The Status of Plutonium Management in Japan

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1. Preface

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 the utilization of plutonium, putting it under the IAEA (International Atomic Energy Agency) safeguards in accordance with the Nuclear Non-Proliferation Treaty (NPT) and made effort to assure its transparency to the public at home and abroad. The annual publication of a report on the status of plutonium management in Japan since 1994 is a part of activities in this regard.

2. The Current Status of Plutonium Management in Japan

The status of separated plutonium management in Japan as of the end of the year 2013 is given on the separate sheet attached herewith. The amounts of plutonium in tables are given in kilograms otherwise mentioned. Figures in brackets are the data published last year.

3. Note on the Data in the Attachment

"Separated plutonium held in Japan" is the plutonium that has been separated at a reprocessing facility and held for loading into nuclear reactors, which includes those at the following facilities:

1) Reprocessing facilities: plutonium nitrate in the separation and purification processes, 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 test or fabrication or contained in newly fabricated fuel.
3) Nuclear reactors and other facilities: plutonium contained in un-irradiated

new fuels held at Joyo, Monju and commercial reactor sites (this item includes the fresh mixed oxide fuels unloaded from the reactor core), and that used for research or held as fuels for critical facilities at research and development facilities.

"Separated plutonium held abroad" is the plutonium that has been separated by reprocessors in the UK and France under contracts with Japanese electric utilities, but not yet has been 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 2013), "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. Reference 1 that gives the amount of plutonium held and loaded in each nuclear reactor and other facility, Reference 2 that gives the balance of the separated plutonium held in Japan, Reference 3 that depicts the flow of plutonium in the year 2013, Reference 4 that gives the amount of plutonium held in Japan as of the end of the year 2013 to be published at the IAEA accordance with the Guidelines for the Management of Plutonium, and Reference 5 that gives the total amount of plutonium held in each country as of the end of the year 2012 published at the IAEA in accordance with the Guideline.

[References]

Reference 1	The amount of plutonium held and loaded in nuclear reactors and other facilities in Japan at the end of the year 2013.
Reference 2	The balance of separated plutonium held in Japan at the end of the year 2013.
Reference 3	The Status of Separated Plutonium in Japan (2013)
Reference 4	The amount of plutonium held in Japan to be published through 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 2012 published through 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 2013

1. Separated plutonium in storage

Figures in brackets are the data published last year for the end of year 2012

(1) Separated plutonium held in Japan

<Unit: kgPu>

			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)	664(668)	283(283)	947(951)
		Plutonium oxide (held as mixed oxide in containers)	84(83)	3,329(3,329)	3,412(3,412)
	Total		748(751)	3,611(3,612)	4,359(4,363)
		Fissile Plutonium	496(498)	2,347(2,348)	2,843(2,846)

			JAEA Plutonium Fabrication Plant
Fuel fabrication Facilities	Breakdown (Note 2)	Plutonium oxide (held in plutonium oxide containers)	1,937(1,939)
		Plutonium in the stage of testing or fabrication	981(978)
		New fuel, etc. (held as finished fuel assemblies, etc.)	446(446)
	Total		3,364(3,364)
		Fissile Plutonium	2,333(2,333)

			Joyo	Monju	Commercial Reactors (Note 3)	R&D Facilities (Note 4)
Reactors and Other Facilities	Un-irradiated new fuel held at nuclear reactor sites, etc.		134 (134)	31 (31)	2,501 (959)	444 (444)
	Total		3,109(1,568)			
		Fissile Plutonium	2,133(1,136)			

Total		10,833(9,295)
	Fissile Plutonium	7,309(6,315)

(Note 1) Changes of the figures may occur not only from the conversion of plutonium nitrate into plutonium-oxides (refer to Note 6), 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 (refer to Note 7), but also possible the movements of materials between material balance areas in a facility caused by reuses of out-specification products, storing of new fuels.

