Unofficial Translation

The Status Report of Plutonium Management in Japan - 2015 -

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Office of Atomic Energy Policy
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 ensuring nuclear non-proliferation throughout research, development and utilization of nuclear energy, the Japanese Government has strictly controlled all nuclear materials and activities, putting them under the IAEA (International Atomic Energy Agency) safeguards in accordance with the Nuclear Non-Proliferation Treaty (NPT). Particularly, for plutonium, the Japanese Government has firmly maintained the principle of not possessing plutonium reserves whose purpose of utilization is unspecified. For assuring its transparency domestically and internationally, Japan has published the status of management of unirradiated separated plutonium (hereafter referred to as "separated plutonium") 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 2015, the total amount of separated plutonium both managed within and outside of Japan was approximately 47.9 tons, approximately 10.8 tons of which was held domestically and the rest of approximately 37.1 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 contracted out to France has been completed and approximately 16.2 tons of separated plutonium is held there as of the end of 2015. ②In the U.K, approximately 20.9 tons of separated plutonium is held, including approximately 0.2 ton separated and added to the stock in 2015. Approximately 1 ton of separated plutonium from the remaining spent fuel contracted out to the U.K. will be 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

<Unit: t Pu>

				As of the end of the year 2014	As of the end of the year 2015
Total (domestic and overseas inventories)				47.8	47.9
Breakdown	Domestic			10.8	10.8
	Overseas	(Total)		37.0	37.1
		Breakdown	U.K.	20.7	20.9
			France	16.3	16.2

2. The Current Status of Separated Plutonium Management in Japan

The status of separated plutonium management in Japan as of the end of the year 2015 is given on the separate sheet attached herewith. The amounts of separated 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 unirradiated separated plutonium that has been separated at reprocessing facilities and held in the following facilities before loading into nuclear reactors:

1) Reprocessing facilities: in the state 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 unirradiated new fuels held at Joyo, Monju and commercial reactor sites (this includes fresh mixed oxide fuels loaded into the reactor core but yet to be irradiated, and such fuels unloaded from the reactor core without having been irradiated), and those held for research at research and development facilities of universities or research institutes, and as both irradiated and unirradiated fuels for critical facilities..

"Separated plutonium held abroad" given in Section 1-(2) of the Attachment 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, such 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-(1) of the Attachment is the amount of plutonium held at a specific point in time (i.e. at the end of the year 2015), "Utilization of separated plutonium" given in Section 2 is the amount of plutonium in various stages of utilization.

"Utilization of separated plutonium" in Sections 2-(1), (2), and (3) of the Attachment is to provide further clarity of the plutonium management. It shows the amount of plutonium in oxide form recovered at reprocessing facilities, the net amount of plutonium transferred to fabrication process of the fuel fabrication facilities and the amount of mixed oxide fuels loaded into the reactors and irradiated.

4. Additional reference information

Here are some developments related to the status of separated plutonium in Japan after the end of 2015. (1) At Takahama Unit 3 reactor of the KEPCO, unirradiated MOX fuel with 720kg of separated plutonium, was loaded in December 2015. The reactor went online in January 2016 and the MOX fuel was irradiated. (2) At Takahama Unit 4 reactor, unirradaited MOX fuel with 184kg plutonium, was loaded and irradiated in February 2016. (3) The 331kg separated plutonium fuel, was completely removed from the Japan Atomic Energy Agency (JAEA)'s Fast Critical Assembly (FCA) in its Tokai Research and Development Center and shipped to the United States. The action followed the Japan-US joint pledge announced at the time of the 2014 Hague Nuclear Security Summit. The three events that took place in or after January 2016 will be reflected in the Plutonium Management Status report for 2016.

Also attached are the following five references.

[References]

Reference 1	The amount of separated plutonium held in nuclear reactors and other facilities in Japan at the end of the year 2015.
Reference 2	The balance of separated plutonium held in Japan at the end of the year 2015.
Reference 3	The Status of Separated Plutonium in Japan (2015) (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 2014 published by the IAEA in accordance with *the Guidelines for the Management of Plutonium*.

