuclear Fuel Ltd.

Major Reprocessing Plants Worldwide

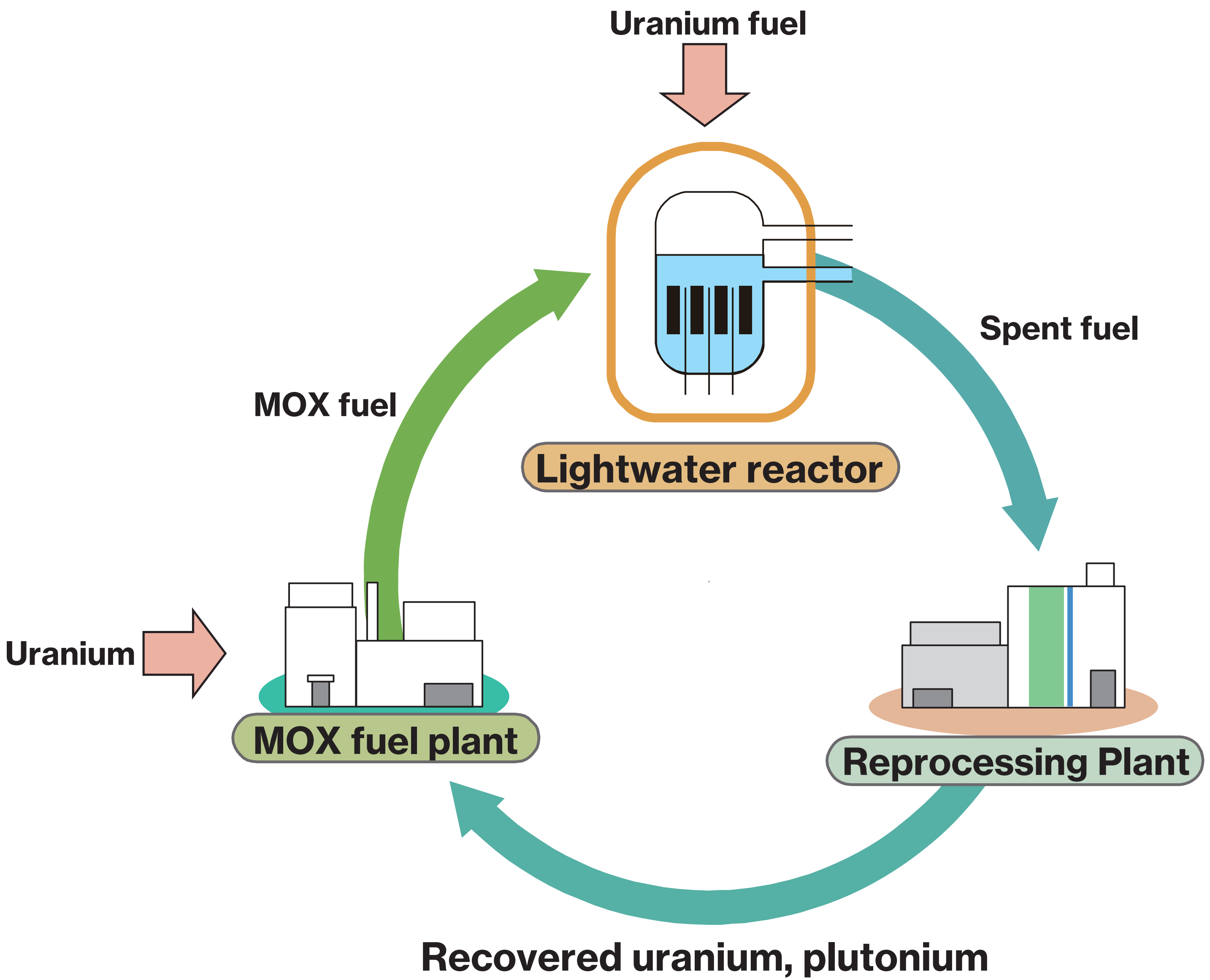
(As of Oct. 2024)

Country	Company Name	Location	Plant	Capacity (tU*/year)	Commercial Operation
China	Lanzhou Nuclear Fuel Complex	Lanzhou, Gansu	Lanzhou Pilot Reprocessing Plant	—	2010
France	Orano R La Hague	La Hague	La Hague Plant	1,700tHM	1966
Japan	Japan Nuclear Fuel Ltd. (JNFL)	Rokkasho, Aomori	Rokkasho Nuclear Fuel Cycle Facility (Reprocessing Plants)	800	2026 (Completion)
Russia	PA Mayak	Ozersk	Joint Mayak Reprocessing Plant RT-1 Plant	400tHM	1977
Russia	Mining and Chemical Complex (MCC)	Zheleznogorsk	Pilot Demonstration Center (PDC)	4.4tHM (PhaseⅠ)	2016 (PhaseⅠ)
				220tHM (PhaseⅡ)	Scheduled for 2024 (PhaseⅡ)
			RT-2 Plant	800tHM	Scheduled for 2035

