

## The Status of Plutonium Management in Japan

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Secretariat of the Atomic Energy Commission  
Cabinet Office

### 1. Preface

#### (1) About this report

This is a report on the current status of plutonium management in Japan. In recognition of the importance of securing nuclear non-proliferation throughout research, development and utilization of nuclear energy, the Japanese Government has strictly controlled all nuclear materials and activities, putting it under the IAEA (International Atomic Energy Agency) safeguards in accordance with the Nuclear Non-Proliferation Treaty (NPT). Especially for plutonium, the Japanese Government has firmly maintained the principle of not possessing plutonium reserves whose purpose of utilization is unspecified. In order to assure its transparency domestically and internationally, Japan has published the status of plutonium management including usage and stockpile both within and outside Japan since 1994. Japan has also annually reported the status to the IAEA in conformity with the “Guideline for the Management of Plutonium.”

#### (2) Overview of the status of separated plutonium management

As of the end of 2014, the total amount of separated plutonium both managed within and outside of Japan was approximately 47.8 tons, approximately 10.8 tons of which was held domestically and the rest of approximately 37.0 tons was held abroad.

The stockpile held abroad was separated from spent fuel of Japanese nuclear power plants in reprocessing facilities in the UK and France under contracts with Japanese electric utilities. ①Reprocessing of spent fuel which was consigned to France has been completed and approximately 16.3 tons of separated plutonium is held there at of the end of 2014. ②In the U.K, approximately 20.7 tons of separated plutonium is held including approximately 0.7 ton which was separated and added to the stock in 2014. Approximately 1 ton of plutonium from the remaining spent fuel consigned to the U.K. will be separated and added to the stockpile by 2018, when the reprocessing facility in the U.K. is scheduled to be closed.

## The Status of Separated Plutonium Management

&lt;Unit: t Pu&gt;

				As of the end of the year 2013	As of the end of the year 2014	
Total (domestic and overseas inventories)				47.1	47.8	
Breakdown	Domestic			10.8	10.8	
	Overseas	(Total)		36.3	37.0	
		Breakdown	U.K.		20.0	20.7
			France		16.3	16.3

## (3) Safeguards Statement for 2014

The IAEA Board of Governors in June 2015 concluded that *“the Secretariat found no indication of the diversion of declared nuclear material from peaceful nuclear activities and no indication of undeclared nuclear material or activities.”* (broader conclusion) in Japan based on IAEA safeguards activities implemented during 2014.

## 2. The Current Status of Plutonium Management in Japan

The status of separated plutonium management in Japan as of the end of the year 2014 is given on the separate sheet attached herewith. The amounts of plutonium in tables are given in kilograms unless otherwise mentioned. Figures in brackets are the data published last year.

## 3. Notes on the Data in the Attachment

“Separated plutonium held in Japan” is plutonium that has been separated at reprocessing facilities and held for loading into nuclear reactors including the following facilities:

- 1) Reprocessing facilities: in the status of plutonium nitrate in the separation and purification processes, or of plutonium oxide both in the co-conversion process and in containers.
- 2) Fuel fabrication facilities: plutonium oxide held as raw materials, in the stage of testing or fabrication, or contained in newly fabricated fuel.
- 3) Nuclear reactors and other facilities: plutonium oxide contained in un-irradiated new fuels held at Joyo, Monju and commercial reactor sites (this includes the fresh mixed oxide fuels unloaded from the reactor core),

and that used for research or held as both irradiated and un-irradiated fuels for critical facilities at research and development facilities.

“Separated plutonium held abroad” is plutonium that has been separated by reprocessors in the U.K. and France under contracts with Japanese electric utilities, but not yet returned to Japan. Basically, this plutonium is to be fabricated into mixed oxide fuels overseas and be utilized at light water reactors (LWRs) in Japan.

Whereas “Separated plutonium held in Japan” given in Section 1 of the Attachment is the amount of plutonium held at a specific point in time (i.e. at the end of the year 2014), “Separated plutonium in use” given in Section 2 is the amount of plutonium in various stages of utilization.

Also attached are the following five references.

[References]

- Reference 1 The amount of plutonium held and loaded in nuclear reactors and other facilities in Japan at the end of the year 2014.
- Reference 2 The balance of separated plutonium held in Japan at the end of the year 2014.
- Reference 3 The Status of Separated Plutonium in Japan (2014) (illustration)
- Reference 4 The amount of plutonium held in Japan to be published by the IAEA in accordance with *the Guidelines for the Management of Plutonium*.
- Reference 5 The amount of plutonium held in each country at the end of the year 2013 published by the IAEA in accordance with *the Guidelines for the Management of Plutonium*.

