The Current Situation of Plutonium Management in Japan

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Cabinet Office
Secretariat of the Atomic Energy Commission

1. Preface

This is a report on the current situation of plutonium management in Japan. Recognizing that it is essential in implementing research, development and utilization of nuclear energy to assure nuclear non-proliferation, 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. To annually publish a report on the situation of plutonium management in Japan is a part of activities in this regard, which started in 1994.

2. The Current Situation of Plutonium Management in Japan

The situation of separated plutonium managed in Japan as of the end of the year 2012 is given on the separate sheet attached. The amounts of plutonium given in tables are weight of the element by kilogram unit except those specified otherwise. Figures in brackets are data published last year.

3. Note on the Data in the Attached Sheet

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

1) Reprocessing facility: plutonium nitrate in the separation and purification processes, plutonium oxide both in the co-conversion process and in containers.
2) Fuel fabrication facility: plutonium oxide stored as raw materials, that in the stage of test or fabrication and that contained in new fuel fabricated.
3) Nuclear reactors and other facilities: plutonium contained in un-irradiated

new fuels stored at Joyo, Monju and commercial reactors, and that used for research or stored as fuels for critical facilities at research and development organizations.

"Separated plutonium in safekeeping abroad" is the plutonium that has been separated by reprocessers in the UK and France under the reprocessing 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 in safekeeping in Japan" given in Section 1 of the Attached Sheet is the amount of plutonium in safekeeping at a certain point in time (as of the end of the year 2012), "Separated plutonium in use" given in Section 2 is the amount of plutonium in various stages of utilization.

Also attached are reference 1 that gives the amount of plutonium stored and loaded in each nuclear reactor and other facility, reference 2 that gives the balance of the separated plutonium stored in Japan, reference 3 that depicts the flow of plutonium in the year 2012, reference 4 that gives the amount of plutonium held in Japan as of the end of the year 2012 to be reported to the IAEA according to the guidelines for the management of plutonium, and reference 5 that gives the sum of the amount of plutonium held in each country as of the end of the year 2011 published through the IAEA in accordance with the guideline.

[References]

Reference 1	The amount of plutonium stored and loaded in each nuclear reactor and other facility in Japan at the end of the year 2012.
Reference 2	The balance of separated plutonium in safekeeping in Japan in 2012.
Reference 3	The situation of management of separated plutonium in Japan (2012).
Reference 4	The amount of plutonium held in Japan to be reported to the IAEA according to the guidelines for the management of plutonium.
Reference 5	The amount of plutonium (note1) held in each country at the end of the year 2011 published through the IAEA accordance with the guidelines for the management of plutonium.

Attached Sheet

The Situation of Separated Plutonium Management in Japan as of the End of the Year 2012

1. Separated plutonium in safekeeping

Figures in brackets are data published last year

(1) Separated plutonium in safekeeping in Japan

<Unit: kgPu>

	Facility Name		Incorporated Administrative Agency, Japan Atomic Energy Agency (JAEA) Reprocessing Plant	Japan Nuclear Fuel Limited (JNFL) Reprocessing Plant	Total
Reprocessing Facilities	Breakdown (Note 1)	Plutonium nitrate, etc. (After dissolution to the process before stored as mixed oxide in containers)	668 (669)	283 (283)	951 (952)
		Plutonium oxide (stored as mixed oxide in containers)	83 (83)	3,329 (3,329)	3,412 (3,411)
	Total		751 (752)	3,612 (3,612)	4,363 (4,364)
		Plutonium fissile in total	498 (499)	2,348 (2,348)	2,846 (2,847)

	Facility Name		JAEA Plutonium Fabrication Plant
Fuel fabrication Facilities	Breakdown (Note 2)	Plutonium oxide (stored plutonium in plutonium oxide containers)	1,939 (1,941)
		Plutonium in the stage of test or fabrication	978 (976)
		New fuel, etc. (stored as finished fuel assemblies, etc.)	446 (446)
	Total		3,364 (3,363)
		Plutonium fissile in total	2,333 (2,333)

	Name of Nuclear Reactor, etc.		Joyo	Monju	Commercial Reactors	R&D Facilities (Note 3)
Reactors and Other Facilities	Unirradiated new fuel stored at nuclear reactor sites, etc.		134 (134)	31 (31)	959 (959)	444 (444)
	Total		1,568 (1,568)			
		Plutonium fissile in total	1,136 (1,136)			

Total		9,295 (9,295)
	Plutonium fissile in total	6,315 (6,316)

(2) Separated plutonium in safekeeping abroad (Note 4)

Safekeeping countries	Separated plutonium	
		Plutonium fissile in total
Recovered in the UK	17,052 (17,028)	11,622 (11,616)
Recovered in France	17,895 (17,931)	11,655 (11,692)
Total	34,946 (34,959)	23,277 (23,308)

2. Separated plutonium in use from Jan. to Dec. in 2012

Figures in brackets are data published last year

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

	JAEA Reprocessing Plant	JNFL Reprocessing Plant	Total
Amount of plutonium-oxide recovered (Note 5)	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 6)	0 (0)

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

	Nuclear Reactors
Amount of plutonium loaded in nuclear reactors (Note 7)	0 (640)

(Note 1) There is not only the “Amount of plutonium-oxide recovered” (refer to Note 5) regarding to the product flow, but the movement between material balance areas in a facility is also needed for the sampling for analysis, inspection, etc.