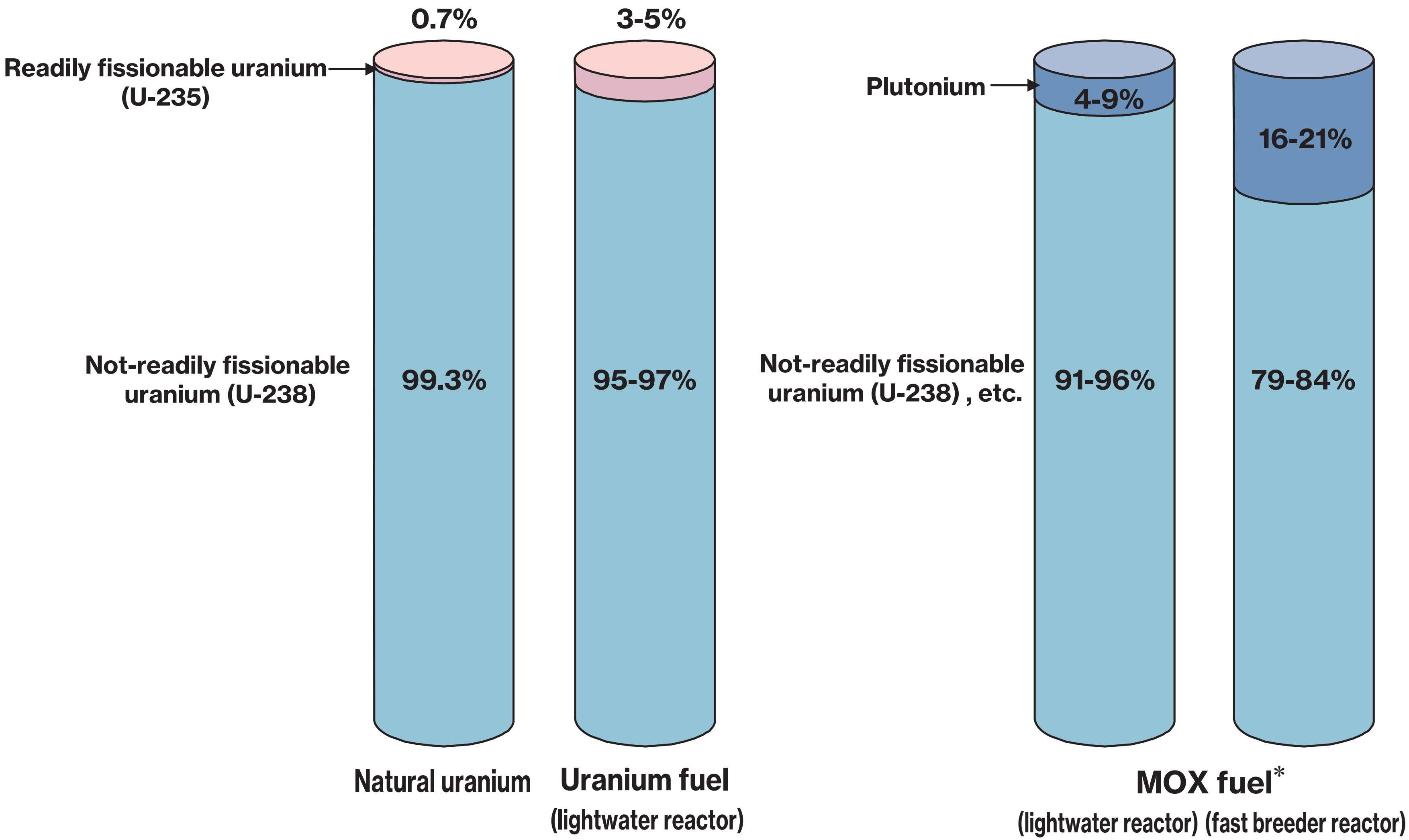
* U: The weight of uranium in its metal state   HM : The mass of metal component of plutonium and uranium in MOX fuel

Source: Japan Nuclear Fuel Ltd., Trends in nuclear power development in the world (2024)

MOX Fuel Use in a Thermal Reactor



MOX Fuel



*MOX (Mixed Oxide) fuel: a combined fuel made of plutonium and uranium, which is used in plutonium-thermal lightwater reactors and fast breeder reactors.

Source: Japan Nuclear Fuel Ltd.

Effect of Plutonium on Fuel Properties

[Melting point]

Drops as plutonium mixing ratio increases.

[Heat conductivity]

Drops as plutonium mixing ratio increases.

- At the ratio of plutonium in MOX fuel used for thermal reactors, the melting point drops just a few tens of degrees.
- The drop in heat conduction is also slight.
- There is plenty of margin between the melting point and actual pellet temperatures.

[Gas release rate]

The proportion of gas from nuclear fission that builds up in the cladding tubes increases somewhat.

- Increases the volume of space (gas reservoir) between fuel rods and inhibits an increase in internal pressure.

Effect of Plutonium on Fuel Nuclear Characteristics

[Fuel Rod Heat Distribution]

Because plutonium reacts readily with neutrons, the output of MOX fuel rods is high.

[Control Rod Efficacy]

Because plutonium readily absorbs neutrons, the number of neutrons absorbed by the control rods is reduced.

[Response to Disturbance]

If an anomaly occurs, causing an increase in pressure in the reactor, the output tends to be greater than traditional models.

If fuel rods and assemblies are deployed properly, a sufficient margin to limits can be achieved, just as with a uranium reactor core.

Major MOX Fuel Fabrication Facilities Worldwide

(As of Oct. 2024)

Country	Company Name	Location	Fuel Type	Capacity (tHM*/year)	Commercial Operation
France	Orano R Melox	Chusclan	PWR, BWR	195	1995
Japan	Japan Atomic Energy Agency (JAEA)	Tōkai, Ibaraki	FBR	4.5 tons HM	1988
	Japan Nuclear Fuel Ltd. (JNFL)	Rokkasho, Aomori	PWR, BWR	130 (max.)	2027 (completion)

*HM: The mass of the metal component of plutonium and uranium in MOX fuel.

Source: Japan Nuclear Fuel Ltd., Trends in nuclear power development in the world (2024)