The Status of Separated Plutonium Management in Japan as of the End of the Year 2014

1. Separated plutonium in storage

Figures in brackets are the data published last year for the end of year 2013

(1) Separated plutonium held in Japan

<Unit: kg Pu>

Reprocessing Facilities			Japan Atomic Energy Agency (JAEA) Reprocessing Plant	Japan Nuclear Fuel Limited (JNFL) Reprocessing Plant	Total
	Breakdown (Note 1)	Plutonium nitrate, etc. (Dissolved into nitric acid for reprocessing)	577(664)	284(283)	862(947)
		Plutonium oxide (held as mixed oxide in containers)	131(84)	3,329(3,329)	3,460(3,412)
	Total		709(748)	3,613(3,611)	4,322(4,359)
Fissile Plutonium		467(496)	2,348(2,347)	2,815(2,843)	

Fuel fabrication Facilities			JAEA Plutonium Fabrication Plant	
	Breakdown (Note 2)	Plutonium oxide (held in plutonium oxide containers)	1,974(1,937)	
		Plutonium in the stage of testing or fabrication	983(981)	
		New fuel, etc. (held as finished fuel assemblies, etc.)	446(446)	
Total		3,404(3,364)		
Fissile Plutonium		2,361(2,333)		

Reactors and Other Facilities			Joyo	Monju	Commercial Reactors	R&D Facilities (Note 3)
	Un-irradiated new fuel held at nuclear reactor sites, etc.		134 (134)	31 (31)	2,501 (2,501)	444 (444)
	Total		3,109(3,109)			
Fissile Plutonium		2,133(2,133)				

Total		10,835(10,833)	
Fissile Plutonium		7,310(7,309)	

(Note 1) Changes of the figures may occur not only from the conversion of plutonium nitrate into plutonium-oxides, but also from possible samplings for analysis and inspection purposes and the transfer between the reprocessing, storage and fabrication facilities.

(Note 2) Changes of the figures may occur not only from the material flows in the course of the fuel fabrication processes, but also possible from the movements of materials between material balance areas in a facility caused by reuses of out-specification products, storing of new fuels.

(Note 3) "R&D Facilities" includes critical assemblies and other R&D facilities.

(2) Separated plutonium held abroad

This is the plutonium that was separated by reprocessors in the U.K. and France under the reprocessing contracts with Japanese electric utilities. Basically, this plutonium is to be fabricated into mixed oxide fuels overseas, imported into Japan for use in light water reactors (LWRs). Thus, "Separated plutonium held abroad" should not be a concern from the peaceful use point of view. However, for the sake of better transparency, the current status of separated plutonium held abroad for the fabrication of fuel is also shown below.

(Note 4) <Unit: kg Pu>

	Separated plutonium	
		Fissile Plutonium
U.K.	20,696(20,002)	13,939(13,526)
France	16,278(16,310)	10,572(10,604)
Total	36,974(36,312)	24,511(24,130)

(Note 4) Nuclear losses (refer to Note 2 of Reference 2) are taken into account in the assessment of the amount of plutonium held in reprocessing facilities.

2. Utilization of separated plutonium from Jan. to Dec., 2014

Figures in brackets are the data for the end of the year 2013

(1) The amount of plutonium-oxide recovered <Unit: kg Pu>

Amount of plutonium-oxide recovered (Note 5)	JAEA Reprocessing Plant	JNFL Reprocessing Plant	Total
	86 (0)	0 (0)	86 (0)

(2) The amount of plutonium in fuel fabrication processes <Unit: kg Pu>

Amount of plutonium in fuel fabrication processes (Note 6)	for Monju, Joyo, etc.
	0 (0)

(3) The amount of plutonium loaded in nuclear reactors <Unit: kg Pu>

Amount of plutonium loaded in nuclear reactors (Note 7)	Nuclear Reactors
	0 (0)

(Note 5) "Amount of plutonium-oxide recovered" is defined as the amount of plutonium in oxide form (MOX powder) converted from plutonium nitrate at reprocessing facilities.

(Note 6) "Amount of plutonium in fuel fabrication processes" is defined as the net amount of plutonium transferred from raw materials storage areas into fabrication process areas at fuel fabrication facilities.

(Note 7) "Amount of plutonium loaded" is defined as the amount of plutonium loaded into reactor cores for use as fuel (to be irradiated).

