The Current Situation of Plutonium Management in Japan

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Cabinet Office
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1. Preface

This is a report on the current condition of separated plutonium in Japan. As it is essential in implementing research, development and utilization of nuclear energy to assure nuclear non-proliferation, Japanese government has not only 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) but also made effort to assure its transparency to the public at home and abroad. To annually publish a report on the condition of separated plutonium in Japan is a part of activities in this regard that started in 1994.

2. The Current Condition of Separated Plutonium in Japan

The condition of separated plutonium in Japan as of the end of the year 2008 is given on the separate sheet attached. The amounts of plutonium are expressed by its 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 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, Fugen 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 2008), "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 balance of the separated plutonium stored in Japan, reference 2 that depicts the flow of plutonium in the year 2008, reference 3 that gives the amount of plutonium held in Japan as of the end of the year 2008 to be reported to the IAEA according to the guidelines for the management of plutonium, and reference 4 that gives the sum of the amount of plutonium held in each country as of the end of the year 2007 published through the IAEA in accordance with the guideline.

[References]

Reference 1	The balance of separated plutonium in safekeeping in Japan in 2008.
Reference 2	The situation of management of separated plutonium in Japan (2008).
Reference 3	The amount of plutonium held in Japan to be reported to the IAEA according to the guidelines for the management of plutonium.
Reference 4	The amount of plutonium (note1) held in each country at the end of the year 2007 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 2008

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	Plutonium nitrate, etc. (After dissolution to the process before stored as mixed oxide in containers)	674 (675)	276 (865)	950 (1,540)
		Plutonium oxide (stored as mixed oxide in containers)	106 (120)	3,329 (1,747)	3,435 (1,867)
	Total		780 (795)	3,604 (2,612)	4,384 (3,407)
		Plutonium fissile in total	520 (531)	2,344 (1,721)	2,864 (2,251)

	Facility Name		JAEA Plutonium Fabrication Plant
Fuel fabrication Facilities	Breakdown	Plutonium oxide (stored plutonium in plutonium oxide containers)	2,495 (2,764)
		Plutonium in the stage of test or fabrication	1,047 (895)
		New fuel, etc. (stored as finished fuel assemblies, etc.)	78 (303)
	Total		3,620 (3,962)
		Plutonium fissile in total	2,515 (2,761)

	Name of Nuclear Reactor, etc.		Joyo	Monju	Fugen	Commercial Reactors	R&D Facilities (Note 1)
Reactors and Other Facilities	Unirradiated new fuel stored at nuclear reactor sites, etc.		134 (126)	699 (367)	0 (0)	415 (415)	444 (444)
	Total		1,692 (1,352)				
		Plutonium fissile in total	1,247 (1,007)				

Total		9,696 (8,721)
	Plutonium fissile in total	6,625 (6,019)

(2) Separated plutonium (Plutonium fissile) in safekeeping abroad (Note 2)

<Unit: kgPuf>

Recovered in the UK	11,380 (11,332)
Recovered in France	13,832 (13,886)
Total	25,212 (25,218)

2. Separated plutonium in use from Jan. to Dec. in 2008

Figures in brackets are data published last year

(1) The amount of plutonium-oxide recovered (Note 3) <Unit: kgPu>

	JAEA Reprocessing Plant	JNFL Reprocessing Plant	Total
Amount of plutonium-oxide recovered (Note 3)	0 (77)	1,582 (1,650)	1,583 (1,727)

(2) The amount of plutonium in fuel fabrication processes (Note 4) <Unit: kgPu>

	for Monju, Joyo, Fugen, etc.
Amount of plutonium in fuel fabrication processes (Note 4)	284 (51)

(3) The amount of plutonium loaded in nuclear reactors (Note 5) <Unit: kgPu>

	Nuclear Reactors
Amount of plutonium loaded in nuclear reactors (Note 5)	0 (23)

(Note 1) “R&D Facilities” means critical assemblies, etc.

(Note 2) Amount of fissile plutonium. Nuclear losses (refer to (Note 3) of Reference 1) 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 3) “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 4) “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 5) “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.