MOX Use in the World

As of Jan. 1, 2024

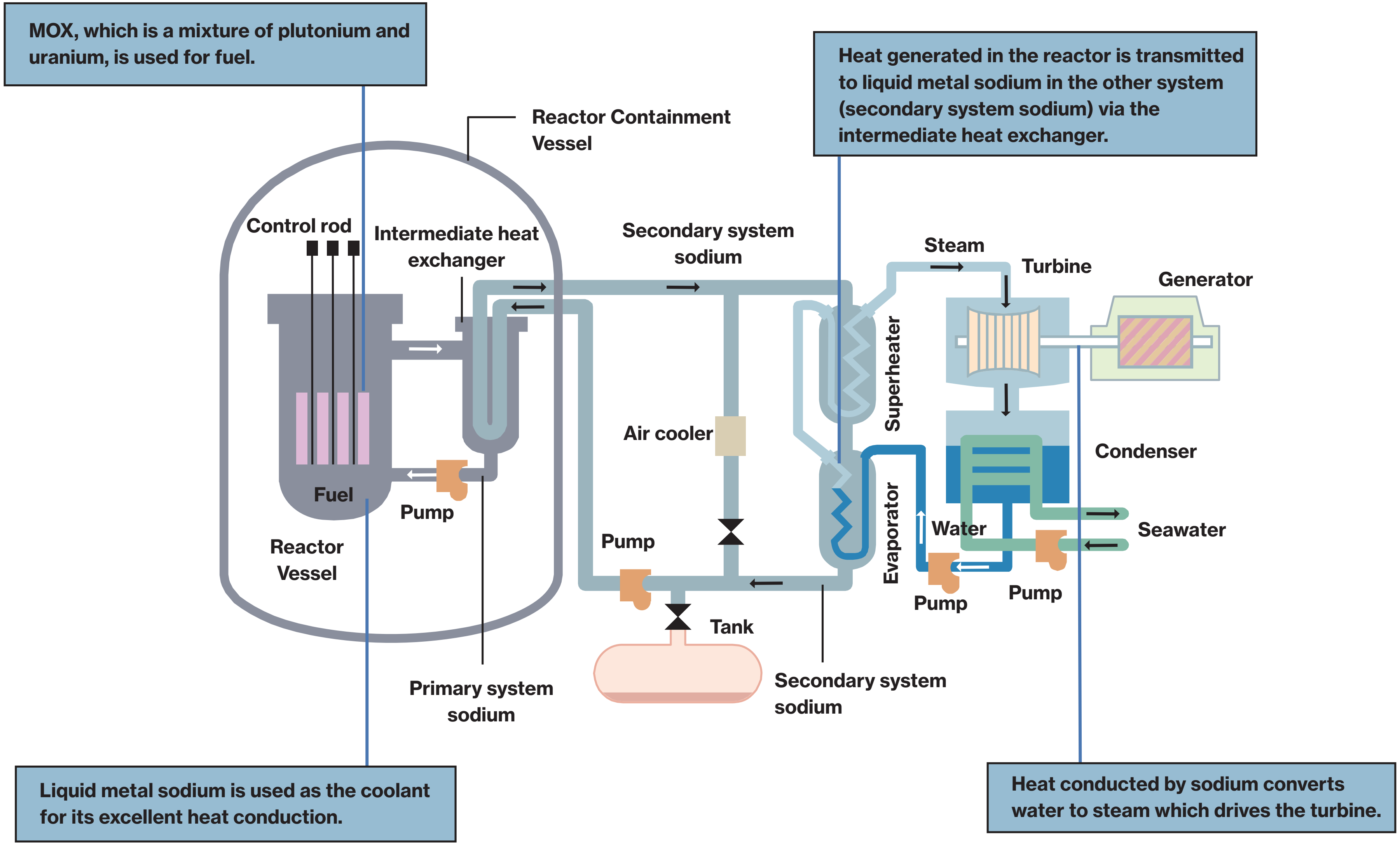
Country	Plant Name	Reactor Type	Gross Output (MW)	Start of Loading	Cumulative Number of MOX Fuel Assemblies As of the End of 2022
Belgium	Tihange-2	PWR	1,055	1994[*1]	96
	Doel-3	PWR	1,056	1994[*1]	
France	Phénix	FBR	140	1973	
	St.Laurent-Des-Eaux-B1	PWR	956	1987	
	St.Laurent-Des-Eaux-B2	PWR	956	1988	
	Gravelines-3	PWR	951	1989	
	Gravelines-4	PWR	951	1989	
	Dampierre-1	PWR	937	1990	
	Dampierre-2	PWR	937	1993	
	Le Blayais-2	PWR	951	1994	
	Tricastin-2	PWR	955	1996	
	Tricastin-3	PWR	955	1996	
	Tricastin-1	PWR	955	1997	
	Tricastin-4	PWR	955	1997	
	Gravelines-1	PWR	951	1997	
	Le Blayais-1	PWR	951	1997	
	Dampierre-3	PWR	937	1998	
	Gravelines-2	PWR	951	1998	
	Dampierre-4	PWR	937	1998	
	Chinon-B4	PWR	954	1998	
	Chinon-B2	PWR	954	1999	
	Chinon-B3	PWR	954	1999	
	Chinon-B1	PWR	954	2000	
	Gravelines-6	PWR	951	2008	
Germany	Obrigheim[*2]	PWR	357	1972	78
	Necker-1[*3]	PWR	840	1982	32
	Unterweser[*3]	PWR	1,410	1984 to 2009	200
	Grafenrheinfeld[*4]	PWR	1,345	1985 to 2012	164
	Philippsburg-2[*5]	PWR	1,468	1989	228
	Grohnde[*6]	PWR	1,430	1988 to 2018	140
	Brokdorf[*6]	PWR	1,480	1989 to 2019	272
	Gundremmingen-C[*6]	BWR	1,344	1995	376
	Gundremmingen-B[*4]	BWR	1,344	1996	532
	Isar-2[*7]	PWR	1,485	1998 to 2019	212
	Necker-2[*7]	PWR	1,400	1998	96
	Emsland[*7]	PWR	1,406	2004	144

Country	Plant Name	Reactor Type	Gross Output (MW)	Start of Loading	Cumulative Number of MOX Fuel Assemblies As of the End of 2022
India	Kakrapar-1	PHWR	220	2003	
	Tarapur TAPS-1	BWR	160	1994	
	Tarapur TAPS-2	BWR	160	1995	
	PFBR	FBR	500		
Netherlands	Borssele	PWR	512	2014	48
Russia	Beloyarsk-3	FBR	600	2003	
	Beloyarsk-4	FBR	885	2020	
Swizerland	Beznau-1	PWR	380	1978 to 2012	124 } 232
	Beznau-2	PWR	380	1978 to 2012	108
	Gosgen	PWR	1,060	1997 to 2012	48
Sweden	Oskarshamn-1	BWR	492	Licensed	
	Oskarshamn-2	BWR	661	Licensed	
	Oskarshamn-3	BWR	1,450	Licensed	
U.S.A.	Catawba-1	PWR	1,188	2005[*8]	4
	Robert E. Ginna	PWR	608	1980[*9] to 1985	4
Japan	Fugen[*10]	ATR	165	1981	772
	Monju[*11]	FBR	280	1993	
	Genkai-3	PWR	1,180	2009	36
	Ikata-3	PWR	890	2010	21
	Takahama-3	PWR	870	2010	44
	Takahama-4	PWR	870	2016[*13]	36
	Fukushima I-3[*12]	BWR	784	2010	32
	Kashiwazaki Kariwa-3	BWR	1,100	Licensed[*15]	
	Hamaoka-4	BWR	1,137	Licensed[*15]	
	Shimane-2	BWR	820	Licensed[*15]	
	Onagawa-3	BWR	825	Licensed[*15]	
	Tomari-3	PWR	912	Licensed[*15]	
	Ohma[*14]	ABWR	1,383	Licensed[*15]	

＊1 : End of MOX use in 2003
＊2 : May 11, 2005, closed
＊3 : August 07, 2011, closed
＊4 : December 31, 2017, closed
＊5 : December 31, 2019, closed
＊6 : December 31, 2021, closed
＊7 : April 15, 2023, scheduled to closed
＊8 : 2005, 4 fuel assemblies loaded. Loaded for about 4 years.
＊9 : 1980, 4 fuel assemblies loaded.
＊10 : March 29, 2003, closed
＊11 : December 21, 2016, decision to decommissioned
＊12 : April 19, 2012, decommissioned
＊13 : In 2016, four fuel assemblies were loaded and stopped after criticality.After that, start operating in 2017.
＊14 : under construction
＊15 : Licensed under the old regulatory standards
(Note) Only the findings from the questionnaire are posted.