(Note 3) The figure includes the fresh mixed oxide fuels unloaded from the reactor core of Genkai No. 3 reactor of Kyushu Electric Company. The 640kgPu(413kgPuf) un-irradiated mixed oxide fuels, were transferred to the fuel pond on the site in March 2013.

(Note 4) “R&D Facilities” includes critical assemblies and other R&D facilities, etc.

(2) Separated plutonium held abroad (Note 5)

This is the plutonium that was separated by reprocessors in the UK 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 at light water reactors (LWRs) in Japan. 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.

	Separated plutonium	
		Fissile Plutonium
UK	20,002(17,052)	13,526(11,622)
France	16,310(17,895)	10,604(11,655)
Total	36,312(34,946)	24,130(23,277)

(Note 5) Nuclear losses (refer to Note 2 of Reference 2) are taken into account in the evaluation of the amount of plutonium held in reprocessing facilities.

2. Utilization of separated plutonium from Jan. to Dec., 2013

Figures in brackets are the data for the end of the year 2012

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

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

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

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

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

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

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

[Reference 1]

The amount of plutonium held and loaded in nuclear reactors and other facilities in Japan at the end of the year 2013.

			Held plutonium (Note 1)		Plutonium newly loaded(Note 3)		(Reference Data) Plutonium loaded(un-irradiated) minus – unloaded plutonium (irradiated) (Note 4)	
			Separated Plutonium		Separated Plutonium			
			Total (kgPu)	Plutonium fissile in total (kgPuf)	Total (kgPu)	Fissile plutonium (kgPuf)	Total (kgPu)	Fissile plutonium (kgPuf)
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(Note 2)	516(Note 2)	–	–	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				

(Note1) Held plutonium at the end of 2013
(Note2) This item includes the fresh unloaded MOX fuel in the reactor core of Genkai No. 3 reactor. The 640kgPu(413kgPuf) un-irradiated MOX fuels, were transferred to the fuel pond on site.
(Note3)Plutonium loaded during the period from January 2013 to December 2013
(Note4) The figures represent the total amount of plutonium loaded into reactor cores by the end of 2013 subtracted by the total amount of unloaded plutonium from reactor cores by the end of 2013. It is equivalent to the amount of plutonium staying in the reactor cores at the end of 2013, 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 2013):
Irradiated plutonium contained in spent fuel in the storage facilities at reactor sites: 133,912kgPu
Irradiated plutonium contained in spent fuel in the storage facilities at reprocessing plants: 26,525kgPu
Small amount of plutonium contained in radioactive nuclear waste and recognized as irrecoverable for the time being: 148kgPu

[Reference 2]

The Balance of Separated Plutonium held in Japan at the end of the year 2013.

Unit: kgPu

<Total> (Note1)	
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	△3
Total amount of plutonium returned from abroad	901
Increase by unloading from a reactor	640
Balance	1,538

[JAEA Reprocessing Facility]

From separation and purification process to storage of raw material at co-conversion process in the reprocessing plant (Note1)				
Inventory as of Jan. 1, 2013 (the end of the year 2012)				751
increase and decrease	Separation of plutonium (in 2013)			0
	Plutonium shipped out (in 2013)			0
	Variance in processes at reprocessing facility (Note 2)			△3
		Breakdown	Transfer to retained waste	△0.1
			Retransfer from retained waste	0.0
			Nuclear loss	△1.2
			Measured discard	0.0
			Material unaccounted for (MUF)	△1.7
Inventory as of the end of Dec. 2013				748

[JAEA Plutonium Fabrication Facility]

From raw material of MOX to fuel assembly products (Note1)				
Inventory as of Jan. 1, 2013 (the end of the year 2012)				3,364
increase and decrease	Plutonium received (in 2013)			0
	Plutonium shipped out (in 2013)			0
	Variance in processes at fuel fabrication facility (Note 2)			0
		Breakdown	Shipper/receiver difference	0.0
			Transfer to retained waste	0.0
			Retransfer from retained waste	0.0
			Nuclear loss	△0.4
			Material unaccounted for (MUF)	0.8
Inventory as of the end of Dec. 2013				3,364