(Note6) 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 Balance of Separated Plutonium in Safekeeping in Japan in 2008

Unit: kgPu

<Total> [*1, 2]	
Total amount of separation of plutonium at reprocessing facilities	997
Total amount of plutonium loaded in nuclear reactors	0
Variation in processes at each facility	△20
Balance	977

[JAEA Reprocessing Plant]

From separation and purification process to storage of raw materials at co-conversion process at the reprocessing facility

Items			Increase and decrease (Note1), (Note2)
Inventory as of Jan. 1, 2008 (the end of the year 2007)			795
Total amount of separation of plutonium (the amount for one year in 2008)			0
Total amount of plutonium shipped out (the amount for one year in 2008)			△ 15
Variation in processes at reprocessing facilities (Note 3)			0
	Breakdown	Transfer to retained waste	△0.6
		Retransfer from retained waste	0.1
		Nuclear loss	△1.5
		Measured discard	0.0
		Material unaccounted for (MUF)	1.8
Inventory as of the end of Dec. 2008			780

15

[JAEA Plutonium Fabrication Plant]

From raw material of MOX to fuel assembly products

Items			Increase and decrease (Note1), (Note2)
Inventory as of Jan. 1, 2008 (the end of 2007)			3,962
Total amount of plutonium received (the amount for one year in 2008)			15
Total amount of plutonium shipped out (the amount for one year in 2008)			△340
Variation in processes at fuel fabrication facilities (Note 3)			△ 17
	Breakdown	Shipper/receiver difference	0.0
		Transfer to retained waste	0.0
		Retransfer from retained waste	0.1
		Nuclear loss (Note4)	△16.7
		Material unaccounted for (MUF)	0.1
Inventory as of the end of Dec. 2008			3,620

340

[Nuclear Reactors and Other Facilities]

"Joyo", "Fugen", "Monju", "Commercial Reactors", and "R&D Facilities"

Items	Increase and decrease (Note1), (Note2)
Inventory as of Jan. 1, 2008 (the end of the year 2007)	1,352
Total amount of plutonium received (the amount for one year in 2008)	340
Total amount of plutonium loaded in nuclear reactors (the amount for one year in 2008)	0
Inventory as of the end of Dec. 2008	1,692

[JNFL Reprocessing Plant]

From separation and purification process to storage of raw materials at mixed conversion process in the reprocessing facilities

Items			Increase and decrease (Note1), (Note2)
Inventory as of Jan. 1st. 2008 (the end of the year 2007) (Note5)			2,610
Total amount of separation of plutonium (the amount for one year in 2008)			997
Total amount of plutonium shipped out (the amount for one year in 2008)			0
Variation in processes at reprocessing facility (Note 3)			△ 3
	Breakdown	Transfer to retained waste	△0.1
		Retransfer from retained waste	0.0
		Nuclear loss	△2.1
		Measured discard	△0.2
		Material unaccounted for (MUF)	△0.5
Inventory as of the end of Dec. 2008			3,604

(Note 1) The total value may differ due to rounding off.

(Note 2) "△" indicates decrease.

(Note 3) 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 inventory under the safeguards, which is deemed to be unrecoverable 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 inventory under the safeguards 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.

(Note 4) Large amount of Nuclear Loss of the JAEA Plutonium Fablication Plant in 2008 comparing to 2007 was reported, because nuclear material used in 2008 was older and larger than that in 2007. Following are the detailed reasons for this.

In light of the Facility Attachment (FA) agreed with IAEA, which is the document of instruction for the nuclear material accountancy procedure in the facility, the Accounting Provisions of the facility was approved by the government of Japan. It is stipulated that Nuclear Loss should be determined based on analyses for nuclear material to be entered into fabrication process areas from storage areas for term between days of analyses before storage and use.

In case of the Nuclear Loss in 2008, fuel fabrication tests were conducted in the facility using nuclear material containing about 364 kg of plutonium analyzed about 13 years ago, and 16.7 kg of the Nuclear Loss of the nuclear material was determined before the tests as cumulative loss for about 13 years storage (as the Attached Sheet said, net consumption of plutonium to be fabricated in 2008 was 284 kg). Concerning the Nuclear Loss mentioned above, Inventory Change Reports (ICRs), which are documents to record details of receipts, shipments and other transactions of use of nuclear material in nuclear facilities, were reported to the IAEA through the government of Japan.