Source: Trends in nuclear power development in the world (2024)

How a Fast Breeder Reactor (FBR Works)



Source: Ministry of Education, Culture, Sports, Science and Technology

A Comparison of Nuclear Reactors

	Neutron that contributes to fission	Fuel	Moderator	Coolant	Conversion Ratio*
Fast breeder reactor (FBR)	Fast neutron	Fissile plutonium about 16 to 21% Depleted uranium about 79-84% (Blanket fuel is depleted uranium only.)	—	Sodium	Approx. 1.2
Lightwater reactor (BWR, PWR)	Thermal neutron	Uranium-235: 3-5% Uranium-238: 95-97%	Light water	Light water	Approx. 0.6

*Conversion Ratio: Percentage of fuel generated relative to fuel consumed as 1.0.

Amount of Spent Fuel Stored at Nuclear Power Plants

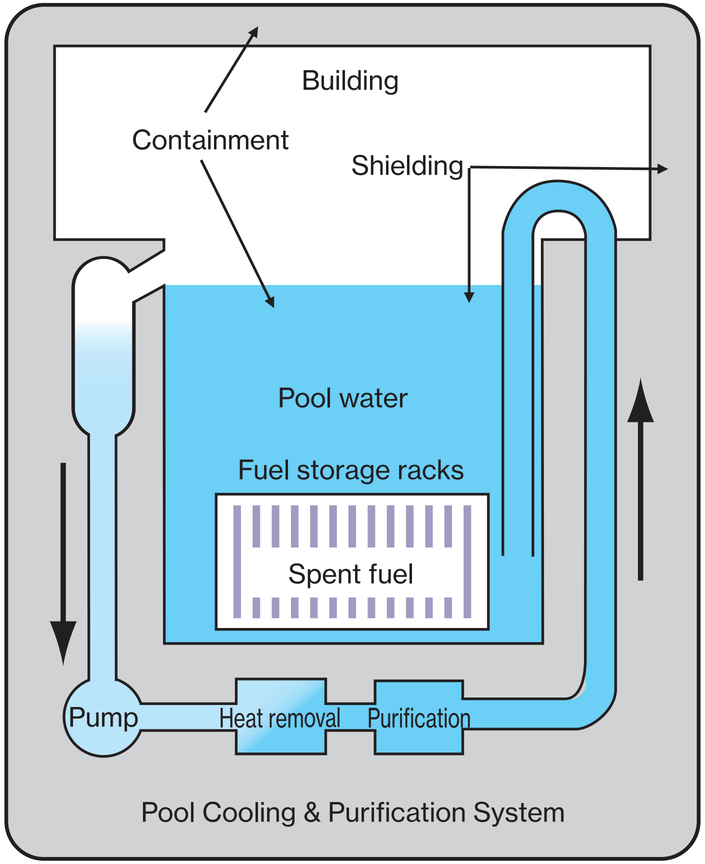
Power Company	Power Plant	1 Reactor Core (tU)	1 Replacement Worth (tU)	As of the end of Dec. 2024	
				Spent Fuel in Storage (tU)	Legally Required Capacity(tU)
Hokkaido Electric Power	Tomari	170	50	400	1,070
Tohoku Electric Power	Onagawa	200	40	490	860
	Higashidōri	130	30	100	440
Tokyo Electric Power (TEPCO)	Fukushima Daiichi	580	140	2,130	2,260
	Fukushima Daini	0	0	1,650	1,880
	Kashiwazaki-Kariwa	960	230	2,360	2,910
Chubu Electric Power	Hamaoka	410	100	1,130	1,300
Hokuriku Electric Power	Shika	210	50	150	740
Kansai Electric Power	Mihama	70	20	500	620
	Takahama	290	100	1,480	1,730
	Ohi	180	60	1,870	2,100
Chugoku Electric Power	Shimane	100	20	480	700
Shikoku Electric Power	Ikata	70	20	770	960
Kyushu Electric Power	Genkai	180	60	1,210	1,540
	Sendai	150	50	1,140	1,340
The Japan Atomic Power Company	Tsuruga	90	30	630	910
	Tokai Daini	130	30	370	440
Total		**3,920**	**1,030**	**16,880**	**21,790**

(Note 1) According to legal requirements, the capacity required is equal to the storage capacity minus the capacity for 1 reactor core. For plants that have ceased operation, it is assumed to be the same as the storage capacity.
(Note 2) Because Reactor 1 and Reactor 2 of the Hamaoka plant and Reactor 1 of the Ikata plant are being decommissioned, and the removal of fuel is completed, they are excluded from the legally required capacity.
(Note 3) Because Fukushima Daiichi is being decommissioned, extension of the dry cask temporary storage facility is excluded due to the subsequent decommissioning work with reference to the value of the first promotion council (as of the end of September 2015) as a reference value.
(Note 4) Due to rounding, the total value may not equal the sum of the individual items.