[Nuclear Reactors and Other Facilities]

"Joyo", "Monju", "Commercial Reactors", and "R&D Facilities" (Note1)		
Inventory as of Jan. 1, 2013 (the end of the year 2012)		1,568
increase and decrease	Plutonium received (in 2013) The amount includes the plutonium returned from oversea reprocessing plants.	901
	Plutonium loading (in 2013)	0
	Plutonium shipped out (in 2013)	0
	Increase by unloading from a reactor (the amount for the year 2013)	640
Inventory as of the end of Dec. 2013		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, 2013 (the end of the year 2012)				3,612
increase and decrease	Separation of plutonium (in 2013)			0
	Plutonium shipped out (in 2013)			△0
	Variance in processes at reprocessing facility (Note 2)			△1
		Breakdown	Transfer to retained waste	△0.4
			Retransfer from retained waste	0.0
			Nuclear loss	△0.9
			Measured discard	△0.7
			Material unaccounted for (MUF)	1.2
Inventory as of the end of Dec. 2013				3,611

(Note 1) The total may not agree due to rounding. "△" indicates 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 stated 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 state 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 it 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.

- The Status of Separated Plutonium in Japan (2013) -

Unit: kgPu

[Separated plutonium held abroad]

Total amount abroad	36,312
Total amount transported from abroad	901

[Amount of Holdings]

New fuel and for R&D	3,109

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
Increase by unloading of the unirradiated fuel	640

Spent Fuels

Total amount shipped out	0

Total in Japan 10,833

(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	0

Fuel Fabrication Facilities

(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	0
Variances in processes	△4

Reprocessing Facilities

Total amount shipped out	0

[Amount of Holdings]

Plutonium oxide	1,937
Plutonium in the stage of testing or fabrication	981
New fuel, etc.	446
Total	3,364

[Amount of Holdings]

Plutonium nitrate, etc.	947
Plutonium oxide	3,412
Total	4,359

(Note 1) "Amount of Holdings" is the figure as of the end of the year 2013.
(Note 2) "Transferred amount in a facility and variances in processes at facility" shows the figure for one year in 2013.
(Note 3) "△" indicates decrease.

[Reference 4]

The Amount of Plutonium Held in Japan to be published through the IAEA in accordance with the Guidelines for the Management of Plutonium
(as of the end of the year 2013. Previous year's figures in brackets)

Annual figures for holdings of civil un-irradiated plutonium [*1] (Unit:tPu)

1. Un-irradiated separated plutonium in product stores at reprocessing plants.	4.4	(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.	2.9	(2.9)
3. Plutonium contained in un-irradiated MOX fuel or other fabricated products at reactor sites or elsewhere.	3.1	(1.6)
4. Un-irradiated separated plutonium held elsewhere.	0.4	(0.4)
[Sum of lines 1-4 above][*2]	[10.8	(9.3)]
(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.	36.3[*3]	(34.9[*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:tPu)

1. Plutonium contained in spent fuel at civil reactor sites.	134	(133)
2. Plutonium contained in spent fuel at reprocessing plants.	27	(26)
3. Plutonium contained in spent fuel held elsewhere.	<0.5	(<0.5)
[Sum of lines 1-3 above][*5]	[160	(159)]
(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 evaluating the amount of fissile plutonium held at the overseas reprocessing plants.
*4: Rounded to 1,000 kg plutonium.

[Reference 5]

The Amount of Plutonium (note 1) Held in Each Country at the End of the Year 2012 Published through the IAEA in Accordance with the Guidelines for the Management of Plutonium

（Unit：tPu）

	Un-irradiated plutonium *1	Plutonium contained in spent fuel *2
U.S	49.0	595
Russia	50.7	135.5
U.K.	120.2	31
France	80.6	261.4
China *3	(13.8kg)	(Checked off)
Japan	9.3	159
German	2.4	106.2
Belgium	－*4	－*4
Switzerland	0.0	17

（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 un-irradiated plutonium.

*4：Not available at the time of publication.

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.