Attachment

The Status of Separated Plutonium Management in Japan as of the End of the Year 2015

1. Separated plutonium in storage

Figures in brackets are the data published last year for the end of year 2014

(1) Separated plutonium held in Japan <Unit: kg Pu>

			Japan Atomic Energy Agency (JAEA) Reprocessing Plant	Japan Nuclear Fuel Limited (JNFL) Reprocessing Plant	Total
Reprocessing Facilities	Breakdown (Note 1)	Plutonium nitrate, etc. (Dissolved into nitric acid for reprocessing)	266(577)	285(284)	551(862)
		Plutonium oxide (held as mixed oxide in containers)	246(131)	3,329(3,329)	3,575(3,460)
	Total		512(709)	3,614(3,613)	4,126(4,322)
		Fissile Plutonium	336(467)	2,348(2,348)	2,684(2,815)

			JAEA Plutonium Fabrication Plant
Fuel fabrication Facilities	Breakdown (Note 2)	Plutonium oxide (held in plutonium oxide containers)	2,150(1,974)
		Plutonium in the stage of testing or fabrication	999(983)
		New fuel, etc. (held as finished fuel assemblies, etc.)	446(446)
	Total		3,596(3,404)
		Fissile Plutonium	2,490(2,361)

			Joyo	Monju	Commercial Reactors (Note 4)	R&D Facilities (Note 3)
Reactors and Other Facilities	Unirradiated 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		10,832(10,835)
	Fissile Plutonium	7,307(7,310)

(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 possibly 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.

(Note 4) The unirradiated MOX fuel was loaded into the KEPCO's Takahama Unit 3 in December 2015. However, as the fuel was not irradiated as of the end of 2015 (the reactor was reactivated in January 2016), this figure includes 720kg of separated plutonium contained in the loaded irradiated fresh MOX fuel, of which 467kg are fissile plutonium.

(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, and brought 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 5) <Unit: kg Pu>

	Separated plutonium	
		Fissile Plutonium
U.K.	20,868(20,696)	14,032(13,939)
France	16,248(16,278)	10,542(10,572)
Total	37,115(36,974)	24,574(24,511)

(Note 5) 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., 2015

Figures in brackets are the data for the end of the year 2014

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

	JAEA Reprocessing Plant	JNFL Reprocessing Plant	Total
Amount of plutonium-oxide recovered (Note 6)	308 (86)	0 (0)	308 (86)

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

	for Monju, Joyo, etc.
Amount of separated plutonium in fuel fabrication processes (Note 7)	0 (0)

(3) The amount of MOX fuel loaded and irradiated in nuclear reactors <Unit: kg Pu>

	Nuclear Reactors
Amount of MOX fuel loaded and irradiated in nuclear reactors(Note 8)	0 (0)

(Note 6) “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 7) “Amount of separated 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 8) “Amount of MOX fuel loaded and irradiated in nuclear reactors” is defined as the amount of unirradiated MOX fuel which was once held in the nuclear reactor facilities and then loaded into reactor cores for use as fuel and irradiated. The MOX fuels that are loaded into the reactors are either unirradiated or in the process of irradiation. For the sake of clarity, the figure here specifically refers to the irradiated amount. The 720kg of the separated plutonium (of which 467kg are fissile plutonium) contained in the unirradiated MOX fuel that was loaded into the KEPCO’s Takahama Unit 3 reacotor in December 2015 was not irradiated as of the end of 2015 (the reactor was reactivated in January 2016). This amount was therefore not included here.

(Note 9) The total figures may not agree completely due to rounding.

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[Reference 1]

The amount of separated plutonium held in nuclear reactors and other facilities in Japan at the end of the year 2015.