(Note 8) The total figures may not agree completely due to rounding.

The amount of plutonium held and loaded in nuclear reactors and other facilities in Japan at the end of the year 2014.

			Plutonium held(Note 1)		Plutonium newly loaded(Note 2)		(Reference Data) Plutonium loaded(un-irradiated) minus – unloaded plutonium (irradiated) (Note 3)	
			Separated Plutonium		Separated Plutonium		Total (kg Pu)	Fissile plutonium (kg Puf)
			Total (kg Pu)	Fissile plutonium in total (kg Puf)	Total (kg Pu)	Fissile plutonium (kg Puf)		
Japan Atomic Energy Agency	Joyo	134	98	–	–	261	184	
	Monju	31	21	–	–	1,533	1,069	
Tokyo Electric Power Company	Fukushima Daiichi Unit 3	–	–	–	–	210	143	
	Kashiwazaki Kariwa Unit 3	205	138	–	–	–	–	
Chubu Electric Power Company Hamaoka Unit 4		213	145	–	–	–	–	
Kansai Electric Power Company	Takahama Unit 3	901	585	–	–	368	221	
	Takahama Unit 4	184	110	–	–	–	–	
Shikoku Electric Power Company Ikata Unit 3		198	136	–	–	633	436	
Kyushu Electric Power Company Genkai Unit 3		801	516	–	–	677	468	
Research and Development Facilities	Japan Atomic Energy Agency	Fast Critical Assembly in Tokai R&D Center	331	293				
		Deuterium Critical Assembly in Oarai R&D Center	87	72				
		Static Experiment Critical Facility and Transient Experiment Critical Facility in Tokai R&D Center	15	11				
	Other facilities	11	9					

(Note 1) Plutonium held at the end of 2014

(Note 2) Plutonium loaded during the period from January 2014 to December 2014

(Note 3) The figures represent the total amount of plutonium loaded into reactor cores by the end of 2014 subtracted by the total amount of unloaded plutonium from reactor cores by the end of 2014. It is equivalent to the amount of plutonium staying in the reactor cores at the end of 2014, with the proviso that the amount does not take into account the nuclear losses. For commercial reactors, some irradiated fuels may be removed to spent fuel pools temporarily for periodic inspection.

Additional information for reference (as of the end of 2014):

Irradiated plutonium contained in spent fuel in the storage facilities at reactor sites: 134,425kg Pu

Irradiated plutonium contained in spent fuel in the storage facilities at reprocessing plants: 26,650kg Pu

Small amount of plutonium contained in radioactive nuclear waste and recognized as irrecoverable for the time being: 148kg Pu

## The Balance of Separated Plutonium held in Japan at the end of the year 2014.

Unit: kg Pu

<Total> <sup>(Note1)</sup>		
Total amount of plutonium newly separated at reprocessing facilities		0
Total amount of plutonium newly loaded in nuclear reactors		0
Variance in processes at facilities		2
Total amount of plutonium returned from abroad		0
Increase by unloading from a reactor		0
Balance		2

## [JAEA Reprocessing Facility]

From separation and purification process to storage of raw material at co-conversion process in the reprocessing plant <sup>(Note1)</sup>				
Inventory as of Jan. 1, 2014 (the end of the year 2013)			748	
increase and decrease	Separation of plutonium (in 2014)		0	
	Plutonium shipped out (in 2014)		Δ39	
	Variance in processes at reprocessing facility <sup>(Note 2)</sup>		Δ0	
	Breakdown	Transfer to retained waste		Δ0.1
		Retransfer from retained waste		0.0
		Nuclear loss		Δ1.1
		Measured discard		0.0
Material unaccounted for (MUF)		1.2		
Inventory as of the end of Dec. 2014			709	

## [JAEA Plutonium Fabrication Facility]

From raw material of MOX to fuel assembly products <sup>(Note1)</sup>				
Inventory as of Jan. 1, 2014 (the end of the year 2013)			3,364	
increase and decrease	Plutonium received (in 2014)		39	
	Plutonium shipped out (in 2014)		0	
	Variance in processes at fuel fabrication facility <sup>(Note 2)</sup>		1	
	Breakdown	Shipper/receiver difference		0.0
		Transfer to retained waste		Δ0.0
		Retransfer from retained waste		0.0
		Nuclear loss		Δ0.6
Material unaccounted for (MUF)		1.4		
Inventory as of the end of Dec. 2014			3,404	