(Note 2) There is not only the “Amount of plutonium in fuel fabrication processes” (refer to Note 6) regarding to the product flow, but the movement between material balance areas in a facility is also needed for the sampling for analysis, inspection, reuse of out specification, storing of new fuel, etc.

(Note 3) “R&D Facilities” means critical assemblies, etc.

(Note 4) Nuclear losses (refer to (Note 3) of Reference 2) are considered in the evaluation of the amount of plutonium held in reprocessing facilities given in the table of “Separated plutonium in safekeeping abroad.”

(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 nuclear reactors from the viewpoint of showing the separated plutonium that has been actually utilized as fuel.

(Note 8) The total value may not agree to the sum of the numbers given due to rounding off at the first decimal place.

[Reference 1]

The amount of plutonium stored and loaded in each nuclear reactor and other facility in Japan in 2012.

Facility name			Stored plutonium (Note 1)		Loaded plutonium (Note 2)		(Reference Data) Loaded plutonium (un-irradiated) – Unloaded plutonium (irradiated) (Note 3)	
			Separated Plutonium		Separated Plutonium			
			Total (kgPu)	Plutonium fissile in total (kgPuf)	Total (kgPu)	Plutonium fissile in total (kgPuf)	Total (kgPu)	Plutonium fissile in total (kgPuf)
Japan Atomic Energy Agency	Joyo		134	98	–	–	261	184
	Monju		31	21	–	–	1,533	1,069
The 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	–	–	–	–
The Kansai Electric Power Company	Takahama Unit 3		–	–	–	–	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			160	103	–	–	1,317	880
Research and Development Facilities	Japan Atomic Energy Agency	Fact 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) Stored plutonium at the end of 2012
(Note2) Loaded plutonium during from January 2012 to December 2012
(Note3) Difference between the total loaded plutonium (un-irradiated) by the end of 2012 and the total unloaded plutonium (irradiated) by the end of 2012 regarding to MOX fuel management. It is equivalent to the plutonium, which is un-irradiated, existing in the core at the end of 2012. In commercial reactors, there is a case that the fuels are stored in the S/F pool temporarily for periodic inspection.

Other Reference Data (at the end of 2012)
Irradiated plutonium in spent fuel in the storage facility of reactor: 133,352kgPu
Irradiated plutonium in spent fuel in the storage facility of reprocessing plant: 26,464kgPu
Plutonium which recognized that will be unrecovered in the immediate future, ex. Plutonium in the stored waste: 147kgPu

[Reference 2]

The Balance of Separated Plutonium in Safekeeping in Japan in 2012

Unit: kgPu

<Total> (Note1)	
Total amount of separated plutonium at reprocessing facilities	0
Total amount of plutonium loaded in nuclear reactors	0
Variation in processes at each facility	0
Total amount of plutonium returned	0
Balance	0

[JAEA Reprocessing Plant]

From separation and purification process to storage of raw material at co-conversion process in the reprocessing plant (Note1)				
Inventory as of Jan. 1, 2012 (the end of the year 2011)				752
increase and decrease	Increase by separation of plutonium (the amount for one year in 2012)			0
	Decrease by plutonium shipped out (the amount for one year in 2012)			0
	Variation in processes at reprocessing facility (Note 2)			△ 1
		Breakdown	Transfer to retained waste	△ 0.2
			Retransfer from retained waste	0.0
			Nuclear loss	△ 1.3
			Measured discard	0.0
			Material unaccounted for (MUF)	0.0
Inventory as of the end of Dec. 2012				751

[JAEA Plutonium Fabrication Plant]

From raw material of MOX to fuel assembly products (Note1)				
Inventory as of Jan. 1, 2012 (the end of the year 2011)				3,363
increase and decrease	Increase by plutonium received (the amount for one year in 2012)			0
	Decrease by plutonium shipped out (the amount for one year in 2012)			0
	Variation 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	0.1
			Nuclear loss	△ 0.3
			Material unaccounted for (MUF)	0.9
Inventory as of the end of Dec. 2012				3,364

[Nuclear Reactors and Other Facilities]

"Joyo", "Monju", "Commercial Reactors", and "R&D Facilities" (Note1)		
Inventory as of Jan. 1, 2012 (the end of the year 2011)		1,568
increase and decrease	Increase by plutonium received (the amount for one year in 2012) The amount includes the plutonium returned from oversea reprocessing plants.	0
	Decrease by plutonium loading (the amount for one year in 2012)	0
	Decrease by plutonium shipped out (the amount for one year in 2012)	0
Inventory as of the end of Dec. 2012		1,568

[JNFL Reprocessing Plant]

From separation and purification process to storage of raw material at mixed conversion process in the reprocessing plant (Note1)				
Inventory as of Jan. 1, 2012 (the end of the year 2011)				3,612
increase and decrease	Increase by separation of plutonium (the amount for one year in 2012)			0
	Decrease by plutonium shipped out (the amount for one year in 2012)			0
	Variation in processes at reprocessing facility (Note 2)			1
		Breakdown	Transfer to retained waste	△ 0.5
			Retransfer from retained waste	0.0
			Nuclear loss	△ 0.9
			Measured discard	△ 0.8
			Material unaccounted for (MUF)	2.7
Inventory as of the end of Dec. 2012				3,612

(Note 1) The total value may differ due to rounding off. "△" indicates decrease.