			Plutonium held (Note 1)		Unirradiated plutonium loaded into the reactors out of the "Plutonium held" in the left column (Note 2)		(Reference Data) Total amount of unirradiated separated plutonium loaded into the reactor cores by the end of 2015 minus – Total amount of irradiated plutonium unloaded from the reactor cores (Note 3)	
			Separated Plutonium		Separated Plutonium			
			Total (kg Pu)	Fissile plutonium in total (kg Puf)	Total (kg Pu)	Fissile plutonium (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	720	467	1,088	688
	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) Separated plutonium held at the end of 2015
(Note 2) Unirradiated separate plutonium loaded into the reactors during the period from January 2015 to December 2015
(Note 3) The figures represent the total amount of unirradated separated plutonium loaded into reactor cores by the end of 2015 subtracted by the total amount of irradiated plutonium unloaded from reactor cores by the end of 2015. It is equivalent to the amount of plutonium of the unirradiated MOX fuel staying in the reactor cores at the end of 2015, 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 2015):
Irradiated plutonium contained in spent fuel in the storage facilities at reactor sites: 136,176kg Pu
Irradiated plutonium contained in spent fuel in the storage facilities at reprocessing plants: 26,713kg Pu
Small amount of plutonium contained in radioactive nuclear waste and recognized as irrecoverable for the time being: 148kg Pu

[Reference 2]

The Balance of Separated Plutonium held in Japan at the end of the year 2015.

Unit: kg Pu

<Total> (Note 1)	
Total amount of plutonium newly separated at reprocessing facilities	0
Total amount of plutonium newly loaded in nuclear reactors and irradiated	0
Variance in processes at facilities	△3
Total amount of plutonium returned from abroad	0
Balance	△3

[JAEA Reprocessing Facility]

From separation and purification process to storage of raw material at co-conversion process in the reprocessing plant (Note 1)				
Inventory as of Jan. 1, 2015 (the end of the year 2014)				709
increase and decrease	Separation of plutonium (in 2015)			0
	Plutonium shipped out (in 2015)			△193
	Variance in processes at reprocessing facility (Note 2)			△3
		Breakdown	Transfer to retained waste	△0.1
			Retransfer from retained waste	0.0
			Nuclear loss	△0.7
			Measured discard	0.0
			Material unaccounted for (MUF)	△2.0
Inventory as of the end of Dec. 2015				512

[JAEA Plutonium Fabrication Facility]

From raw material of MOX to fuel assembly products (Note 1)				
Inventory as of Jan. 1, 2015 (the end of the year 2014)				3,404
increase and decrease	Plutonium received (in 2015)			193
	Plutonium shipped out (in 2015)			0
	Variance in processes at fuel fabrication facility (Note 2)			△1
		Breakdown	Shipper/receiver difference	0.0
			Transfer to retained waste	△0.0
			Retransfer from retained waste	0.0
			Nuclear loss	△1.7
			Material unaccounted for (MUF)	0.4
Inventory as of the end of Dec. 2015				3,596

[Nuclear Reactors and Other Facilities]

"Joyo", "Monju", "Commercial Reactors", and "R&D Facilities" (Note 1)		
Inventory as of Jan. 1, 2015 (the end of the year 2014)		3,109
increase and decrease	Plutonium received (in 2015) The amount includes the plutonium returned from oversea reprocessing plants.	0
	Plutonium loading and irradiated (in 2015)	0
	Plutonium shipped out (in 2015)	0
Inventory as of the end of Dec. 2015		3,109

[JNFL Reprocessing Facility]

From separation and purification process to storage of raw material at mixed conversion process in the reprocessing facility (Note 1)				
Inventory as of Jan. 1, 2015 (the end of the year 2014)				3,613
increase and decrease	Separation of plutonium (in 2015)			0
	Plutonium shipped out (in 2015)			△0
	Variance in processes at reprocessing facility (Note 2)			1
		Breakdown	Transfer to retained waste	△0.0
			Retransfer from retained waste	0.0
			Nuclear loss	△0.8
			Measured discard	0.0
			Plutonium sample received	0.1
			Material unaccounted for (MUF)	1.6
Inventory as of the end of Dec. 2015				3,614

(Note 1) The total may not agree due to rounding. "△" indicates consequential decrease. "Total amount of plutonium newly loaded in nuclear reactors and irradiated" in the uppermost section titled <Total> and "Plutonium loading and irradiated (in 2015)" in the table titled "Nuclear Reactors and Other Facilities" do not include the 720kg of the separated plutonium (467kg of fissile plutonium) contained in the unirradiated MOX fuel that was loaded into the KEPCO's Takahama Unit 3 rector in December 2015 since it was not irradiated as of the end of 2015 (the reactor was reactivated in January 2016).