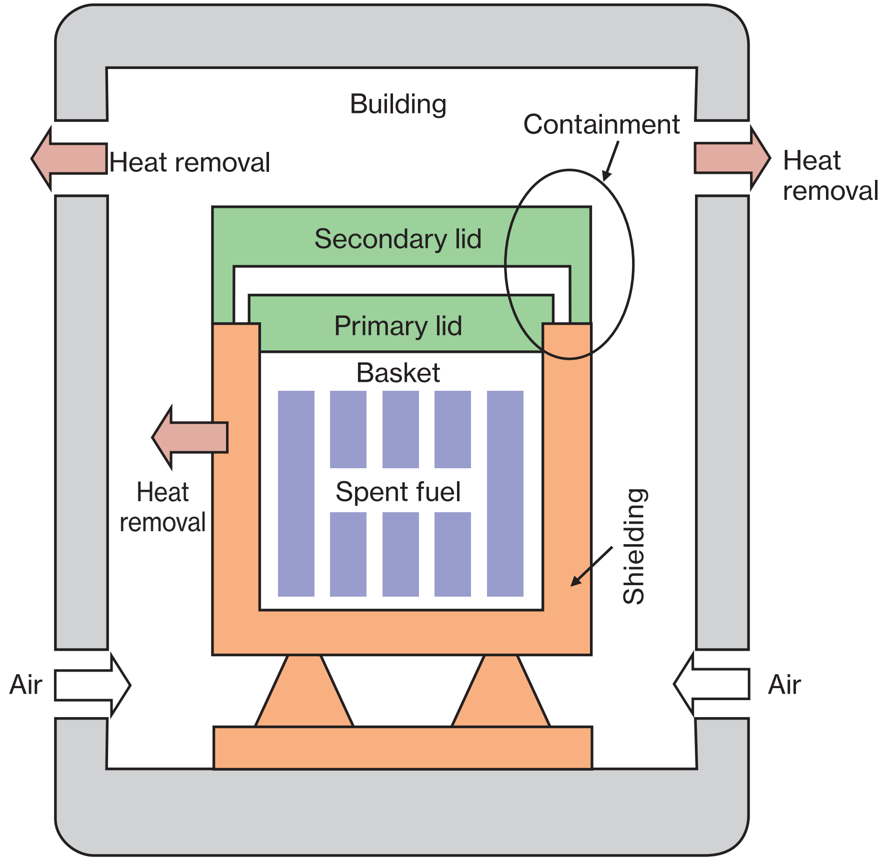
Source: The Federation of Electric Power Companies of Japan

Methods of Midterm Storage of Spent Fuel (Example)

Wet Pool Storage System



Dry Metal Cask Storage System



Spent Fuel Interim Storage Facility

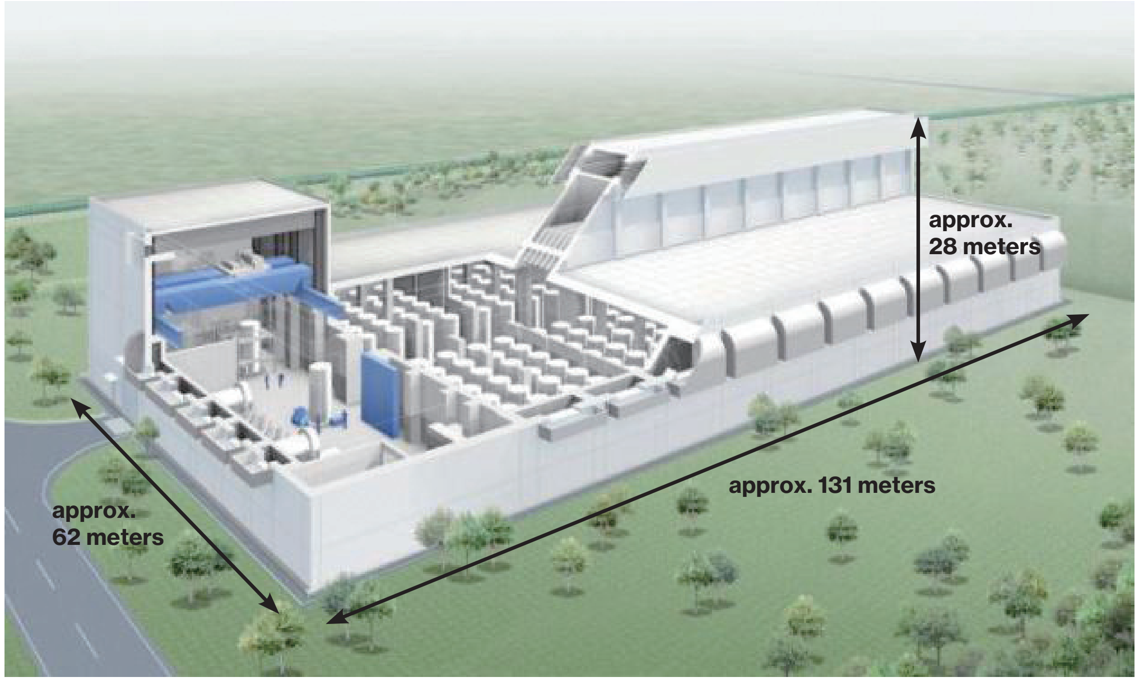
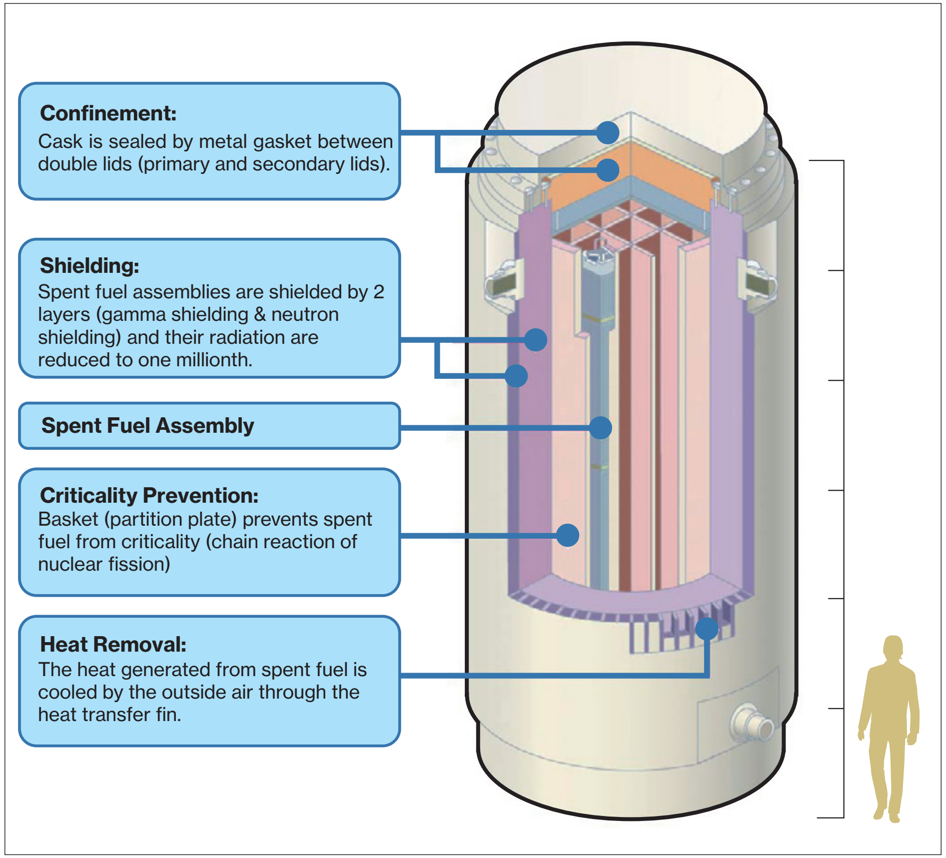