[Nuclear Reactors and Other Facilities]		
“Joyo”, “Monju”, “Commercial Reactors”, and “R&D Facilities” (Note1)		
Inventory as of Jan. 1, 2014 (the end of the year 2013)		3,109
increase and decrease	Plutonium received (in 2014) The amount includes the plutonium returned from oversea reprocessing plants.	0
	Plutonium loading (in 2014)	0
	Plutonium shipped out (in 2014)	0
	Increase by unloading from a reactor (the amount for the year 2014)	0
Inventory as of the end of Dec. 2014		3,109

[JNFL Reprocessing Facility]			
From separation and purification process to storage of raw material at mixed conversion process in the reprocessing facility (Note1)			
Inventory as of Jan. 1, 2014 (the end of the year 2013)		3,611	
increase and decrease	Separation of plutonium (in 2014)	0	
	Plutonium shipped out (in 2014)	△0	
	Variance in processes at reprocessing facility (Note 2)		2
	Breakdown	Transfer to retained waste	△0.0
		Retransfer from retained waste	0.0
		Nuclear loss	△0.9
		Measured discard	0.0
		Plutonium sample received	0.1
Material unaccounted for (MUF)		2.5	
Inventory as of the end of Dec. 2014		3,613	

(Note 1) The total may not agree due to rounding. “△” indicates consequential decrease.

(Note 2) The variances in processes at each facility includes, in addition to receipts into and shipments from the facility, inventory change in the material control and accounting (shipper/receiver difference, transfer to retained waste, retransfer from retained waste, nuclear loss, measured discard and so on), and material unaccounted for. The definition of inventory change and material unaccounted for are described below. These are concepts recognized internationally in the measurement and control of nuclear fuel materials. The variance that causes the reduction of inventory is shown with “△”.

○ Shipper/receiver difference:

The difference between the quantity of nuclear fuel materials as status by the shipping side and that as measured by the receiving side when nuclear fuel materials are transferred between different facilities.

○ Transfer to retained waste:

Amount of the nuclear fuel materials that are removed from the booked inventory, which is deemed to be in unrecoverable status for the time being but which is held, such as plutonium contained in high level radioactive liquid or low level radioactive liquid generated in the process of recovering nuclear fuel materials from spent fuel solution.

○ Retransfer from retained waste:

Amount of the nuclear fuel materials that had been retained as waste but was re-classified as the booked inventory in order to be processed for volume reduction and other purposes.

○ Nuclear loss:

Amount of the loss (decrease) of nuclear fuel materials as a result of natural decay.

○ Measured discard:

Amount of the nuclear fuel materials that has been measured or estimated on the basis of measurements, and disposed of in such a way (vitrification, etc.) that is not suitable for further nuclear use.

○ Material unaccounted for (MUF):

The difference between the “booked inventory” and the “physical inventory” that is defined by actual measurement. MUF is inevitably generated from measurement error or adhesion of plutonium to equipments in a facility where plutonium is treated in powder or liquid status.

# - The Status of Separated Plutonium in Japan (2014) -

Unit: kg Pu

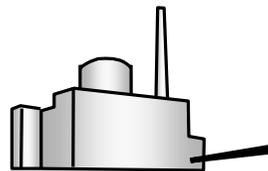
## [Separated plutonium held abroad]

Total amount abroad	36,974
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Total amount transported from abroad	0
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## [Amount of Holdings]

New fuel and for R&D	3,109
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**Nuclear Reactors and Other Facilities**

(Transferred amount in a facility and variances in processes at facilities)

[Total amount loaded] Amount of plutonium loaded into reactors	0
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Increase by unloading of the unirradiated fuel	0
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(Transferred amount in a facility and variation in processes at a facility)

[Total amount separated] Amount of reprocessed spent fuel	0
[Amount recovered] Amounts converted from plutonium nitrate to plutonium oxide	86

Variances in processes	2
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Spent Fuels

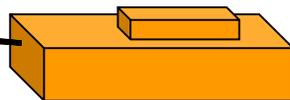
<b>Total in Japan</b>	<b>10,835</b>
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(Transferred amount in a facility and variation in processes at a facility)

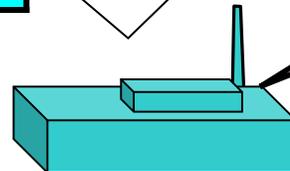
Total amount shipped out	0
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[Used amount] Amount of plutonium in fuel fabrication processes	0
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Variances in processes	1
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**Fuel Fabrication Facilities**



**Reprocessing Facilities**

## [Amount of Holdings]

Plutonium oxide	1,974
Plutonium in the stage of testing or fabrication	983
New fuel, etc.	446
<b>Total</b>	<b>3,404</b>

Total amount shipped out	39
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## [Amount of Holdings]

Plutonium nitrate, etc.	862
Plutonium oxide	3,460
<b>Total</b>	<b>4,322</b>

(Note 1) "Amount of Holdings" is the figure as of the end of the year 2014.  
 (Note 2) "Transferred amount in a facility and variances in processes at facility" shows the figure for one year in 2014.  
 (Note 3) "Δ" indicates decrease.