(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 state.

Unofficial Translation
[Reference 3]

- The Status of Separated Plutonium in Japan (2015) -

Unit: kg Pu

[Separated plutonium held abroad]

Total amount abroad	37,115
Total amount transported from abroad	0

[Amount of Holdings]

New fuel and for R&D	3,109

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

[Total amount loaded] Amount of plutonium loaded into reactors and irradiated	0 (Note 4)

Nuclear Reactors and Other Facilities

Spent Fuels

(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	308
Variances in processes	△2

Reprocessing Facilities

[Amount of Holdings]

Plutonium nitrate, etc.	551
Plutonium oxide	3,575
Total	4,126

Total amount shipped out	193

Fuel Fabrication Facilities

(Transferred amount in a facility and variation in processes at a facility)

[Used amount] Amount of plutonium in fuel fabrication processes	0
Variances in processes	△1

[Amount of Holdings]

Plutonium oxide	2,150
Plutonium in the stage of testing or fabrication	999
New fuel, etc.	446
Total	3,596

Total amount shipped out	0

Total amount in Japan	10,832

(Note 1) "Amount of Holdings" is the figure as of the end of the year 2015.
(Note 2) "Transferred amount in a facility and variances in processes at facility" shows the figure for one year in 2015.
(Note 3) "△" indicates decrease.
(Note 4) Separated plutonium contained in the unirradiated MOX fuel that was loaded into the KEPCO's Takahama Unit 3 reactor is not included here as it was not irradiated as of the end of 2015 (the reactor was reactivated in January 2016).

[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*
(as of the end of the year 2015. Previous year's figures in brackets)

Annual figures for holdings of civil unirradiated plutonium [*1] (Unit: t Pu)

1. Unirradiated separated plutonium in product stores at reprocessing plants	4.1	(4.3)
2. Unirradiated separated plutonium in the course of manufacture or fabrication and plutonium contained in unirradiated semi-fabricated or unfinished products at fuel or other fabricating plants or elsewhere	3.1	(3.0)
3. Plutonium contained in unirradiated MOX fuel or other fabricated products at reactor sites or elsewhere	3.1	(3.1)
4. Unirradiated separated plutonium held elsewhere	0.4	(0.4)
[Sum of lines 1-4 above][*2]	[10.7	(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.	37.1[*3]	(37.0[*3])
(iii) Plutonium not included in lines 1-4 above which is in international shipment prior to its arrival in the recipient State.	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.	136	(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]	[163	(161)]
(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.

Additional reference information

Here are some developments related to the status of separated plutonium for civil use in Japan after the end of 2015. (1) At Takahama Unit 3 reactor of the KEPCO, unirradiated MOX fuel with 720kg of separated plutonium, was loaded in December 2015. The reactor went online in January 2016 and the MOX fuel was irradiated. (2) At Takahama Unit 4 reactor, unirradaited MOX fuel with 184kg plutonium, was loaded and irradiated in February 2016. (3) The 331kg separated plutonium fuel, was completely removed from the Japan Atomic Energy Agency (JAEA)'s Fast Critical Assembly (FCA) in its Tokai Research and Development Center and shipped to the United States. The action followed the Japan-US joint pledge announced at the time of the 2014 Hague Nuclear Security Summit. The three events that took place in or after January 2016 will be reflected in the publication for 2016.

[Reference 5]

The Amount of Plutonium (note 1) Held in Each Country at the End of the Year 2014 Published by the IAEA in Accordance with *the Guidelines for the Management of Plutonium*

（Unit：t Pu）

	Unirradiated plutonium*1	Plutonium contained in spent fuel*2
U.S	49.0	637
Russia	6.8	146.5
U.K.	126.3	30
France	78.8	275.6
China*3	25.4kg	-
Japan	10.8	161
Germany	2.1	113
Belgium	0.9	40
Switzerland	< 50kg	18

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

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

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

*3：China declared that it published only the amount of unirradiated 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 on the establishment of an international framework aimed 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.