(Note 2) The breakdown of variation 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 variation 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 unrecoverable state for the time being but which is stored, for example such 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 is re-classified as the booked inventory in order to be processed for volume reduction, etc.
- ○ Nuclear loss:
  Amount of the loss (decrease) of nuclear fuel materials due to its transformation into other elements 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.

[Reference 3]

- The Situation of Management of Separated Plutonium in Japan (2012) -

Unit: kgPu

[Separated plutonium in safekeeping abroad]

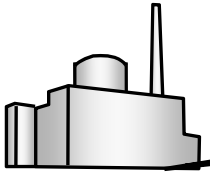
Total in foreign countries	34,946

[Safekeeping amount]

New fuel and for R&D	1,568

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

[Total loaded amount] Amount of plutonium loaded into reactors	0

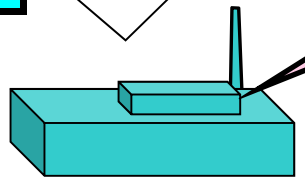


Nuclear Reactors and Other Facilities

Spent Fuels

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

[Total separated amount] Amount of reprocessed spent fuel	0
[Recovered amount] Converted amount from plutonium nitrate to plutonium oxide	0
Variation in processes	△1



Reprocessing Facilities

[Safekeeping amount]

Plutonium nitrate, etc.	951
Plutonium oxide	3,412
Total	4,363

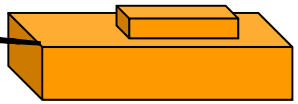
Total shipped out amount	0

Total in Japan	9,295

Total shipped out amount	0

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

[Used amount] Amount of Plutonium in fuel fabrication processes	0
Variation in processes	1



Fuel Fabrication Facilities

[Safekeeping amount]

Plutonium oxide	1,939
Plutonium in the stage of test or fabrication	978
New fuel, etc.	446
Total	3,364

(Note 1) "Safekeeping amount" shows the figure as of the end of the year 2012.
(Note 2) "Transferred amount in a facility and variation in processes at facility" shows the figure for one year in 2012.
(Note 3) "△" indicates decrease.

[Reference 4]

The Amount of Plutonium Held in Japan to be Reported to the IAEA According to the Guidelines for the Management of Plutonium
(as of the end of the year 2012. Previous year's figures in brackets)

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

1. Unirradiated separated plutonium in product stores at reprocessing plants.	4.4	(4.4)
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.	2.9	(2.9)
3. Plutonium contained in unirradiated MOX fuel or other fabricated products at reactor sites or elsewhere.	1.6	(1.6)
4. Unirradiated separated plutonium held elsewhere.	0.4	(0.4)
[Sum of lines 1-4 above] [*2]	[9.3	(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.	34.9 [*3]	(35.0 [*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: tPu)

1. Plutonium contained in spent fuel at civil reactor sites.	133	(133)
2. Plutonium contained in spent fuel at reprocessing plants.	26	(26)
3. Plutonium contained in spent fuel held elsewhere.	<0.5	(<0.5)
[Sum of lines 1-3 above] [*5]	[159	(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 according to the guidelines.
*3: Loss of Pu-241 due to radioactive decay is taken into account in evaluating the amount of fissile plutonium in safekeeping at the overseas reprocessing plants.
*4: Rounded to 1,000 kg plutonium.

The Amount of Plutonium (note 1) Held in Each Country at the End of the Year 2011 Published through the IAEA in Accordance with the Guidelines for the Management of Plutonium

（Unit：tPu）

	Unirradiated plutonium *1	Plutonium contained in spent fuel *2
U.S	49.3	576
Russia	49.5	131
U.K.	118.2	32
France	80.3	253
China *3	(13.8kg)	(Checked off)
Japan	9.3	159
German	2.1	102
Belgium	0.5	35
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 unirradiated plutonium.

A short history of the guidelines for the management of plutonium

In Feb.1994, the nine countries, these are, U.S., Russia, the U.K., France, China, Japan, Germany, Belgium and Switzerland started to deliberate about the establishment of the international framework aiming to enhance the transparency of plutonium utilization.

In Dec.1997, these nine countries decided to adopt the guidelines for the management of plutonium that prescribes the basic principles about plutonium utilization, the publication of the amount of plutonium held in each country and so on.

In Mar.1998, the IAEA published the amount of plutonium held in each country and its policy statement about plutonium utilization reported to the IAEA according to the guideline.