Image for the Recyclable Fuel Storage Center which is under construction in Mutsu City, Aomori Prefecture
(storage capacity: 3,000tU)

Cask for Transport & Storage



Source: Recyclable-Fuel Storage Company, Outline of construction work for the storage building, with others

Safety Regulation Flow of Nuclear Fuel Transport

Design Stage

Approval of designs of materials to be transported

Authorities:
- Land transport included: Nuclear Regulation Authority or Ministry of Land, Infrastructure, Transport and Tourism
- Marine transport only: Ministry of Land, Infrastructure, Transport and Tourism

Manufacturing Stage

Approval of containers

Authorities:
- Land transport included: Nuclear Regulation Authority or Ministry of Land, Infrastructure, Transport and Tourism
- Marine transport only: Ministry of Land, Infrastructure, Transport and Tourism

Before Transportation Stage

Inspection of materials to be transported

Authorities:
- Land transport included: Nuclear Regulation Authority or Ministry of Land, Infrastructure, Transport and Tourism
- Marine transport only: Ministry of Land, Infrastructure, Transport and Tourism

Inspection of transport methods

Authorities:
Ministry of Land, Infrastructure, Transport and Tourism

Notification of transport

Authorities:
- Land transport: Public Safety Commission
- Marine transport: Regional Coast Guard Headquarters of the Japan Coast Guard

Confirmation on agreement of nuclear materials physical protection

Authorities:
Nuclear Regulation Authority

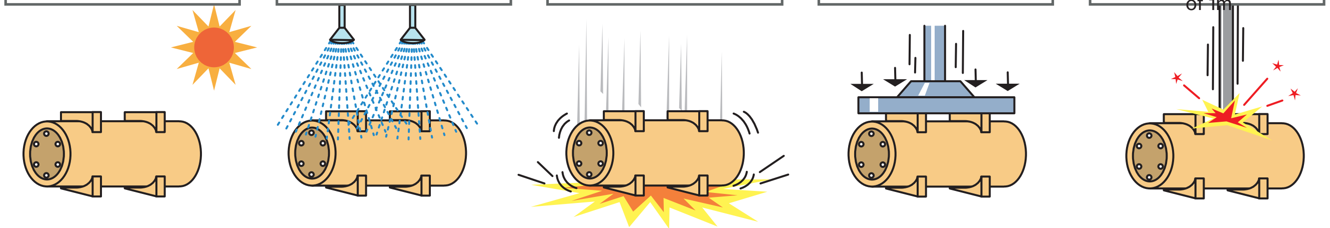
Transportation

In case of land transport, a truck is accompanied with escort cars to lead or guard.

Safety of Transport Containers

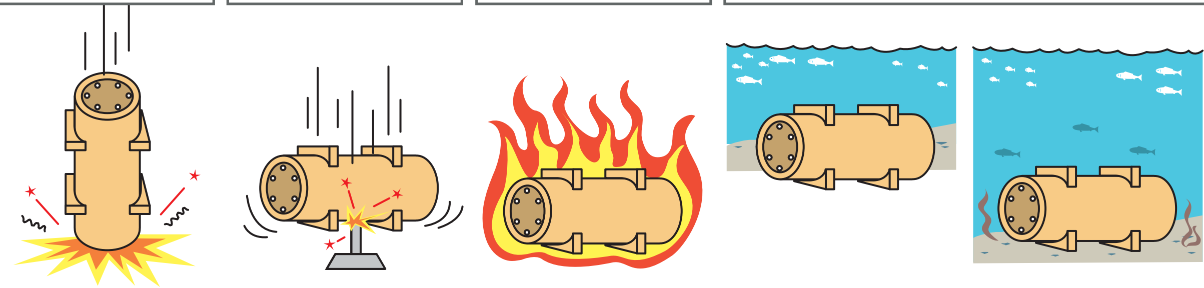
Standard Test Conditions

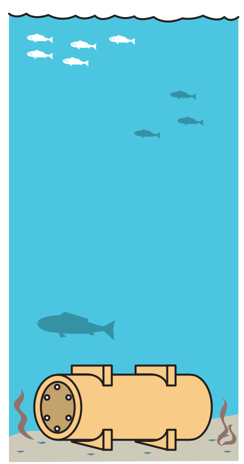
Environmental Test	Water Spray Test	Free Drop Test	Crush Test	Penetration Test
Leave for 1 week at 38℃	Rain at 50mm/hr	Drop from 0.3 to 1.2m	24 hours under 5x its own weight	6kg round bar dropped from a height of 1m



Special Test Conditions

Drop Test I	Drop Test II	Fire-resistance Test	Immersion Test		
Drop from height of 9m	Drop from a height of 1m onto a round bar	30 minutes at 800℃	8 hours under 0.9m of water*1	8 hours under 15m of water	1 hour under 200m of water*2