On the other hand, in 2007, 1.5 kg of the Nuclear Loss was determined for nuclear material, used in tests, containing about 129 kg of plutonium, which was analyzed about 3 years before the tests.

Consequently, about tripled amount and 10 years older nuclear material used in 2008 caused over 10 times larger Nuclear Loss than that in 2007 (as the Attached Sheet said, net consumption of plutonium to be fabricated in 2007 was 51 kg).

In addition, Nuclear Loss of plutonium is generally caused as a result of natural decay of Plutonium-241 (Pu-241), whose half-life is 14 years and relatively shorter than other plutonium isotopes, which is transformed to Americium-241 (Am-241). Nuclear Loss of Pu-241 doesn’t mean that nuclear material loses weight, because Pu-241 is replaced by almost equal weight of Am-241 in its decay.

(Note 5) After the publication of “The Current Situation of Plutonium Management in Japan” on September 9, 2008, amendments to ICRs of the Reprocessing Plant were reported by the JNFL to the IAEA through the government of Japan. 2,612 kg of plutonium inventory of the plant as of Jan. 1st. 2008 (the end of the year 2007) provided in the last report, was revised to 2,610kg in this report based on the amendments.

- The Situation of Management of Separated Plutonium in Japan (2008) -

[Reference 2]

[Separated plutonium in safekeeping abroad]

Total in foreign countries	25,212

(Plutonium fissile)

[Safekeeping amount]

New fuel and for R&D	1,692

(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	997
[Recovered amount] Converted amount from plutonium nitrate to plutonium oxide	1,583
Variation in processes	△ 3

Reprocessing Facilities

Total shipped out amount	340

Total in Japan 9,696

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

[Used amount] Amount of Plutonium in fuel fabrication processes	284
Variation in processes	△ 17

Fuel Fabrication Facilities

Total shipped out amount	15

[Safekeeping amount]

Plutonium nitrate, etc.	950
Plutonium oxide	3,435
Total	4,384

[Safekeeping amount]

Plutonium oxide	2,495
Plutonium in the stage of test or fabrication	1,047
New fuel, etc.	78
Total	3,620

(Note 1) The unit is kgPu for figures in Japan, and kgPuf for figures in foreign countries.
(Note 2) "Safekeeping amount" shows the figure as of the end of the year 2008.
(Note 3) "Transferred amount in a facility and variation in processes at facility" shows the figure for one year in 2008.
(Note 4) "△" indicates decrease.

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 2008. Previous year's figures in brackets)

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

1. Unirradiated separated plutonium in product stores at reprocessing plants.	4,400 (3,400)
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.	3,500 (3,700)
3. Plutonium contained in unirradiated MOX fuel or other fabricated products at reactor sites or elsewhere.	1,300 (1,200)
4. Unirradiated separated plutonium held elsewhere.	400 (400)
[Sum of lines 1-4 above][*2]	[9,700 (8,700)]
(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.	25,200[*3] (25,200[*3])
(iii) Plutonium 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 (Unit: kgPu[*4])

1. Plutonium contained in spent fuel at civil reactor sites.	115,000 (112,000)
2. Plutonium contained in spent fuel at reprocessing plants.	21,000 (19,000)
3. Plutonium contained in spent fuel held elsewhere.	<500 (<500)
[Sum of lines 1-3 above][*5]	[137,000 (131,000)]
(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 place. Amount of plutonium in foreign countries is given by the weight of fissile plutonium.(refer to*3)

*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: Amount of fissile plutonium. 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 1000 kg plutonium place.

The Amount of Plutonium (note 1) Held in Each Country at the End of the Year 2007 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	53.9	492
Russia	44.9	111
U.K.	108.0	35
France	82.2	219
China	0.0	(Checked off) *3
Japan	8.7	131
German	5.5	85
Belgium	1.4	31
Switzerland	0.0	14

（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 1000 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.

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 guidelines.