The Amount of Plutonium Held in Japan to be published by the IAEA in accordance with  
*the Guidelines for the Management of Plutonium*  
 (as of the end of the year 2014. Previous year's figures in brackets)

Annual figures for holdings of civil un-irradiated plutonium *1	(Unit: t Pu)	
1. Un-irradiated separated plutonium in product stores at reprocessing plants	4.3	(4.4)
2. Un-irradiated separated plutonium in the course of manufacture or fabrication and plutonium contained in un-irradiated semi-fabricated or unfinished products at fuel or other fabricating plants or elsewhere	3.0	(2.9)
3. Plutonium contained in un-irradiated MOX fuel or other fabricated products at reactor sites or elsewhere	3.1	(3.1)
4. Un-irradiated separated plutonium held elsewhere	0.4	(0.4)
[Sum of lines 1-4 above]*2	[ 10.8	(10.8) ]
( i ) Plutonium included in lines 1-4 above belonging to foreign bodies.	0	( 0)
( ii ) Plutonium in any of the forms in lines 1-4 above held in locations in other countries and therefore not included above.	37.0*3	(36.3*3)
(iii) Plutonium not included in lines 1-4 above which is in international shipment prior to its arrival in the recipient Status.	0	( 0)

Estimated amount of plutonium contained in spent civil reactor fuel *4	(Unit: t Pu)	
1. Plutonium contained in spent fuel at civil reactor sites.	134	(134)
2. Plutonium contained in spent fuel at reprocessing plants.	27	( 27)
3. Plutonium contained in spent fuel held elsewhere.	<0.5	( <0.5)
[Sum of lines 1-3 above]*5	[ 161	(160) ]
(Definition)		
Line 1: covers estimated amounts of plutonium contained in fuel discharged from civil reactors		
Line 2: covers estimated amounts of plutonium contained in fuel received at reprocessing plants but not yet reprocessed.		

\*1: Rounded to 100 kg plutonium.

\*2, 5: The sum is calculated for the sake of convenience and it is out of the scope of the report in accordance with the Guidelines.

\*3: Loss of Pu-241 due to radioactive decay is taken into account in the assessment of the amount of fissile plutonium held at the overseas reprocessing plants.

\*4: Rounded to 1,000 kg plutonium.

The Amount of Plutonium <sup>(note 1)</sup> Held in Each Country at the End of the Year 2013  
Published by the IAEA in Accordance with *the Guidelines for the Management of  
Plutonium*

(Unit: t Pu)

	Un-irradiated plutonium * <sup>1</sup>	Plutonium contained in spent fuel * <sup>2</sup>
U.S	49.0	617
Russia	51.9	140.0
U.K.	123.0	31
France	78.1	268.9
China * <sup>3</sup>	13.8kg	-
Japan	10.8	161
Germany	3.0	109.5
Belgium	1.4	38
Switzerland	< 50kg	18

(note1) Sum of civil plutonium and plutonium no longer required for defense purpose.

\*<sup>1</sup>: Values rounded to 100 kg plutonium. The items reported as less than 50 kg are not included.

\*<sup>2</sup>: Values rounded to 1,000 kg plutonium, The items reported as less than 500 kg are not included.

\*<sup>3</sup>: China declared that it published only the amount of un-irradiated plutonium.

A short history of *the Guidelines for the Management of Plutonium*

In Feb.1994, the nine countries, i.e. U.S., Russia, U.K., France, China, Japan, Germany, Belgium and Switzerland started to deliberate the establishment of an international framework aiming at enhancing the transparency of plutonium utilization.

In Dec.1997, these nine countries adopted *the Guidelines for the Management of Plutonium* that provided the basic norms about plutonium management, transparency through publication of the amount of plutonium held in each country and the importance of non-proliferation.

In Mar.1998, the IAEA published for the first time the amount of plutonium held in each country and the policy statement of each country about plutonium utilization reported to the IAEA in accordance with the Guideline.