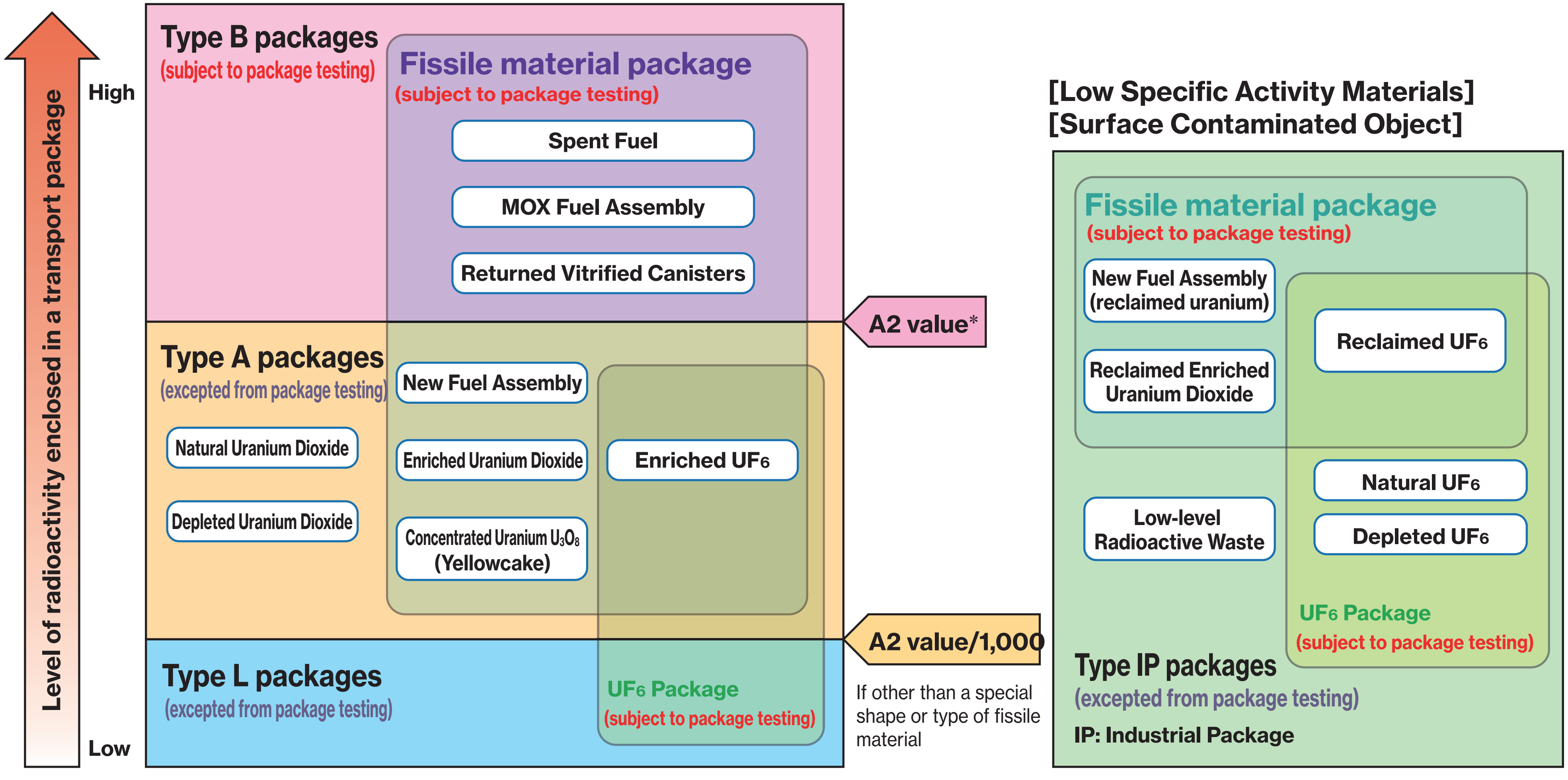


(Note) Transport containers are categorized as type IP, L, A or B, according to the level of radioactivity and the concentration of the nuclear fuel they house. The test conditions in this diagram are based on the technical standards for type B (fissile) transport material.

*1: Fissile Material Transport

*2: If the radioactivity of materials housed exceeds $10^5 A_2$

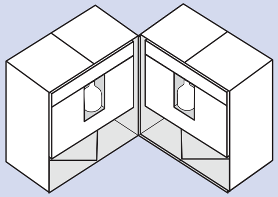
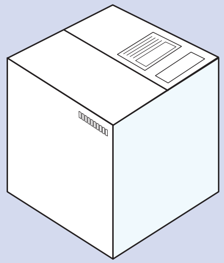
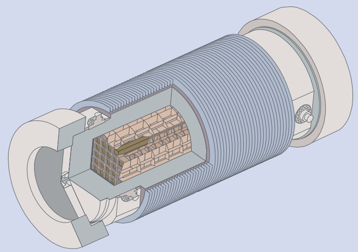
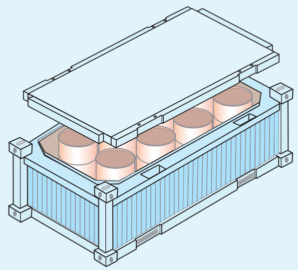
Types of Packages for Transport of Radioactive Materials



*Refers to the regulated values applied to limits of packaged materials for transport.

Source: Nuclear Regulation Authority homepage

Detailed Examples of Packages for Transport of Radioactive Materials

Type	Overview	Representative Example	Detailed Example	
Type L package	Packages whose safe transport is ensured because the allowed radioactive content is restricted to such low levels that the potential hazards are insignificant.	Radio-pharmaceuticals		**Packing standards** ●Can be handled easily and safely ●Cracking/damage will not occur during transport ●Easily decontaminated w/o unnecessary projections
Type A package	Packages whose safe transport is ensured because the radioactive materials contained is limited to a fixed level (mid-level) and it is strong enough to withstand normally expected accident conditions in transport.	New fuel assembly		**Packing standards (In addition to packing standards of type L)** ●10cm or more on each side ●No possibility of cracking or damage in transit at temperatures of 40 to 70℃ ●No leakage at atmospheric pressures of 60kPa or lower
Type B package	As they contain highly radioactive materials, these packages must ensure safety by being extremely strong and able to withstand expected conditions from a serious accident during transport.	Spent fuel		
Type IP package	Packages whose safe transport is ensured because materials are limited to materials with relatively low risk, such as materials with low specific activity.	Low-level radioactive waste		

Source: Ministry of Land, Infrastructure and Transport and Tourism materials

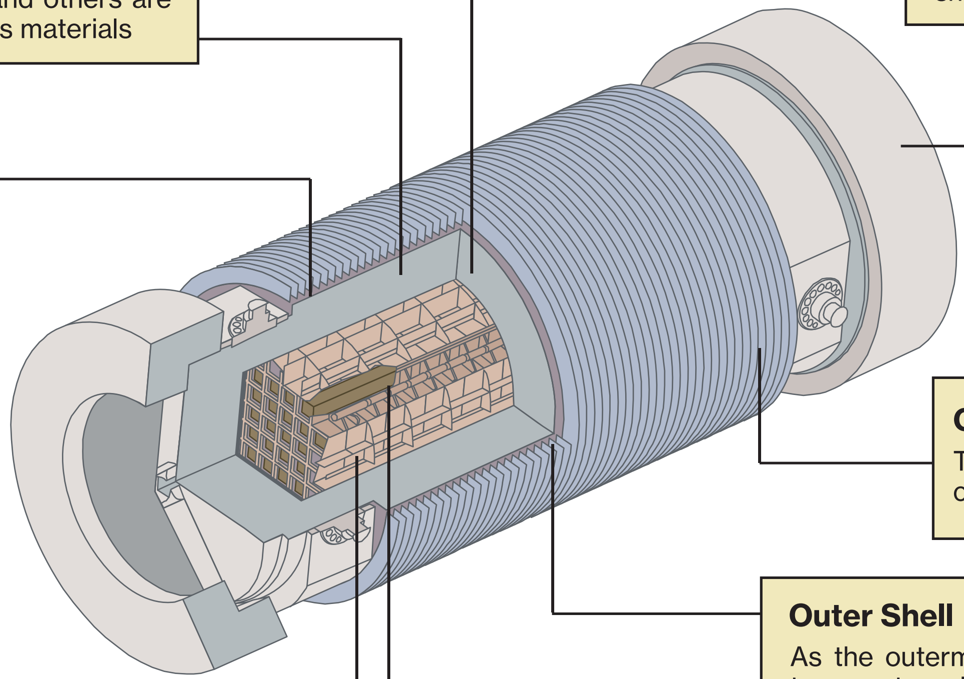
Transport Casks for Spent Fuel (Cask)

Gamma Shielding (lead and others)
Lead and others are used as materials

Inner Shell
As the innermost structural material of the transport cask, the fuel basket is stored inside here

Shock Absorber
Shock absorbers are placed at each end of the cask and absorb the shock if the cask falls

Neutron Shielding (ethylene glycol)
Resin is used



Cooling Fin
The cooling fins work to aid dispersal of heat generated by the used fuel

Outer Shell
As the outermost structural material of the transport cask, the outer shell is designed with cooling fins

Basket
Where the fuel assemblies are stored, neutron absorbent made of boron and stainless steel is used to prevent a fission chain reaction

Fuel Assemblies

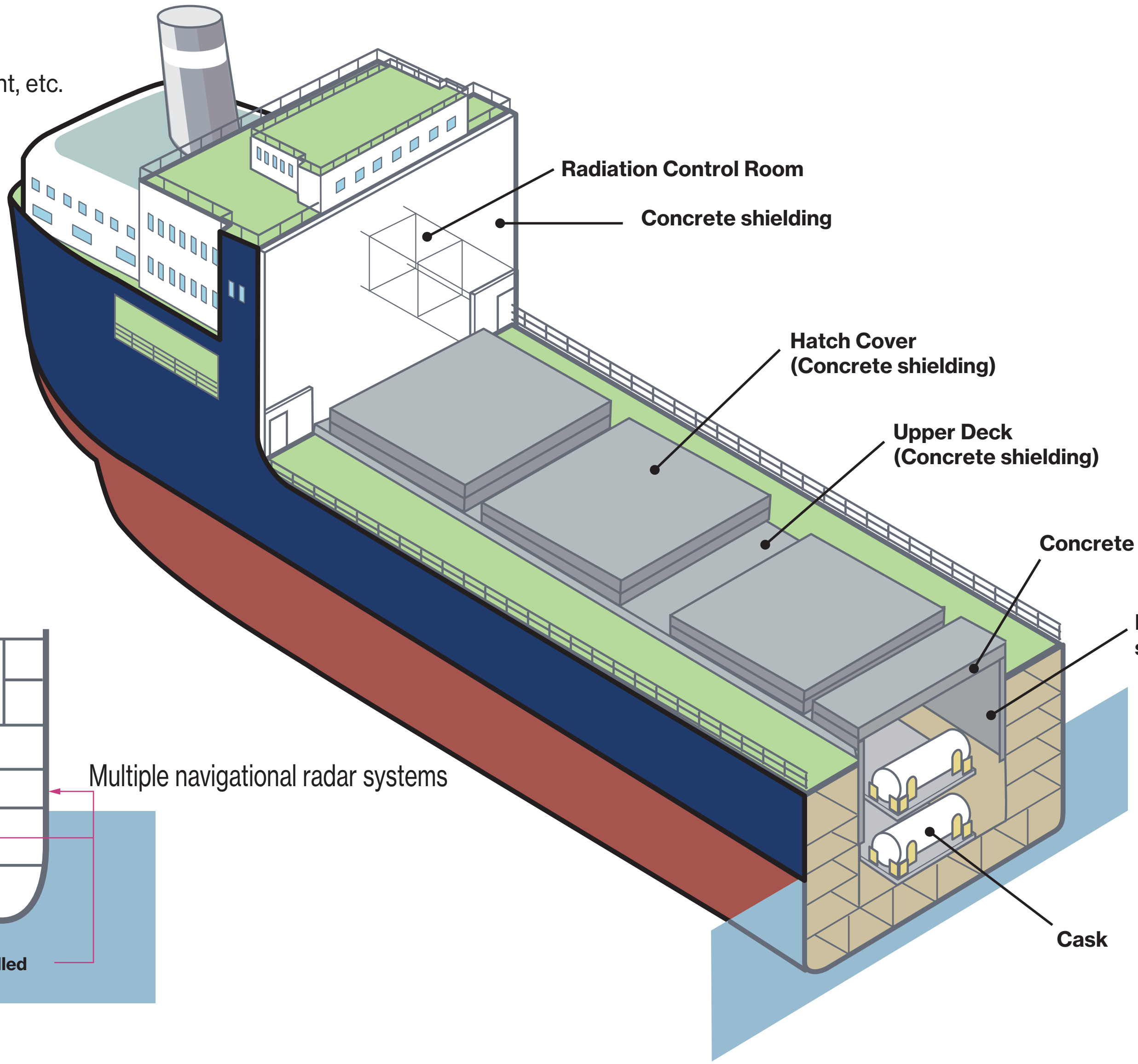
(Note) Figure shown is NFT-38B(Dry Cask) used for domestic transport.

Transport Vessels for Spent Fuel

(1) Securing safe navigation
- Multiple navigational radar systems
- Automatic collision-avoidance assistance equipment, etc.

(2) Safe structure
- Double hulled structures
- Enhanced buoyancy

(3) Fire prevention
- Compartmentalized leak-containment structure
- Hold flooding system, etc.



Cross Section